Environmentally friendly treatment of highly potent pharmaceuticals in hospital wastewater - Mermiss


Den traditionelle metode til rensning af spildevand er baseret på aktivt slam. Metoden er effektiv overfor letnedbrydelige lægemidler, men ineffektiv overfor middelsvære og svært nedbrydelige lægemidler.

Teknologien med biofilm er testet i laboratorieskala og i pilot-skala på dels råspildevand med koncentreret indhold af lægemidler fra en kræftafdeling, dels blandet råspildevand fra et hospital, dels almindeligt råspildevand fra Herning Vand, og dels på udløbsvand fra Viby renseanlæg. Over 95% af den samlede belastning med lægemidler i miljøet kommer i dag fra almindeligt husspildevand, både fra håndkøbsmedicin og fra patienter i ambulant behandling.

Projektet gennemførte således en benchmarking af lægemiddelfjernelse på forskellige typer af spildevand, og kunne på den baggrund demonstre, at en biofilm-baseret teknologi er langt mere effektiv end den konventionelle aktiv slam behandling, som bruges i dag. Bl.a. viser projektet, at teknologien med fordel kan anvendes til at efterpolere allerede renset spildevand, og at driftsomkostningerne til teknologien er relativt lave.

Resultaterne af projektet er så lovende, at de allerede er anvendt til at starte et nyt MUDP-projekt, MerEff, der tester teknologien til at efterpolere renset spildevand i større skala på Herning Vands renseanlæg.
Applicability of disulfide-polymer particles surface embedded on alginate beads for cadmium removal from airport derived stormwater

Stormwater runoff derived from airports causes severe cadmium contamination in excess of the maximum limit level and is difficult to treat due to the irregular contamination levels from scattered rainfall. To overcome this and remove cadmium from runoff, a new reactive filtration column is introduced. Sulfur functionalized polymer particles were successfully embedded onto the surface of alginate bead (DiS-algi) and simulated a real stormwater treatment filtration column. The DiS-algi shows 22.3mg/g of batch and 877μg/g of continuous flow sorption capacity. Also, the results for the new sorption material show that within 6 mins half of the cadmium was removed with 31L/mg of Langmuir sorption affinity, outperforming an activated carbon filter. From a breakthrough test the reactive column shows complete uptake of cadmium from a contaminated flow, lasting two hours until reaching the breakthrough point. Furthermore, regeneration tests of the column verified its reusability. DiS-algi appears to be a viable new cadmium sorption material for airport derived stormwater runoff filtration systems.

Application of forward osmosis technology in crude glycerol fermentation biorefinery-potential and challenges

Forward osmosis (FO) is a low energy-intensive process since the driving force for water transport is the osmotic pressure difference, Δτr, between the feed and draw solutions, separated by the FO membrane, where τdraw > τfeed. The potential of FO in wastewater treatment and desalination have been extensively studied; however, regeneration of the draw solution...
(thereby generating clean water) requires application of an energy-intensive process step like reverse osmosis (RO). In this study, the potential of applying FO for direct water recirculation from diluted fermentation effluent to concentrated feedstock, without the need for an energy-intensive regeneration step (e.g. RO), has been investigated. Butanol production during crude glycerol fermentation by Clostridium pasteurianum, has been selected as a model process and the effect of cross-flow velocity and the dilution of draw solution on the water flux during short-term experiments (200 min), were investigated. Statistical analysis revealed that the dilution of the draw solution is the most influential factor for the water flux. Subsequent modelling of an integrated FO-fermentation process, showed that water recoveries could lead to substantial financial benefits, although the integrated FO-fermentation process demonstrated lower water flux than expected. FTIR analyses of the membrane surface implied that the decrease in water flux was due to the presence of proteins, polysaccharides and other extracellular polymeric substances on the membrane active layer, indicating the presence of a fouling layer. Based on these findings, possible fouling alleviation strategies and future research directions are discussed and proposed.

**General information**

State: Accepted/In press  
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, PILOT PLANT, Department of Environmental Engineering, Water Technologies, Aquaporin A/S  
Authors: Kalafatakis, S. (Intern), Braekevelt, S. (Ekstern), Lymperatou, A. (Intern), Zarebska, A. (Intern), Hélix-Nielsen, C. (Intern), Lange, L. (Intern), Skiadas, I. V. (Intern), Gavala, H. N. (Intern)

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BFI (2014): BFI-level 1  
Scopus rating (2014): SJR 0.699 SNIP 0.964 CiteScore 1.95  
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BFI (2012): BFI-level 1  
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Scopus rating (2010): SJR 0.823 SNIP 1.015  
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BFI (2009): BFI-level 1  
Scopus rating (2009): SJR 0.673 SNIP 0.926  
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Scopus rating (2008): SJR 0.588 SNIP 0.881  
Scopus rating (2007): SJR 0.622 SNIP 0.815  
Scopus rating (2006): SJR 0.546 SNIP 0.958
Application of the NDHA model to describe N₂O dynamics in activated sludge mixed culture biomass

A pseudo-mechanistic model describing three biological nitric oxide (NO) and nitrous oxide (N₂O) production pathways was calibrated for an activated sludge mixed culture biomass treating municipal wastewater with laboratory-scale experiments. The model (NDHA) comprehensively describes N₂O producing pathways by both autotrophic ammonium oxidizing and heterotrophic bacteria. Extant respirometric assays and anaerobic batch experiments were designed to calibrate the endogenous, heterotrophic denitrification and autotrophic ammonium/nitrite oxidation processes together with the associated net N₂O production. Ten parameters describing heterotrophic processes and seven for autotrophic processes were estimated accurately (variance/mean < 25%). The model predicted the N₂O and NO dynamics at varying dissolved oxygen, ammonium and nitrite levels and was validated with a different set of batch experiments with the same biomass. Aerobic ammonium oxidation experiments at two oxygen levels used for model evaluation (2 and 0.5 mg/L) indicated that the nitrifier denitrification (42, 64%) and heterotrophic denitrification (7, 17%) pathways increased and dominated the total N₂O production at high nitrite and low oxygen concentrations; while the nitrifier nitrification pathway showed the largest contribution at high dissolved oxygen levels (51, 19%). The uncertainty of the biological parameter estimates was propagated to N₂O model outputs via Monte Carlo simulations as 95% confidence intervals. The accuracy of the estimated parameters corresponded to a low uncertainty of the N₂O emission factors (4.6 ± 0.6% and 1.2 ± 0.1%).

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Organisations: Department of Environmental Engineering, Water Technologies
Authors: Domingo-Felez, C. (Intern), Smets, B. F. (Intern)
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Modelling, ASM, Nitrous oxide, Uncertainty, Activated sludge

Bio-Electro-Fenton process for the degradation of Non-Steroidal Anti-Inflammatory Drugs in wastewater

Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) are ubiquitous municipal wastewater pollutants of which several are resistant to degradation in conventional wastewater treatment, and represent a major environmental health concern worldwide. An alternative treatment, the bio-electro-Fenton process, has received increasing attention in past years. In this process the strong oxidant •HO is formed using the electrons derived from bacterial oxidation of organic substrate. In this work, a laboratory scale microbial electrolysis cell based bio-electro-Fenton process was developed for the treatment of four different NSAIDs. The system was demonstrated to remove low concentration NSAIDs from water and wastewater and all tested parameters (cathode pH, cathode air-flow, cathode Fe²⁺ concentration, applied voltage, NSAIDs concentration and reaction time) were found to affect the apparent first order rate constant and removal efficiency for NSAIDs. Optimum parameter values were found to be pH = 2, Fe⁺² = 7.5 mM, air-flow = 8 mL min⁻¹, applied voltage = 0.3 V; the apparent rate constant was higher for higher NSAIDs initial concentration. For reaction times of 5 hours removal efficiencies were 59%-61% for Ketoprofen, 87%-97% for Diclofenac, 80%-86% for Ibuprofen and 75%-81% for Naproxen. Prolonged reaction times lead to substantial increase in removal efficiencies for Ketoprofen and Naproxen. Finally results obtained with real wastewater show lower removal rate constants than with distilled water matrices suggesting interference from wastewater components in the NSAIDs oxidation process. The results offer insight into future developments of an efficient platform for wastewater treatment technology targeting micropollutants.
General information
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Organisations: Department of Environmental Engineering, Residual Resource Engineering, Water Technologies, University of Aveiro
Authors: Nadas, H. (Ekstern), Li, X. (Intern), Alves, N. (Ekstern), Couras, C. (Ekstern), Andersen, H. R. (Intern), Angelidaki, I. (Intern), Zhang, Y. (Intern)
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BFI (2014): BFI-level 2
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Scopus rating (2011): CiteScore 3.96
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Web of Science (2011): Indexed yes
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Bioethanol from corn stover – a review and technical assessment of alternative biotechnologies

Reviewing the literature from the last decade regarding the bioconversion of corn stover into ethanol, 474 references were identified containing 561 datasets. We found 144 datasets which were sufficiently consistent and detailed to address the current state of the art of corn stover conversion to bioethanol, and we were able to categorise 93% of these datasets into eight different technological configurations for the production of bioethanol, based on the pretreatment approaches used. After pretreating, the corn stover is subject to hydrolysis and fermentation, but these two process steps were largely identical in all datasets, albeit a range of operating conditions was reported. The final distillation of the ethanol was very rarely included in the datasets. By parameterising the bioethanol production by 26 parameters, including corn stover compositions, solid loadings, operational conditions, conversion efficiencies and material consumption, we were able to quantify the material flows for each technological configuration and estimate the uncertainty of the flows. The eight technological configurations produced 11–22% ethanol from the dry solid content of the corn stover. Technologies using alkaline-, solvent or ammonia-based pretreatments produced the largest amount of ethanol (19–22%), while fungi-based pretreatment produced much less (11%). All technological configurations resulted in large flows of solid as well as liquid residues, typically containing 60 to 70% of the dry solid corn stover content. Based on the selected datasets, statistical description is provided for all parameters, including mode, median, average and deviation, within each technological configuration. Bivariate correlation analysis across and within all technological configurations indicates that some operational parameters usually considered crucial in laboratory studies, e.g. pretreatment severity, show from a statistical perspective very little correlation with the yields. The review reveals that a great deal of research has addressed the challenge of converting corn stover into bioethanol, but a significant part of these studies is of limited value in terms of scope and documentation when addressing overall material flows and key parameters in a technological context.

General information

State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering, Water Technologies, Beijing Normal University
Authors: Zhao, Y. (Ekstern), Damgaard, A. (Intern), Christensen, T. H. (Intern)
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  BFI (2017): BFI-level 2
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  Web of Science (2017): Indexed Yes
  BFI (2016): BFI-level 2
  Scopus rating (2016): CiteScore 19.82 SJR 5.443 SNIP 9.119
  BFI (2015): BFI-level 2
  Scopus rating (2015): SJR 8.077 SNIP 10.2 CiteScore 21.6
  BFI (2014): BFI-level 2
  Scopus rating (2014): SJR 7.426 SNIP 11.879 CiteScore 21.55
  BFI (2013): BFI-level 2
  Scopus rating (2013): SJR 8.259 SNIP 12.951 CiteScore 22.43
  ISI indexed (2013): ISI indexed yes
  BFI (2012): BFI-level 2
  Scopus rating (2012): SJR 5.859 SNIP 12.194 CiteScore 17.82
  ISI indexed (2012): ISI indexed yes
  Web of Science (2012): Indexed yes
  BFI (2011): BFI-level 2
  Scopus rating (2011): SJR 7.61 SNIP 11.61 CiteScore 18.43
  ISI indexed (2011): ISI indexed yes
  Web of Science (2011): Indexed yes
  BFI (2010): BFI-level 2
  Scopus rating (2010): SJR 5.154 SNIP 9.996
  Web of Science (2010): Indexed yes
Characterization of Irreversible Fouling after Ultrafiltration of Thermomechanical Pulp Mill Process Water

Large volumes of wastewater with dissolved wood components are treated in wastewater treatment plants at thermomechanical pulp mills. It has been shown previously that hemicelluloses in these wastewater streams can be recovered by membrane filtration. A serious obstacle when treating lignocellulose process streams is fouling of the membranes. Fouling not only increases operating costs but also reduces the operating time of the membrane plant. When optimizing the membrane cleaning method, it is important to know which compounds cause the fouling. In this work fouling of an ultrafiltration membrane was studied. The fouling propensity of untreated process water and microfiltrated process water was compared. Fouled membranes were analyzed using scanning electron microscopy and attenuated total reflection Fourier transform infrared spectrometry. Acid hydrolysis of membranes exposed to untreated process water and microfiltrated process water revealed that 508 mg/m² and 37 mg/m² of polysaccharides, respectively, remained on the membranes even after alkaline cleaning.
Comammox Nitrospira are abundant ammonia oxidizers in diverse groundwater-fed rapid sand filter communities
The recent discovery of completely nitrifying Nitrospira demands a re-examination of nitrifying environments to evaluate their contribution to nitrogen cycling. To approach this challenge, tools are needed to detect and quantify comammox Nitrospira. We present primers for the simultaneous quantification and diversity assessment of both comammox Nitrospira clades. The primers cover a wide range of comammox diversity, spanning all available high quality sequences. We applied these primers to 12 groundwater-fed rapid sand filters, and found comammox Nitrospira to be abundant in all filters. Clade B comammox comprise the majority (~75%) of comammox abundance in all filters. Nitrosomonadaceae were present in all filters, although at low abundance (mean=1.8%). Ordination suggests that temperature impacts the structure of nitrifying communities, and in particular that increasing temperature favours Nitrospira. The nitrogen content of the filter material, sulfate concentration and surface ammonium loading rates shape the structure of the comammox guild in the filters. This work provides an assay for simultaneous detection and diversity assessment of clades A and B comammox Nitrospira, expands our current knowledge of comammox Nitrospira diversity and demonstrates a key role for comammox Nitrospira in nitrification in groundwater-fed biofilters.
Comparative genomics sheds light on niche differentiation and the evolutionary history of comammox Nitrospira

The description of comammox Nitrospira spp., performing complete ammonia-to-nitrate oxidation, and their co-occurrence with canonical β-proteobacterial ammonia oxidizing bacteria (β-AOB) in the environment, calls into question the metabolic potential of comammox Nitrospira and the evolutionary history of their ammonia oxidation pathway. We report four new comammox Nitrospira genomes, constituting two novel species, and the first comparative genomic analysis on comammox Nitrospira. Unlike canonical Nitrospira, comammox Nitrospira genomes lack genes for assimilatory nitrite reduction, suggesting that they have lost the potential to use external nitrite nitrogen sources. By contrast, compared to canonical Nitrospira, comammox Nitrospira harbor a higher diversity of urea transporters and copper homeostasis genes and lack cyanate hydratase genes. Additionally, the two comammox clades differ in their ammonium uptake systems. Contrary to β-AOB, comammox Nitrospira genomes have single copies of the two central ammonia oxidation pathway operons. Similar to ammonia oxidizing archaea and some oligotrophic AOB strains, they lack genes involved in nitric oxide reduction. Furthermore, comammox Nitrospira genomes encode genes that might allow efficient growth at low oxygen concentrations. Regarding the evolutionary history of comammox Nitrospira, our analyses indicate that several genes belonging to the ammonia oxidation pathway could have been laterally transferred from β-AOB to comammox Nitrospira. We postulate that the absence of comammox genes in other sublineage II Nitrospira genomes is the result of subsequent loss.

General information
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Organisations: Department of Environmental Engineering, Water Technologies, Department of Bio and Health Informatics, Disease Intelligence and Molecular Evolution
Authors: Palomo, A. (Intern), Pedersen, A. G. (Intern), Fowler, J. (Intern), Dechesne, A. (Intern), Sicheritz-Pontén, T. (Intern), Smets, B. F. (Intern)
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Concentrating molasses distillery wastewater using biomimetic forward osmosis (FO) membranes

Treatment of sugarcane molasses distillery wastewater is challenging due to the presence of complex phenolic compounds (melanoids and polyphenols) having antioxidant properties. Due to zero liquid discharge regulations, Indian distilleries continue to explore effective treatment options. This work examines the concentration of distillery wastewater by forward osmosis (FO) using aquaporin biomimetic membranes and magnesium chloride hexahydrate (MgCl₂·6H₂O) as draw solution. The operational parameters viz. feed solution and draw solution flow rate and draw solution concentration were optimized using 10% v/v melanoids model feed solution. This was followed by trials with distillery wastewater. Under the conditions of this work, feed and draw flow rates of 1 L/min and draw solution concentration of 2M MgCl₂·6H₂O for melanoids model solution and 3M MgCl₂·6H₂O for distillery wastewater were optimal for maximum rejection. Rejection of 90% melanoids, 96% antioxidant activity and 84% COD was obtained with melanoids model feed, with a corresponding water flux of 6.3 L/m²h. With as-received distillery wastewater, the rejection was similar (85–90%) to the melanoids solution, but the water flux was lower (2.8 L/m²h). Water recovery from distillery wastewater over 24 h study period was higher with FO (70%) than reported for RO (35–45%). Repeated use of the FO membrane over five consecutive 24 h cycles with fresh feed and draw solutions and periodic cleaning showed consistent average water flux and rejection of the feed constituents.

General information
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Organisations: Department of Environmental Engineering, Water Technologies, TERI University, University of Maribor
Authors: Singh, N. (Ekstern), Petrinic, I. (Ekstern), Hélix-Nielsen, C. (Intern), Basu, S. (Ekstern), Balakrishnan, M. (Ekstern)
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ISI indexed (2012): ISI indexed yes
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Web of Science (2011): Indexed yes
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Scopus rating (2010): SJR 2.592 SNIP 2.192
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.319 SNIP 2.224
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.073 SNIP 2.178
Web of Science (2008): Indexed yes
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Scopus rating (2006): SJR 1.902 SNIP 2.233
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.113 SNIP 2.334
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Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.702 SNIP 1.908
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.568 SNIP 1.757
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.319 SNIP 1.69
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Scopus rating (2000): SJR 1.399 SNIP 1.662
Web of Science (2000): Indexed yes
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Decolourisations and biodegradations of model azo dye solutions using a sequence batch reactor, followed by ultrafiltration

The main objective of this study was to investigate the efficiency of biological treatment of azo dye-containing wastewater with a sequencing batch reactor system, followed by ultrafiltration. The performance of the system was quantified by measuring the chemical oxygen demand and azo dye concentration. The biodegradation was carried out under combined alternating anaerobic and aerobic conditions with Nylosan Yellow E2RL SGR as a model azo dye contaminant. The bioprocess revealed a maximal reduction in chemical oxygen demand and dye removal efficiency of 91 and 85%, respectively. After ultrafiltration of effluent from the biological treatment, the efficiency increased to 94% for chemical oxygen demand and to 97% for the azo dye decolourisation. Samples of activated sludge from the bioprocess were collected for microbial characterisation. Bacteria and fungi were isolated and identified by 16S rRNA gene and ITS1-5.8S rDNA-ITS2 sequence analysis, respectively. Serratia marcescens and Klebsiella oxytoca were the most common bacteria with the highest number present during the aerobic and anaerobic phases of the bioprocess. In addition, a high number of Elizabethkingia miricola, Morganella morganii, Comamonas testosteroni, Trichosporon sp. and Galactomyces sp. were detected. Taken together, our results demonstrated that the sequencing batch reactor system combined with ultrafiltration is an efficient technique for treatment of wastewater containing azo dye. Moreover, the ultrafiltration effectively removes the microbiota from the final effluent resulting in stable product water.

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Authors: Korenak, J. (Ekstern), Ploder, J. (Ekstern), Trček, J. (Ekstern), Hélix-Nielsen, C. (Intern), Petrinic, I. (Ekstern)
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Scopus rating (2015): SJR 0.568 SNIP 1.035 CiteScore 1.95
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Scopus rating (2011): SJR 1.268 SNIP 1.875 CiteScore 4.13
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.801 SNIP 1.697
Scopus rating (2009): SJR 0.552 SNIP 1.031
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DETERMINATION_OF_REQUIRED_OZONE_DOSAGE_IN_FRESHWATER_PILOT_RECIRCULATING_AND_OZONE_EFFECT_ON_WATER_QUALITY_PARAMETERSLFP_PART_comm.pdf
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Diagnostics, Monitoring and Mitigation of N2O Emissions from Wastewater Treatment Operations – Outcomes of the LAGAS project

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Disulfide polymer grafted porous carbon composites for heavy metal removal from stormwater runoff

The emerging concern of heavy metal pollution derived from stormwater runoff has triggered a demand for effective heavy metal sorbents. To be an effective sorbent, high affinity along with rapid sorption kinetics for environmental relevant concentrations of heavy metals is important. Herein, we have introduced a new composite suitable for trace metal concentration removal, which consists of cheap and common granular activated carbon covered with polymers containing soft bases, thiols, through acyl chlorination (DiS-AC). Material characterization demonstrated that the polymer was successfully grafted and grown onto the surface of the carbon substrate. The distribution coefficient for Cd2+ bonding was 89·103 L/kg at a solution concentration of 0.35 mg/L, which is notably higher than sorption affinities for Cd2+ seen in conventional sorbents. The sorption isotherm is well described by the Freundlich isotherm and within an hour, half of the initial trace (0.2 mg/L) concentration of Cd2+ was removed by the DiS-AC at a sorbent loading of 2 g/L. Therefore, the novel material DiS-AC promises to be an ideal candidate for filters treating stormwater runoff.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Department of Micro- and Nanotechnology, Surface Engineering, Korean Advanced Institute of Science and Technology (KAIST), University of Copenhagen
Does universal 16S rRNA gene amplicon sequencing of environmental communities provide an accurate description of nitrifying guilds?

Universal (i.e., targeting most bacteria/prokaryotes) 16S rRNA gene based amplicon sequencing is widely used for assessing microbial communities due to its low cost, time efficiency, and ability to provide a full overview of the
community. However, it is currently unclear if it can yield reliable information on specific microbial guilds, which can be obtained by using primer sets targeting functional genes or specific 16S rRNA gene sequences. Here, we compared the relative abundance, diversity, richness, and composition of selected guilds (nitrifiers), obtained from universal 16S rRNA gene based amplicon sequencing and from guild targeted approaches. The universal amplicon sequencing provided 1) accurate estimates of nitrifier composition, 2) clustering of the samples based on these compositions consistent with sample origin, 3) estimates of the relative abundance of the guilds correlated with those obtained from the targeted approaches and within ~1.2 orders of magnitude of them, but with measurable bias that should be considered when comparing estimates from both approaches. In contrast, the diversity and richness estimations using the universal 16S rRNA based amplicon sequencing were likely limited by the sequencing depth; therefore, we suggest preferring targeted approaches for assessing nitrifiers diversity and richness or using sequencing depth larger than those currently typically practiced.

**General information**
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Urban Water Systems
Authors: Diwan, V. (Intern), Albrechtsen, H. (Intern), Smets, B. F. (Intern), Dechesne, A. (Intern)
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Scopus rating (2017): SJR 0.696 SNIP 0.781
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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.05 SJR 0.742 SNIP 0.817
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.819 SNIP 0.86 CiteScore 2.04
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.91 SNIP 1.032 CiteScore 2.28
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.924 SNIP 1.015 CiteScore 2.5
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.867 SNIP 0.997 CiteScore 2.32
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.903 SNIP 0.963 CiteScore 2.29
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.954 SNIP 1.05
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.001 SNIP 1.157
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.936 SNIP 1.023
The aim of this paper is to present the first study on spatial and temporal variation in the enantiomeric profile of chiral drugs in eight European cities. Wastewater-based epidemiology (WBE) and enantioselective analysis were combined to evaluate trends in illicit drug use in the context of their consumption vs direct disposal as well as their synthetic production routes. Spatial variations in amphetamine loads were observed with higher use in Northern European cities. Enantioselective analysis showed a general enrichment of amphetamine with the R-(−)-enantiomer in wastewater indicating its abuse. High loads of racemic methamphetamine were detected in Oslo (EF = 0.49 ± 0.02). This is in contrast to other European cities where S-(+)-methamphetamine was the predominant enantiomer. This indicates different methods of methamphetamine synthesis and/or trafficking routes in Oslo, compared with the other cities tested. An enrichment of MDMA with the R-(−)-enantiomer was observed in European wastewaters indicating MDMA consumption rather than disposal of unused drug. MDA’s chiral signature indicated its enrichment with the S-(+)-enantiomer, which confirms its origin from MDMA metabolism in humans. HMMA was also detected at quantifiable concentrations in wastewater and was found to be a suitable biomarker for MDMA consumption. Mephedrone was only detected in wastewater from the United Kingdom with population-normalised loads up to 47.7 mg 1000 people−1 day−1. The enrichment of mephedrone in the R-(+)-enantiomer in wastewater suggests stereoselective metabolism in humans, hence consumption, rather than direct disposal of the drug. The investigation of drug precursors, such as ephedrine, showed that their presence was reasonably ascribed to their medical use.
Estimating the Transfer Range of Plasmids Encoding Antimicrobial Resistance in a Wastewater Treatment Plant Microbial Community

Wastewater treatment plants (WWTPs) have been suggested as reservoirs and sources of antibiotic resistance genes (ARGs) in the environment. In a WWTP ecosystem, human enteric and environmental bacteria are mixed and exposed to pharmaceutical residues, potentially favoring genetic exchange and thus ARG transmission. However, the contribution of microbial communities in WWTPs to ARG dissemination remains poorly understood. Here, we examined for the first time plasmid permissiveness of an activated sludge microbial community by utilizing an established fluorescent bioreporter system. The activated sludge microbial community was challenged in standardized filter matings with one of three multidrug resistance plasmids (pKJK5, pB10, and RP4) harbored by Escherichia coli or Pseudomonas putida. Different donor–plasmid combinations had distinct transfer frequencies, ranging from 3 to 50 conjugation events per 100000 cells of the WWTP microbial community. In addition, transfer was observed to a broad phylogenetic range of 13 bacterial phyla with several taxa containing potentially pathogenic species. Preferential transfer to taxa belonging to the predicted evolutionary host range of the plasmids was not observed. Overall, the ARG dissemination potential uncovered in WWTP communities calls for a thorough risk assessment of ARG transmission across the wastewater system, before identification of possible mitigation strategies.

Evaluation of direct membrane filtration and direct forward osmosis as concepts for compact and energy-positive municipal wastewater treatment

Municipal wastewater treatment commonly involves mechanical, biological and chemical treatment steps to protect humans and the environment from adverse effects. Membrane technology has gained increasing attention as an alternative to conventional wastewater treatment due to increased urbanization. Among the available membrane technologies, microfiltration (MF) and forward osmosis (FO) have been selected for this study due to their specific characteristics, such as compactness and efficient removal of particles. In this study, two treatment concepts were evaluated with regard to their specific electricity, energy and area demands. Both concepts would fulfill the Swedish discharge demands for small- and medium-sized wastewater treatment plants at full scale: (1) direct MF and (2) direct FO with seawater as the draw solution. The framework of this study is based on a combination of data obtained from bench- and pilot-scale experiments applying direct MF and FO, respectively. Additionally, available complementary data from a Swedish full-scale wastewater treatment plant and the literature were used to evaluate the concepts in depth. The results of this study indicate that both concepts are net positive with respect to electricity and energy, as more biogas can be
produced compared to that using conventional wastewater treatment. Furthermore, the specific area demand is significantly reduced. This study demonstrates that municipal wastewater could be treated in a more energy- and area-efficient manner with techniques that are already commercially available and with future membrane technology.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Aalborg University, Lund University, Aquaporin A/S
Authors: Hey, T. (Ekstern), Bajraktari, N. (Intern), Davidsson, Å. (Ekstern), Vogel, J. (Ekstern), Madsen, H. T. (Ekstern), Hélix-Nielsen, C. (Intern), La Cour Jansen, J. (Ekstern), Jønsson, K. (Ekstern)
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Scopus rating (2017): SNIP 0.675 SJR 0.503
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.6 SJR 0.569 SNIP 0.802
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.656 SNIP 0.786 CiteScore 1.63
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.646 SNIP 0.789 CiteScore 1.39
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.504 SNIP 0.68 CiteScore 1.3
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.663 SNIP 0.879 CiteScore 1.47
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.595 SNIP 0.682 CiteScore 1.35
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.496 SNIP 0.468
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.394 SNIP 0.414
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.424 SNIP 0.578
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.402 SNIP 0.586
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.477 SNIP 0.544
Evaluation of moving-bed biofilm sequencing batch reactor (MBSBR) in operating A\(^2\)O process with emphasis on biological removal of nutrients existing in wastewater

In this study, the performance of moving-bed biofilm sequencing batch reactor in operating the anaerobic/anoxic/oxic (A\(^2\)O) process for treatment of wastewaters containing nitrogen and phosphorous was evaluated. For this purpose, a pilot system with two bench-scale sequencing batch reactors with a total volume of 30 L and functional volume of 10 L was used. The installation was elaborated using plexiglass, in which 60% of the functional volume consisted of PVC suspended carriers (Kaldnes K3) with a specific surface area of 560 m\(^2\)/m\(^3\). The independent variables used in this study were hydraulic retention time (HRT) (1.5, 2, 2.5, 3, and 3.5 h) and the initial organic load (300, 500, 800, 1000 mg O\(_2\)/L). The results showed impressive performance in the case of an initial organic load of 300 mg O\(_2\)/L and HRT of 3 h with maximum removal of COD and TN, respectively, by 95.1 and 89.8%. In the case of an initial organic load of 1000 mg O\(_2\)/L and HRT of 3.5 h, the maximum total phosphorus removal was 72.3%. Therefore, according to the analysis of data obtained by different HRTs, it was revealed that the system of A\(^2\)O has greater efficiency in removing organic matter from wastewater in the shortest possible time.
Evidence of co-metabolic bentazone transformation by methanotrophic enrichment from a groundwater-fed rapid sand filter

The herbicide bentazone is recalcitrant in aquifers and is therefore frequently detected in wells used for drinking water production. However, bentazone degradation has been observed in filter sand from a rapid sand filter at a waterworks with methane-rich groundwater. Here, the association between methane oxidation and removal of bentazone was investigated with a methanotrophic enrichment culture derived from methane-fed column reactors inoculated with that filter sand. Several independent lines of evidence obtained from microcosm experiments with the methanotrophic enrichment culture, tap water and bentazone at concentrations below 2 mg/L showed methanotrophic co-metabolic bentazone transformation: The culture removed 53% of the bentazone in 21 days in presence of 5 mg/L of methane, while only 31% was removed in absence of methane. Addition of acetylene inhibited methane oxidation and stopped bentazone removal. The presence of bentazone partly inhibited methane oxidation since the methane consumption rate was significantly lower at high (1 mg/L) than at low (1 μg/L) bentazone concentrations. The transformation yield of methane relative to bentazone normalized by their concentration ratio ranged from 58 to 158, well within the range for methanotrophic co-metabolic degradation of trace contaminants calculated from the literature, with normalized substrate preferences varying from 3 to 400. High-resolution mass spectrometry revealed formation of the transformation products (TPs) 6-OH, 8-OH, isopropyl-OH and di-OH-bentazone, with higher abundances of all TPs in the presence of methane. Overall, we found a suite of evidence all showing that bentazone was co-metabolically transformed to hydroxy-bentazone by a methanotrophic culture enriched from a rapid sand filter at a waterworks.

General information
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Organisations: Department of Environmental Engineering, Urban Water Systems, Water Technologies, John Hopkins University, Technical University of Denmark
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Web of Science (2017): Indexed yes
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From wastewater to fertilizing water- pilot scale operation

**General information**
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Organisations: Department of Environmental Engineering, Water Technologies, Danish Technological Institute, Samsø spildevand, Teknologisk Institut, Minor Change Group
Authors: Lindholst, S. (Ekstern), Mikkelsen, N. (Ekstern), Lison, M. (Ekstern), Rasmussen, P. E. (Ekstern), Heinen, N. (Ekstern), Haase, J. (Ekstern), Hansen, K. (Ekstern), Droumpali, A. (Intern), Tang, K. (Intern), Andersen, H. R. (Intern)
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Main Research Area: Technical/natural sciences
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Electronic versions:
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Granular activated carbon with grafted nanoporous polymer enhances nanoscale zero-valent iron impregnation and water contaminant removal
Granular activated carbon was customized with a chemical grafting procedure of a nanoporous polymeric network for the purpose of nanoscale zero-valent iron impregnation and subsequent water contaminant remediation. Characterization of the prepared composite material revealed that not only was the polymer attachment and iron impregnation successful, but also that the polymeric shell acted as a protective barrier against the effects of oxidation from the surrounding environment, nearly 99% of total iron content was in the form of zero-valent iron. When applied towards the remediation of two common water contaminants, nitrobenzene and nitrate, the composite material exploited the qualities of both the activated carbon and the polymeric network to work together in a synergistic manner. In that the increased protection from oxidation allowed for increased reactivity of the nanoscale zero-valent iron, and that the adsorption abilities of both the carbon and the polymer achieved a higher amount of total removal of the contaminants.

**General information**
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Organisations: Department of Micro- and Nanotechnology, Surface Engineering, Department of Environmental Engineering, Water Technologies, Korea Advanced Institute of Science and Technology, Seoul National University
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Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.16
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.75
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.72
A life cycle assessment (LCA) was performed on five commonly applied sewage sludge treatment practices: dewatering of mixed sludge (DMS), lime stabilisation of dewatered sludge (LIMS), anaerobic digestion of mixed sludge (ADS), dewatering of anaerobically-digested sludge (DADS) and incineration of dewatered anaerobically-digested sludge (INC).

In the first four scenarios, the sludge residues were applied on agricultural land, while in the fifth scenario ash from sludge incineration was landfilled. It was found that the sludge treatment technology influenced in which processes C and N emissions happened. In general, the INC scenario performed better than or comparably to the scenarios with land application of the sludge. Human toxicity (non-carcinogenic) and eco-toxicity showed the highest normalised impact potentials for all the scenarios with land application. In both categories, impacts were dominated by the application of zinc and copper to agricultural soil. For the eutrophication potentials, different scenarios appeared beneficial depending on the receiving compartment in focus. The fate of P dominated freshwater eutrophication, while the fate of N had a profound effect on all non-toxic impact categories other than freshwater eutrophication. The sensitivity analysis showed that the results were sensitive to soil and precipitation conditions. The ranking of scenarios was affected by local conditions for marine eutrophication. Overall, the present study highlighted the importance of including all sludge treatment stages and conducting a detailed N flow analysis, since the emission of reactive N into the environment is the major driver for almost all non-toxic impact categories.

**General information**

State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering, Water Technologies, University of Copenhagen, Technical University of Denmark
Authors: Yoshida, H. (Intern), ten Hoeve, M. (Ekstern), Christensen, T. H. (Intern), Bruun, S. (Ekstern), Jensen, L. S. (Ekstern), Scheutz, C. (Intern)
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Scopus rating (2017): SJR 1.467 SNIP 2.194
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.83 SJR 1.659 SNIP 2.502
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.635 SNIP 2.375 CiteScore 5.57
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.665 SNIP 2.481 CiteScore 4.6
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.618 SNIP 2.527 CiteScore 4.47
ISI indexed (2013): ISI indexed yes
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Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.454 SNIP 1.823 CiteScore 3.19
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.409 SNIP 1.723
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 0.961 SNIP 1.564
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Scopus rating (2008): SJR 0.81 SNIP 1.347
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.921 SNIP 1.497
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.84 SNIP 1.489
Scopus rating (2005): SJR 0.547 SNIP 1.324
Scopus rating (2004): SJR 0.766 SNIP 1.784
Scopus rating (2003): SJR 0.503 SNIP 1.113
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.529 SNIP 1.044
Web of Science (2002): Indexed yes
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Scopus rating (2000): SJR 0.205 SNIP 0.883
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Scopus rating (1999): SJR 0.265 SNIP 0.763
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Metagenomic analysis to elucidate the metabolic potential of microbial communities in Danish waterworks

General information
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Authors: Fowler, J. (Intern), Palomo, A. (Intern), Gülay, A. (Intern), Smets, B. F. (Intern)
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Abstract book
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Microalgae modeling in water resource recovery facilities - Toward a consensus

General information
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Authors: Shoener, B. (Ekstern), Béline, F. (Ekstern), Bernard, O. (Ekstern), Plösz, B. G. (Ekstern), Schramm, S. (Ekstern), Snowling, S. (Ekstern), Steyer, J. (Ekstern), Valverde Pérez, B. (Intern), Martinez von Dossow, C. (Ekstern), Wagner, D. (Ekstern), Guest, J. (Ekstern)
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Publication: Research - peer-review › Poster – Annual report year: 2018

Microbial electrochemical separation of CO₂ for biogas upgrading
Biogas upgrading to natural gas quality has been under focus the recent years for increasing the utilization potential of biogas. Conventional methods for CO₂ removal are expensive and have environmental challenges, such as increased emissions of methane in the atmosphere with serious greenhouse impact. In this study, an innovative microbial electrochemical separation cell (MESC) was developed to in-situ separate and regenerate CO₂ via alkali and acid regeneration. The MESC was tested under different applied voltages, inlet biogas rates and electrolyte concentrations. Pure biomethane was obtained at 1.2 V, inlet biogas rate of 0.088 mL/h/mL reactor and NaCl concentration of 100 mM at a 5-day operation. Meanwhile, the organic matter of the domestic wastewater in the anode was almost completely removed at the end. The study demonstrated a new sustainable way to simultaneously upgrade biogas and treat wastewater which can be used as proof of concept for further investigation.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Residual Resource Engineering
Authors: Kokkoli, A. (Intern), Zhang, Y. (Intern), Angelidaki, I. (Intern)
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Publication information
Model-based optimization biofilm based systems performing autotrophic nitrogen removal using the comprehensive NDHA model

Completely autotrophic nitrogen removal (CANR) can be obtained in single stage biofilm-based bioreactors. However, their environmental footprint is compromised due to elevated N2O emissions. We developed novel spatially explicit biochemical process model of biofilm based CANR systems that predicts N2O dynamics and stripping, using the biological NDHA model coupled with a simple and robust pH calculator. In this work we present two case studies: i) membrane aerated biofilm reactor (MABR) with focus on model calibration; and ii) granular system with focus on process optimization.

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering, Water Technologies, Technical University of Denmark, University of Santiago de Compostela
Authors: Valverde Pérez, B. (Intern), Ma, Y. (Intern), Morset, M. (Ekstern), Domingo-Felez, C. (Intern), Mauricio-Iglesias, M. (Ekstern), Smets, B. F. (Intern)
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Model identification for hindered-compression settling velocity

Two of the key questions regarding secondary settling are (a) Does a process model exist for which all hindered and compression settling velocity parameters can be estimated using experimental data?; (b) What is the minimum data that need be inferred, from a settling sensor setup to identify process models?" This international research effort aimed to address these questions by carrying out a comprehensive practical identifiability assessment of constitutive functions for hindered and compression settling velocity using laboratory-scale measurements and one-dimensional (1-D) simulation models. For model validation, the triangulation technique was used, including independent laboratory- and full-scale measurements as well as 1-D and computational fluid dynamics (CFD) simulation models.

General information
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Organisations: Department of Environmental Engineering, Residual Resource Engineering, Water Technologies, University Jaume I, University of Bath, Bioras
Authors: Plósz, B. G. (Intern), Climent, J. (Ekstern), Griffith, C. (Ekstern), Haecky, P. (Ekstern), Blackburn, N. (Ekstern), Chiva, S. (Ekstern), Valverde Pérez, B. (Intern)
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Main Research Area: Technical/natural sciences
Activated sludge settling velocity, Computational fluid dynamics (CFD), Model identification
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Monitoring and modeling of nitrogen conversions in membrane-aerated biofilm reactors: Effects of intermittent aeration

Nitrogen can be removed from sewage by a variety of physicochemical and biological processes. Due to the high removal efficiency and relatively low costs, biological processes have been widely adopted for treating nitrogen-rich wastewaters. Among the biological technologies, biofilm processes show great advantages as compared to suspended growth processes, allowing for biomass accumulation and retention without the need of external solid separation devices. The
decoupling of solids retention from hydraulic retention is especially useful for slow-growing microorganisms, such as nitrifying bacteria, e.g. ammonium-oxidizing bacteria (AOB) and nitrite-oxidizing bacteria (NOB), and anaerobic ammonium-oxidizing bacteria (AnAOB), which are involved in ammonium (NH4+) removal process. Stability of engineered biological processes requires an appropriate balance between activities of the main microbial groups involved in the system. However, finding proper operational conditions is especially challenging in biofilms. On the one hand, the existence of strong spatial chemical gradients within biofilms increases the difficulty to prescribe environmental conditions that favor any desired biological process. On the other hand, the presence of multiple simultaneous chemical gradients complicates the performance optimization. Mathematical modeling offers a way to describe and analyze multi-ple processes that occur simultaneously in time and space in biofilm systems.

This PhD project investigated NH4+ removal process in membrane-aerated biofilm reactors (MABRs), focusing on aeration control, especially the application of intermittent aeration. Compared to conventional biofilms which are characterized by co-diffusion, MABRs display counter-diffusion fluxes of substrates: oxygen is supplied through the membrane, whilst NH4+ is provided from the bulk liquid phase. The counter substrate supply not only offers flexible aeration control, but also supports the development of a unique microbrial community and spatial structure inside the biofilm. In this study, lab-scale MABRs were operated under two types of aeration control: continuous versus intermittent aeration. Long-term reactor performance was monitored. Based on bulk measurements of NH4+, nitrite (NO2-) and nitrate (NO3-), microbial activities of individual functional guilds were evaluated. I found that NOB suppression occurred under intermittent aeration, but not under continuous aeration.

To further investigate the causal link between NOB suppression and aeration regime change, a 1-dimensional (1-D) multispecies nitrifying biofilm model was developed in Aquasim software, incorporating a pH calculation. Kinetic parameters to be estimated were chosen based on a local sensitivity analysis, and were estimated from in situ microprofiles. With the calibrated model, I identified that the periodically varying free ammonia inhibition, which was associated with transient pH variations, was the likely key factor causing NOB suppression in intermittently-aerated nitrifying MABRs.

To further investigate the mechanisms of N2O mitigation under aeration control, the 1-D biofilm model was extended to a partial nitritation-anammox (PNA) biofilm model, including description of all relevant biological N2O production pathways. Sensitive kinetic parameters were estimated with long-term bulk performance data. With the calibrated model, roles of HB and AnAOB were discussed and evaluated in mitigating N2O emissions in auto-trophic nitrogen removal MABRs. Moreover, I developed a 1-D biofilm model in Matlab software describing the counter-diffusion PNA process, aiming at an improved model calibration/evaluation for the highly variable N2O emissions.

Overall, a combination of experimental and modeling efforts were implemented to study nitrogen conversions in MABRs. The results showed that intermittent aeration was an efficient strategy to regulate microbial activities in counter-diffusion biofilms, achieving an energy-efficient NH4+ removal process with low N2O emissions.
Nitrous oxide production in intermittently aerated Partial Nitritation-Anammox reactor: oxic N₂O production dominates and relates with ammonia removal rate

Emissions of the greenhouse gas nitrous oxide from the Partial Nitritation-Anammox process are of concern and can determine the carbon footprint of the process. In order to reduce nitrous oxide emissions intermittent aeration regimes have been shown to be a promising mode of operation, possibly due to an effective control of accumulation of nitrogen intermediates. However, due to frequent changes of redox conditions under intermittent aeration regimes, nitrous oxide production and emissions are dynamic. In this study the production and emission dynamics of nitrous oxide in an intermittently aerated sequencing batch reactor were monitored in high temporal resolution, the contribution of different redox conditions to overall nitrous oxide production was quantified and the most relevant factors for nitrous oxide production were identified. The average fraction of nitrous oxide produced (per unit ammonium removed) was 1.1 ± 0.5%. Cycle-averaged approx. 80% of nitrous oxide was produced during aerated phases, the remaining 20% were produced during non-aerated phases. Yet, the intra-cycle dynamics of nitrous oxide were substantial. The net-production rate of nitrous oxide during aerated phases correlated with the ammonia removal rate, whereas the concentration of nitrite determined the production during non-aerated phases. While aerated phases contributed predominantly at the beginning of reactor cycles, non-aerated phases became the dominant source of nitrous oxide at the end. Particularly low net-production rates were observed at ammonia removal rates below 5 mg NH₃-N*gVSS−1*L−1, when the fraction of nitrous oxide produced was 0.011 ± 0.004% (per ammonia removed). Based on the nitrous oxide dynamics and correlations, reactor operation at relatively low nitrogen loadings (below 100 mg NH₄+-N*L−1), ammonia removal rates of approx. 5 mg NH₃-N*gVSS−1*L−1 and nitrite concentrations below 1 mg NO₂−1-N*L−1 appears as beneficial for low emission of nitrous oxide.
Novel method reveals a narrow phylogenetic distribution of bacterial dispersers in environmental communities exposed to low hydration conditions

In this study, we developed a method that provides community-level surface dispersal profiles under controlled hydration conditions from environmental samples and enables us to isolate and uncover the diversity of the fastest bacterial dispersers. The method expands on the Porous Surface Model (PSM), previously used to monitor dispersal of individual bacterial strains in liquid films at the surface of a porous ceramic disc. The novel procedure targets complex communities and captures the dispersed bacteria on a solid medium for growth and detection. The method was first validated by distinguishing motile Pseudomonas putida and Flavobacterium johnsoniae strains from their non-motile mutants. Applying the method to soil and lake water bacterial communities showed that community-scale dispersal declined as conditions became drier. However, for both communities, dispersal was detected even under low hydration conditions (matric potential: -3.1 kPa), previously proven too dry for P. putida KT2440 motility. We were then able to specifically recover and characterize the fastest dispersers from the inoculated communities. For both soil and lake samples, 16S rRNA gene amplicon sequencing revealed that the fastest dispersers were substantially less diverse than the total communities. The dispersing fraction of the soil microbial community was dominated by Pseudomonas which increased in abundance at low hydration conditions, while the dispersing fraction of the lake community was dominated by Aeromonas and, under wet conditions (-0.5 kPa), also by Exiguobacterium The results gained in this study bring us a step closer to assessing the dispersal ability within complex communities under environmentally relevant conditions.IMPORTANCE Dispersal is a key process of bacterial community assembly. Yet, very few attempts have been made at assessing bacterial dispersal at the community level as focus has previously been on pure culture studies. A crucial factor for dispersal in habitats where hydration conditions vary, such as soils, is the thickness of the liquid films surrounding solid surfaces, but little is known on how the ability to disperse in such films varies within bacterial communities. Therefore, we developed a method to profile community dispersal and identify fast dispersers on a rough surface resembling soil surfaces. Our results suggest that within the motile fraction of a bacterial community only a minority of the bacterial types are able to disperse in the thinnest...
liquid films. During dry periods, these efficient dispersers can gain a significant fitness advantage through their ability to colonize new habitats ahead of the rest of the community.

**General information**
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, University of Copenhagen, Geological Survey of Denmark and Greenland
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Source: FindIt
Source-ID: 2395843687
Publication: Research - peer-review › Journal article – Annual report year: 2018

**Nutrient recovery from industrial wastewater as single cell protein by a co-culture of green microalgae and methanotrophs**
Conventional water treatment technologies remove nutrients via resource intensive processes. However, new approaches for nutrient recycling are needed to provide food to the increasing population. This work explores the use of microbial biomass as a means to recover nutrients from industrial wastewater and upcycle them to feed grade single cell protein. Results demonstrated that both algae and bacteria could remove or assimilate most of the organic carbon present in the wastewater (~95% removal for monocultures and 91% for the algal-bacterial consortium). However, their growth stopped before nutrients and substrates in the gas phase (i.e., methane and oxygen for methanotrophs and carbon dioxide for algae) were depleted. Likely, algal growth was light limited and stopped after organic carbon was consumed. Methanotrophs growth could be limited by trace elements (e.g., copper). Nevertheless, for all cultures the protein content (45% of dry weight, DW, for methanotrophs; 52.5% of DW for algae; and 27.6% of DW for consortium) and amino acid profile was suitable for substitution of conventional protein sources. Further research should focus on increasing productivity of biomass grown on wastewater resources.

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Organisations: Department of Environmental Engineering, Residual Resource Engineering, Water Technologies, Technical University of Denmark
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Main Research Area: Technical/natural sciences

**Publication information**
Journal: Biochemical Engineering Journal
Ozonation control and effects of ozone on water quality in recirculating aquaculture systems

To address the undesired effect of chemotherapeutants in aquaculture, ozone has been suggested as an alternative to improve water quality. To ensure safe and robust treatment, it is vital to define the ozone demand and ozone kinetics of the specific water matrix to avoid ozone overdose. Different ozone dosages were applied to water in freshwater recirculating aquaculture systems (RAS). Experiments were performed to investigate ozone kinetics and demand, and to evaluate the effects on the water quality, particularly in relation to fluorescent organic matter. This study aimed at predicting a suitable ozone dosage for water treatment based on daily ozone demand via laboratory studies. These ozone dosages will be eventually applied and maintained at these levels in pilot-scale RAS to verify predictions. Selected water quality parameters were measured, including natural fluorescence and organic compound concentration changes during ozonation. Ozone reactions were described by first order kinetics. Organic matter, assessed as chemical oxygen demand and fluorescence, decreased by 25% (low O3), 30% (middle O3) and 53% (high O3), while water transmittance improved by 15% over an 8-day period. No fish mortality was observed. Overall, this study confirms that ozone can improve RAS water quality, provides a better understanding of the ozone decay mechanisms that can be used to define further safe ozone treatment margins, and that fluorescence could be used as a monitoring tool to control ozone. This study might be used as a tool to design ozone systems for full-scale RAS by analysing water sample from the specific RAS in the
The textile industry produces large volumes of wastewater that requires appropriate treatment before being released into the environment. Research globally has focused on advanced desalination technologies to augment the limited freshwater resources. Forward osmosis (FO) technology has gained substantial interest as a possible lower-energy desalination technology. However, challenges such as the availability of effective draw solutions (DS) have limited its implementation. This study evaluated alternative feed water resources and assessed the potential of dye solutions as DS. The aim is to dilute a concentrated dye DS to a target concentration for direct dye-batch use, thereby reclaiming water resources. The measured osmotic pressure (OP) of the alternative feed solutions (synthetic brackish water; synthetic seawater; seawater from the Atlantic and Indian Oceans; and wastewater from two textile factories) were 414, 2 761, 2 580, 2 614; 1 716 and 7 822 kPa, respectively. Three basic dyes (Maxilon Turquoise, Red and Blue) and three reactive dyes (Carmine, Olive Green and Black) were selected based on common use in the South African textile industry. The dye samples were prepared without and with salt at different concentrations and different dye-to-salt mass ratios ranging from 1:10 to 1:60. The OP trends for the basic dyes followed Blue >> Red > Turquoise and for the reactive dyes Black >> Olive > Carmine. The overall OP trend was Black > Olive > Carmine > Blue > Red > Turquoise. The OP at different dye concentrations and different dye-to-salt ratios was mostly influenced by the dye chemistry and molecular weight (Mw) rather than the type of dye, i.e., reactive vs basic. The OP trend for the dye-to-salt ratios was 1:60 > 1:50 > 1:40 > 1:30 > 1:20 > 1:10. For both the basic and reactive dyes a linear relationship exists between OP and dye concentration; as well as between OP and Mw. The dye DS exhibited larger OP compared to that of the FS evaluated, thus rendering them suitable DS.

Potential of dyes as draw solutions in forward osmosis for the south african textile industry

The textile industry produces large volumes of wastewater that requires appropriate treatment before being released into the environment. Research globally has focused on advanced desalination technologies to augment the limited freshwater resources. Forward osmosis (FO) technology has gained substantial interest as a possible lower-energy desalination technology. However, challenges such as the availability of effective draw solutions (DS) have limited its implementation. This study evaluated alternative feed water resources and assessed the potential of dye solutions as DS. The aim is to dilute a concentrated dye DS to a target concentration for direct dye-batch use, thereby reclaiming water resources. The measured osmotic pressure (OP) of the alternative feed solutions (synthetic brackish water; synthetic seawater; seawater from the Atlantic and Indian Oceans; and wastewater from two textile factories) were 414, 2 761, 2 580, 2 614; 1 716 and 7 822 kPa, respectively. Three basic dyes (Maxilon Turquoise, Red and Blue) and three reactive dyes (Carmine, Olive Green and Black) were selected based on common use in the South African textile industry. The dye samples were prepared without and with salt at different concentrations and different dye-to-salt mass ratios ranging from 1:10 to 1:60. The OP trends for the basic dyes followed Blue >> Red > Turquoise and for the reactive dyes Black >> Olive > Carmine. The overall OP trend was Black > Olive > Carmine > Blue > Red > Turquoise. The OP at different dye concentrations and different dye-to-salt ratios was mostly influenced by the dye chemistry and molecular weight (Mw) rather than the type of dye, i.e., reactive vs basic. The OP trend for the dye-to-salt ratios was 1:60 > 1:50 > 1:40 > 1:30 > 1:20 > 1:10. For both the basic and reactive dyes a linear relationship exists between OP and dye concentration; as well as between OP and Mw. The dye DS exhibited larger OP compared to that of the FS evaluated, thus rendering them suitable DS.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Cape Peninsula University of Technology, University of Maribor
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Scopus rating (2017): SNIP 0.624 SJR 0.361
Web of Science (2017): Indexed Yes
Reactor staging influences microbial community composition and diversity of denitrifying MBBRs- Implications on pharmaceutical removal

The subdivision of biofilm reactor in two or more stages (i.e., reactor staging) represents an option for process optimisation of biological treatment. In our previous work, we showed that the gradient of influent organic substrate availability (induced by the staging) can influence the microbial activity (i.e., denitrification and pharmaceutical biotransformation kinetics) of a denitrifying three-stage Moving Bed Biofilm Reactor (MBBR) system. However, it is unclear whether staging and thus the long-term exposure to varying organic carbon type and loading influences the microbial community structure and diversity.
In this study, we investigated biofilm structure and diversity in the three-stage MBBR system (S) compared to a single-stage configuration (U) and their relationship with microbial functions. Results from 16S rRNA amplicon libraries revealed a significantly higher microbial richness in the staged MBBR (at 99% sequence similarity) compared to single-stage MBBR. A more even and diverse microbial community was selected in the last stage of S (S3), likely due to exposure to carbon limitation during continuous-flow operation. A core of OTUs was shared in both systems, consisting of Burkholderiales, Xanthomonadales, Flavobacteriales and Sphingobacteriales, while MBBR staging selected for specific taxa (i.e., Candidate division WS6 and Deinococcales). Results from quantitative PCR (qPCR) showed that S3 exhibited the lowest abundance of 16S rRNA but the highest abundance of atypical nosZ, suggesting a selection of microbes with more diverse N-metabolism (i.e., not-complete denitrifiers) in the stage exposed to the lowest carbon availability. A positive correlation (p<0.05) between removal rate constants of several pharmaceuticals with abundance of relevant denitrifying genes was observed, but not with biodiversity. Despite the previously suggested positive relationship between microbial diversity and functionality in macrobial and microbial ecosystems, this was not observed in the current study, suggesting a need to further investigate structure-function relationships for denitrifying systems.

General information
State: Published
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Scopus rating (2017): SJR 2.601 SNIP 2.358
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.49 SJR 2.663 SNIP 2.563
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BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.665 SNIP 2.482 CiteScore 6.63
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.946 SNIP 2.702 CiteScore 6.13
Web of Science (2014): Indexed yes
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Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.914 SNIP 2.442 CiteScore 5.15
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Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.862 SNIP 2.355 CiteScore 5.43
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.592 SNIP 2.192
Web of Science (2010): Indexed yes
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The pH dependency of N-converting enzymatic processes, pathways and microbes: effect on net N₂O production

Nitrous oxide (N₂O) is emitted during microbiological nitrogen (N) conversion processes, when N₂O production exceeds N₂O consumption. The magnitude of N₂O production vs. consumption varies with pH and controlling net N₂O production might be feasible by choice of system pH. This article reviews how pH affects enzymes, pathways and microorganisms that are involved in N-conversions in water engineering applications. At a molecular level, pH affects activity of cofactors and structural elements of relevant enzymes by protonation or deprotonation of amino acid residues or solvent ligands, thus causing steric changes in catalytic sites or proton/electron transfer routes that alter the enzymes’ overall activity. Augmenting molecular information with, e.g., nitritation or denitrification rates yields explanations of changes in net N₂O production with pH. Ammonia oxidizing bacteria are of highest relevance for N₂O production, while heterotrophic denitrifiers are relevant for N₂O consumption at pH > 7.5. Net N₂O production in N-cycling water engineering systems is predicted to display a 'bell-shaped' curve in the range of pH 6.0-9.0 with a maximum at pH 7.0-7.5. Net N₂O production at acidic pH is dominated by N₂O production, whereas N₂O consumption can outweigh production at alkaline pH. Thus, pH 8.0 may be a favourable pH set-point for water treatment applications regarding net N₂O production.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Residual Resource Engineering
Authors: Blum, J. (Intern), Su, Q. (Intern), Ma, Y. (Intern), Valverde Pérez, B. (Intern), Domingo-Felez, C. (Intern), Jensen, M. M. (Intern), Smets, B. F. (Intern)
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The response of fluorescent organic matter to ozone treatment in pilot freshwater RAS

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, National Institute of Aquatic Resources, Section for Aquaculture, Section for Oceans and Arctic
Authors: Spiliotopoulou, A. (Intern), Andersen, H. R. (Intern), Pedersen, L. (Intern), Stedmon, C. (Intern), Hambly, A. (Intern)
Number of pages: 1
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Towards Biomimetic Phosphate Recovery: Molecular Dynamics Simulations of Phosphate Binding Proteins

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State: Published
Organisations: Department of Environmental Engineering, Water Technologies, University of Copenhagen
Authors: Truelsen, S. F. (Intern), Wang, Y. (Ekstern), Lindorff-Larsen, K. (Ekstern), Hélix-Nielsen, C. (Intern)
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.13 SNIP 1.134 CiteScore 3.3
Web of Science (2015): Indexed yes
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Scopus rating (2014): SJR 2.21 SNIP 1.15 CiteScore 3.33
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Scopus rating (2013): SJR 2.245 SNIP 1.156 CiteScore 3.64
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 2.361 SNIP 1.143 CiteScore 3.57
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Web of Science (2012): Indexed yes
Use of Forward Osmosis to Harvest Methane Oxidizing Bacteria Producing Single Cell Protein

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering, Water Technologies, Technical University of Denmark
Authors: Valverde Pérez, B. (Intern), Pape, M. L. (Ekstern), Schneider, C. (Intern), Kjeldgaard, A. F. (Intern), Zachariae, A. A. (Ekstern), Hélix-Nielsen, C. (Intern), Zarebska, A. (Intern), Smets, B. F. (Intern)
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Abstract book
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2018
Waste management in the Irkutsk region, Siberia, Russia: An environmental assessment of alternative development scenarios

The current waste management system, handling around 500,000 t of household, commercial, and institutional waste annually in the Irkutsk region, Siberia, is based on landfilling in an old landfill with no controls of leachate and gas. Life-cycle assessment modelling of the current system shows that it is a major load on the environment, while the simulation of seven alternative systems results in large savings in many impact categories. With respect to climate change, it is estimated that a saving of about 1200 kg CO2 equivalents is possible per year, per inhabitant, which is a significant reduction in greenhouse gas emissions. The best alternatives involve efficient energy recovery from waste and recycling by source separation for commercial and institutional waste, the major waste type in the Irkutsk region. Recycling of household waste seems less attractive, and it is therefore recommended only to consider this option after experience has been gained with the commercial and institutional waste. Sensitivity analysis shows that recovery of energy - in particular electricity, heat, and steam - from waste is crucial to the environmental performance of the waste management system. This relates to the efficiencies of energy recovery as well as what the recovered energy substitutes, that is, the 'dirtier' the off-set energy, the higher the environmental savings for the waste management system. Since recovered energy may be utilised by only a few energy grids or industrial users, it is recommended to perform additional local assessments of the integration of the waste energy into existing systems and facilities.

General information
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Organisations: Department of Environmental Engineering, Residual Resource Engineering, Water Technologies, Irkutsk National Research Technical University
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Scopus rating (2017): SNIP 0.92 SJR 0.519
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Scopus rating (2016): CiteScore 1.76 SJR 0.673 SNIP 1.091
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.623 SNIP 0.893 CiteScore 1.53
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.733 SNIP 1.097 CiteScore 1.28
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.58 SNIP 0.925 CiteScore 1.17
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.874 SNIP 1.053 CiteScore 1.4
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.028 SNIP 0.858 CiteScore 1.33
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
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Water & Sanitation: An Essential Battlefront in the War on Antimicrobial Resistance

Water and sanitation represents a key battlefront in combating the spread of antimicrobial resistance (AMR). Basic water sanitation infrastructure is an essential first step to protecting public health, thereby limiting the spread of pathogens and the need for antibiotics. AMR presents unique human health risks, meriting new risk assessment frameworks specifically adapted to water and sanitation-borne AMR. There are numerous exposure routes to AMR originating from human waste, each of which must be quantified for its relative risk to human health. Wastewater treatment plants (WWTPs) play a vital role in centralized collection and treatment of human sewage, but there are numerous unresolved questions in terms of the microbial ecological processes occurring within and the extent to which they attenuate or amplify AMR. Research is needed to advance understanding of the fate of resistant bacteria and antibiotic resistance genes (ARGs) in various waste management systems, depending on the local constraints and intended re-use applications. WHO and national AMR action plans would benefit from a more holistic ‘One Water’ understanding. Here we provide a framework for research, policy, practice, and public engagement aimed at limiting the spread of AMR from water and sanitation in both low-, medium- and high-income countries, alike.

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Journal: Fems Microbiology Ecology
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Where does N2O from Partial Nitritation-Anammox processes come from? – A high temporal resolution study of a lab-scale system gives answers

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Estimation of caffeine intake from analysis of caffeine metabolites in wastewater

Caffeine metabolites in wastewater were investigated as potential biomarkers for assessing caffeine intake in a population. The main human urinary metabolites of caffeine were measured in the urban wastewater of ten European cities and the metabolic profiles in wastewater were compared with the human urinary excretion profile. A good match was found for 1,7-dimethyluric acid, an exclusive caffeine metabolite, suggesting that might be a suitable biomarker in wastewater for assessing population-level caffeine consumption. A correction factor was developed considering the percentage of excretion of this metabolite in humans, according to published pharmacokinetic studies. Daily caffeine intake estimated from wastewater analysis was compared with the average daily intake calculated from the average amount of coffee consumed by country per capita. Good agreement was found in some cities but further information is needed to standardize this approach. Wastewater analysis proved useful to providing additional local information on caffeine use.
Accelerated anaerobic hydrolysis rates under a combination of intermittent aeration and anaerobic conditions

Anaerobic hydrolysis in activated return sludge was investigated in laboratory scale experiments to find if intermittent aeration would accelerate anaerobic hydrolysis rates compared to anaerobic hydrolysis rates under strict anaerobic conditions. The intermittent reactors were set up in a 240 h experiment with intermittent aeration (3h:3h) in a period of 24 h followed by a subsequent anaerobic period of 24 h in a cycle of 48 hours which was repeated 5 times during the experiment. The anaerobic reactors were kept under strict anaerobic conditions in the same period (240 h). Two methods for calculating hydrolysis rates based on soluble COD were compared. Two-way ANOVA with the Bonferroni post-test was performed in order to register any significant difference between reactors with intermittent aeration and strictly anaerobic conditions respectively. The experiment demonstrated a statistically significant difference in favor of the reactors with intermittent aeration showing a tendency towards accelerated anaerobic hydrolysis rates due to application of intermittent aeration. The conclusion of the work is thus that intermittent aeration applied in the activated return sludge process (ARP) can improve the treatment capacity further in full scale applications.

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Organisations: Department of Environmental Engineering, Water Technologies, EnviDan A/S, Technical University of Denmark
Activated return sludge process (ARP), anaerobic hydrolysis, intermittent aeration, wastewater treatment

Algal toxicity of the alternative disinfectants performic acid (PFA), peracetic acid (PAA), chlorine dioxide (ClO2) and their by-products hydrogen peroxide (H2O2) and chlorite (ClO2-) Environmental effect evaluation of disinfection of combined sewer overflow events with alternative chemical disinfectants requires that the environmental toxicity of the disinfectants and the main by-products of their use are known. Many disinfectants degrade quickly in water which should be included in the evaluation of both their toxicity as determined in standardized tests and their possible negative effect in the water environment. Here we evaluated according to the standardized ISO 8692 test the toxicity towards the green microalgae, Pseudokirchneriella subcapitata, of three disinfectants: performic acid (PFA), peracetic acid (PAA) and chlorine dioxide (ClO2) as well as two by-products of their use: hydrogen peroxide (H2O2) and chlorite. All of the five chemicals investigated showed clear toxicity to the algae with well-defined dose response curves. The EC50 values ranged from 0.16 to 2.9 mg/L based on nominal concentrations leading to the labeling of the chemicals as either toxic or very toxic. The five investigated chemicals decreased in toxicity in the order chlorine dioxide, performic acid, peracetic acid, chlorite and hydrogen peroxide. The stability of the chemicals increased in the same order as the toxicity decrease. This indicates that even though ClO2 has the highest environmental hazard potential, it may still be suitable as an alternative disinfectant due to its rapid degradation in water.
Aquaporin based biomimetic membrane in forward osmosis: Chemical cleaning resistance and practical operation

Aquaporin plays a promising role in fabricating high performance biomimetic forward osmosis (FO) membranes. However, aquaporin as a protein also has a risk of denaturation caused by various chemicals, resulting in a possible decay of membrane performance. The present study tested a novel aquaporin based biomimetic membrane in simulated membrane cleaning processes. The effects of cleaning agents on water flux and salt rejection were evaluated. The membrane showed a good resistance to the chemical agents. The water flux after chemical cleaning showed significant increases, particularly after cleaning with NaOCl and Alconox. Changes in the membrane structure and increased hydrophilicity in the surrounding areas of the aquaporin may be accountable for the increase in water permeability. The membrane shows stable salt rejection up to 99% after all cleaning agents were tested. A 15-day experiment with secondary wastewater effluent as the feed solution and seawater as the draw solution showed a stable flux and high salt rejection. The average rejection of the dissolved organic carbon from wastewater after the 15-day test was 90%. The results demonstrated that the aquaporin based biomimetic FO membrane exhibits chemical resistance for most agents used in membrane cleaning procedures, maintaining a stable flux and high salt rejection.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Northwest Agriculture and Forestry University, King Abdullah University of Science and Technology, Clemson University
Authors: Li, Z. (Ekstern), Linares, R. V. (Ekstern), Bucs, S. (Ekstern), Fortunato, L. (Ekstern), Hélix-Nielsen, C. (Intern), Vrouwenvelder, J. S. (Ekstern), Ghaffour, N. (Ekstern), Leiknes, T. (Ekstern), Amy, G. (Ekstern)
Number of pages: 8
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Publication date: 2017
Main Research Area: Technical/natural sciences
Biomimetic membrane, Aquaporin, Desalination, Forward osmosis, Chemical stability

DOIs:
10.1016/j.desal.2017.07.015
A systematic model identification method for chemical transformation pathways – the case of heroin biomarkers in wastewater

This study presents a novel statistical approach for identifying sequenced chemical transformation pathways in combination with reaction kinetics models. The proposed method relies on sound uncertainty propagation by considering parameter ranges and associated probability distribution obtained at any given transformation pathway levels as priors for parameter estimation at any subsequent transformation levels. The method was applied to calibrate a model predicting the transformation in untreated wastewater of six biomarkers, excreted following human metabolism of heroin and codeine. The method developed was compared to parameter estimation methods commonly encountered in literature (i.e., estimation of all parameters at the same time and parameter estimation with fix values for upstream parameters) by assessing the model prediction accuracy, parameter identifiability and uncertainty analysis. Results obtained suggest that the method developed has the potential to outperform conventional approaches in terms of prediction accuracy, transformation pathway identification and parameter identifiability. This method can be used in conjunction with optimal experimental designs to effectively identify model structures and parameters. This method can also offer a platform to promote a closer interaction between analytical chemists and modellers to identify models for biochemical transformation pathways, being a prominent example for the emerging field of wastewater-based epidemiology.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Department of Chemical and Biochemical Engineering, CAPEC-PROCESS, Environmental Chemistry, Water Resources Engineering
Authors: Ramin, P. (Intern), Valverde Pérez, B. (Intern), Polesel, F. (Intern), Locatelli, L. (Intern), Plósz, B. G. (Intern)
Number of pages: 11
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Scientific Reports
Volume: 7
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.245 SJR 1.533
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.63 SJR 1.692 SNIP 1.354
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.034 SNIP 1.597 CiteScore 5.3
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.163 SNIP 1.554 CiteScore 4.75
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.998 SNIP 1.57 CiteScore 4.06
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.531 SNIP 0.962 CiteScore 2.44
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
ISI indexed (2011): ISI indexed no
Original language: English
Electronic versions:
s41598_017_09313_y.pdf
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10.1038/s41598-017-09313-y
Bacteria from Wheat and Cucurbit Plant Roots Metabolize PAHs and Aromatic Root Exudates: Implications for Rhizodegradation

The chemical interaction between plants and bacteria in the root zone can lead to soil decontamination. Bacteria which degrade PAHs have been isolated from the rhizospheres of plant species with varied biological traits, however, it is not known what phytochemicals promote contaminant degradation. One monocot and two dicotyledon plants were grown in PAH-contaminated soil from a manufactured gas plant (MGP) site. A phytotoxicity assay confirmed greater soil decontamination in rhizospheres when compared to bulk soil controls. Bacteria were isolated from plant roots (rhizobacteria) and selected for growth on anthracene and chrysene on PAH-amended plates. Rhizosphere isolates metabolized 3- and 4-ring PAHs and PAH catabolic intermediates in liquid incubations. Aromatic root exudate compounds, namely flavonoids and simple phenols, were also substrates for isolated rhizobacteria. In particular, the phenolic compounds - morin, caffeic acid, and protocatechuic acid - appear to be linked to bacterial degradation of 3- and 4- ring PAHs in the rhizosphere.
Biodegradation testing of chemicals with high Henry's constants – separating mass and effective concentration reveals higher rate constants

During simulation-type biodegradation tests, volatile chemicals will continuously partition between water phase and headspace. This study addressed how (1) this partitioning affects biodegradation test results and (2) it can be accounted for by combining mass balance and dynamic biodegradation models. An aqueous mixture of 9 (semi)volatile chemicals was first prepared using passive dosing and then diluted with environmental surface water to produce test systems containing concentrations in the ng/L to µg/L range. After incubation for 2 hours to 4 weeks, automated Headspace Solid Phase Microextraction (HS-SPME) was applied directly on the test systems to measure substrate depletion by biodegradation relative to abiotic controls. HS-SPME was also applied to determine air to water partitioning ratios. Water phase biodegradation rate constants, $k_{\text{water}}$, were up to 72 times higher than test system biodegradation rate constants, $k_{\text{system}}$. True water phase degradation rate constants facilitate extrapolation to other air-water systems and are more suitable input parameters for aquatic exposure and fate models. As such, they should be considered more appropriate for risk assessments than test system rate constants.

General information
State: Published
Organisations: Department of Environmental Engineering, Environmental Chemistry, Water Technologies, Mike Comber Consulting
Authors: Birch, H. (Intern), Andersen, H. R. (Intern), Comber, M. (Ekstern), Mayer, P. (Intern)
Number of pages: 1
Publication date: 2017
Main Research Area: Technical/natural sciences
Biodegradation, Surface water, Partitioning, Degradation
Electronic versions:
Abstract_1_volatile_chemicals_FINAL.pdf
Source: PublicationPreSubmission
Source-ID: 133789762
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2017
Calibration of the comprehensive NDHA-N$_2$O dynamics model for nitrifier-enriched biomass using targeted respirometric assays

The NDHA model comprehensively describes nitrous oxide (N$_2$O) producing pathways by both autotrophic ammonium oxidizing and heterotrophic bacteria. The model was calibrated via a set of targeted extant respirometric assays using enriched nitrifying biomass from a lab-scale reactor. Biomass response to ammonium, hydroxylamine, nitrite and N$_2$O additions under aerobic and anaerobic conditions were tracked with continuous measurement of dissolved oxygen (DO) and N$_2$O. The sequential addition of substrate pulses allowed the isolation of oxygen-consuming processes. The parameters to be estimated were determined by the information content of the datasets using identifiability analysis. Dynamic DO profiles were used to calibrate five parameters corresponding to endogenous, nitrite oxidation and ammonium oxidation processes. The subsequent N$_2$O calibration was not significantly affected by the uncertainty propagated from the DO calibration because of the high accuracy of the estimates. Five parameters describing the individual contribution of three biological N$_2$O pathways were estimated accurately (variance/mean < 10% for all estimated parameters). The NDHA model response was evaluated with statistical metrics (F-test, autocorrelation function). The 95% confidence intervals of DO and N$_2$O predictions based on the uncertainty obtained during calibration are studied for the first time. The measured data fall within the 95% confidence interval of the predictions, indicating a good model description. Overall, accurate parameter estimation and identifiability analysis of ammonium removal significantly decreases the uncertainty propagated to N$_2$O production, which is expected to benefit N$_2$O model discrimination studies and reliable full scale applications.
Calibration of the NDHA N2O model via respirometric assays

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Department of Chemical and Biochemical Engineering, PROSYS - Process and Systems Engineering Centre, Centre for oil and gas – DTU, Technical University of Denmark
Authors: Domingo-Felez, C. (Intern), Calderó-Pascual, M. (Ekstern), Sin, G. (Intern), Plósz, B. G. (Intern), Smets, B. F. (Intern)
Number of pages: 4
Publication date: 2017
Event: Abstract from Frontiers International Conference on Wastewater Treatment (FICWTM2017), Palermo, Italy.
Challenges in using allylthiourea and chlorate as specific nitrification inhibitors

Allylthiourea (ATU) and chlorate (ClO3-) are often used to selectively inhibit nitritation and nitratation. In this work we identified challenges with use of these compounds in inhibitory assays with filter material from a biological rapid sand filter for groundwater treatment. Inhibition was investigated in continuous-flow lab-scale columns, packed with filter material from a full-scale filter and supplied with NH4+ or NO2-. ATU concentrations of 0.1-0.5 mM interfered with the indophenol blue method for NH4+ quantification leading to underestimation of the measured NH4+ concentration. Interference was stronger at higher ATU levels and resulted in no NH4+ detection at 0.5 mM ATU. ClO3- at typical concentrations for inhibition assays (1-10 mM) inhibited nitratation by less than 6%, while nitritation was instead inhibited by 91% when NH4+ was supplied. On the other hand, nitratation was inhibited by 67-71% at 10-20 mM ClO3- when NO2- was supplied, suggesting significant nitratation inhibition at higher NO2- concentrations. No chlorite (ClO2-) was detected in the effluent, and thus we could not confirm that nitration inhibition was caused by ClO3- reduction to ClO2-. In conclusion, ATU and ClO3- should be used with caution in inhibition assays, because analytical interference and poor selectivity for the targeted process may affect the experimental outcome and compromise result interpretation.

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Systems, Water Technologies, University of Southern Denmark
Authors: Tatari, K. (Intern), Gülay, A. (Intern), Thamdrup, B. (Ekstern), Albrechtsen, H. (Intern), Smets, B. F. (Intern)
Number of pages: 5
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Publication date: 2017
Main Research Area: Technical/natural sciences

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Journal: Chemosphere
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Scopus rating (2017): SJR 1.435 SNIP 1.448
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.39 SJR 1.447 SNIP 1.625
Web of Science (2016): Indexed yes
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Scopus rating (2015): SJR 1.497 SNIP 1.567 CiteScore 4.04
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.59 SNIP 1.639 CiteScore 3.76
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.721 SNIP 1.751 CiteScore 3.92
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.794 SNIP 1.618 CiteScore 3.5
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.962 SNIP 1.508 CiteScore 3.61
ISI indexed (2011): ISI indexed yes
ATU, Ammonium, Chlorate, Drinking water, Inhibition, Nitrite

Changes in intermittent aeration regimes are effective tools to manage bio-granule size and microbial communities in partial nitritation-anammox SBRs

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Blum, J. (Intern), Smets, B. F. (Intern)
Pages: 20-20
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Main Research Area: Technical/natural sciences
Conference: 11th Annual Meeting of Danish Water Forum, Copenhagen, Denmark, 30/01/2017
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Abstract proceedings book
Chemical disinfection of combined sewer overflows

In Copenhagen, a significant number of harbour bathing areas are occasionally closed for recreational activities, due to the discharge of untreated combined sewer overflows (CSOs). A CSO event occurs when the designed capacity of the combined sewer system is exceeded during major rainfall events. A CSO, a variable mixture of wastewater and rainwater, is discharged into the nearby surface water, which renders surface water unusable for recreational activities, such as bathing. This is because the microbial water quality of receiving waters is not of a suitable quality as mentioned in the EU directive 2006/7/EC. Nordic countries have a short summer season, and the frequent closures of harbour bathing areas in prime weeks for recreational activities are due mainly to the discharge of untreated CSO. Disinfecting a CSO in the existing CSO structure, before discharging it to the surface water, would be a quick way to maintain limits on the indicator bacteria of 500 MPN Escherichia coli (E. coli) per 100 mL and 200 MPN Enterococcus spp per 100 mL in the receiving waters. Disinfecting CSO has not been practiced before in Denmark, but it would increase the usability of surface waters for recreational activities. The occurrence of a CSO event, and its quality and quantity, is unpredictable, so the disinfectants employed for such a task should be robust, in order to treat water varying in quality.

The present thesis provides a solution to designing a CSO disinfection system, without changing CSO overflow structures. An overview of the chemical disinfection of a CSO, from the batch scale to the full-scale, was studied, and disinfection efficiency was evaluated by calculating the removal of bacteria from a CSO and quantifying disinfectants during treatment. Residual toxicity was studied for a preliminary risk assessment of disinfectants entering the aquatic ecosystem in the receiving water’s post-disinfection discharge.

Perfomic acid (PFA) and peracetic acid (PAA) are used to disinfect CSO water, in order to reduce the number of indicator bacteria. Moreover, PFA and PAA do not form toxic by-products when they react with the ammonia present in the CSO. Disinfectant dose and contact time in the present study were designed by disinfecting a laboratory-simulated CSO with different wastewater concentrations. Degradation kinetics of PFA and PAA in the simulated CSO as well as the disinfection efficiency were studied. PAA degradation in the simulated CSO was slower compared to the degradation of PFA, the latter of which, at a dose (1-8 mg/L) and with 10 minutes’ contact time, efficiently removed 4.2 logs of E. coli and 3 logs of Enterococcus spp from the simulated CSO. Furthermore, the ecotoxicity of the residual disinfectants PFA, PAA and chlorine dioxide (ClO2), and their degradation products hydrogen peroxide and chlorite, in relation to organisms in the aquatic ecosystem was studied. With the help of ecotoxicity data, a preliminary environmental risk assessment of PFA, PAA and ClO2 for CSO disinfection was done, to ensure the safety of the aquatic ecosystem in the receiving waters. This assessment could also be used to obtain permission from authorities for full-scale disinfection. Based on the maximum allowable concentration quality standards for the freshwater and predicted residual concentrations of PFA, PAA and ClO2, a minimum dilution factor (590 times for PFA, 138 times for PAA and 700 times for ClO2) is needed for discharge into the surface water, to avoid the risk of toxic effect in the aquatic environment, albeit the rapid degradation of PFA and ClO2 in water will not have an acute toxic effect, and lower dilution factors may also be safe for the receiving waters.

PFA and PAA were applied for the full-scale disinfection of CSO in two different Danish CSO structures. In the first CSO events, 2-8 mg/L PFA with 20 minutes’ contact time efficiently reduced E. coli and Enterococcus spp below the limit mentioned in EU directive 2006/7/EC, when treated CSO was diluted into the Øresund strait. In the second CSO event, however, low PFA (1-4 mg/L) failed to reduce the number of E. coli and Enterococcus spp bacteria below the limit mentioned in the EU directive, even after dilution, entering the Øresund. PAA was used for full-scale disinfection when CSO was pretreated with chemical coagulation and through the HydroSeparator to remove suspended solids. During the CSO event, 10 mg/L PAA reduced Enterococcus spp from 105.5 MPN per 100 mL to 103.7 MPN per 100 ml with 10 minutes’ contact time. Microbial profiles, made by measuring Enterococcus spp before and after a CSO event, revealed that the numbers of Enterococcus spp post-disinfection were almost the same as pre-existing Enterococcus spp in the first recipient. To summarise, frequent closures of recreational areas can be minimised by chemically disinfecting CSOs before discharging into surface waters.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Urban Water Systems
Authors: Chhetri, R. K. (Intern), Andersen, H. R. (Intern), Albrechtsen, H. (Intern)
Number of pages: 42
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Original language: English
Main Research Area: Technical/natural sciences
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Thesis_online_version_Ravi_Chhetri.pdf. Embargo ended: 24/12/2017

Relations
Projects:
Chemical disinfection of combined sewer overflows
Co-cultivation of Green Microalgae and Methanotrophic Bacteria for Single Cell Protein Production from Wastewater

Conventional water treatment technologies remove nutrients via resource intensive processes. However, new approaches for residual nutrient recycling are needed to provide food to the increasing world population. This work explores the use of microbial biomass – methane oxidizing bacteria and green microalgae – as a means to recover nutrients from industrial wastewater and upcycle them to feed grade single cell protein. Results demonstrated that both algae and bacteria could remove or assimilate most of the organic carbon present in the wastewater. However, their growth stopped before nutrients and substrates in the gas phase (i.e., methane and oxygen for methanotrophs and carbon dioxide for algae) were depleted. Likely, algal growth was light limited and stopped after organic carbon was consumed, whilst growth of methanotrophic bacteria could be limited by trace elements (e.g., copper). Nevertheless, the amino acid profile of both the monocultures and the algal-bacteria consortium was suitable for substitution of conventional protein sources. Further research should focus on increasing productivity of biomass grown on wastewater resources.

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering, Water Technologies, Technical University of Denmark
Authors: Rasouli, Z. (Ekstern), Valverde Pérez, B. (Intern), D'Este, M. (Intern), De Francisci, D. (Intern), Angelidaki, I. (Intern)
Number of pages: 1
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Publisher: Technical University of Denmark (DTU)
Article number: Sustain Abstract R-11
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ABSTRACT
ABSTRACT BOOK
Source: PublicationPreSubmission
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Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2017

Comammox Nitrospira are key nitrifiers in diverse groundwater-fed drinking water filters

Nitrification is a dominant process in groundwater-fed rapid sand filters (RSFs) used for drinking water purification. Near complete removal of ammonium and nitrite is required in the EU and Denmark due to strict regulatory limits that enable high water stability in the distribution system. RSFs are a unique environment harboring diverse microbial communities including a range of ammonia oxidizers (AOs); Betaproteobacterial ammonia oxidizers (Nitrosomonas, Nitrosospira), ammonia oxidizing archaea, diverse heterotrophs and a large fraction of Nitrospira spp., which in one studied filter have been shown to comprise both nitrite oxidizers as well as complete nitrifying (comammox) Nitrospira spp. (Palomo et al. 2016). We developed a new qPCR assay for the quantification of the comammox Nitrospira amoA gene which amplifies both clades A and B and applied this assay to the study of 12 drinking water treatment plants across Denmark. We further sequenced amplicons of the 16S rRNA gene of total Bacteria and amoA gene of Nitrospira to examine the microbial biodiversity present in the filters. Our results show that comammox Nitrospira are present in high abundance making up an average of 19% of the microbial communities in the examined filters. While members of both clades A (41 sequence variants) and B (47 sequence variants) were both present in high abundance, the majority of comammox diversity (70-90% in each filter) was made up by clade B. Ordination analysis with variance partitioning was performed on the total microbial communities and the comammox Nitrospira communities to identify physicochemical parameters of the influent water, filter material, or operational parameters which influenced the community structures in an effort to understand the success of comammox Nitrospira in these filters. Our results show that comammox Nitrospira are present in high abundance making up an average of 19% of the microbial communities in the examined filters. Temperature as well as the sulfate and calcium content of the influent water made significant contributions towards explaining both the total and comammox community structures, while the iron content of the filter material made a significant contribution to explaining only the structure of the comammox Nitrospira communities. Further examination of groundwater-fed RSFs with higher variability in microbial communities and physicochemical parameters may provide further information on the ecology of comammox Nitrospira and explain their success in the groundwater-fed filters examined in this study. Together this work provides a new assay for the simultaneous detection of clade A and B comammox Nitrospira and expands our current knowledge of the diversity of comammox Nitrospira, while attempting to explain the success of comammox Nitrospira in these groundwater-fed filters.

General information
State: Published
Combined forward osmosis-reverse osmosis for the treatment of brewery wastewater

Both UV treatment and ozonation are used to reduce different types of disinfection by-products (DBPs) in swimming pools. UV treatment is the most common approach, as it is particularly efficient at removing combined chlorine. However, the UV treatment of pool water increases chlorine reactivity and the formation of chloro-organic DBPs such as trihalomethanes. Based on the similar selective reactivity of ozone and chlorine, we hypothesised that the created reactivity to chlorine, as a result of the UV treatment of dissolved organic matter in swimming pool water, might also be expressed as increased reactivity to ozone. Moreover, ozonation might saturate the chlorine reactivity created by UV treatment and mitigate increased formation of a range of volatile DBPs. We found that UV treatment makes pool water highly reactive to ozone. The subsequent reactivity to chlorine decreases with increasing ozone dosage prior to contact with chlorine. Furthermore, ozone had a half-life of 5 min in non-UV treated pool water whereas complete consumption of ozone was obtained in less than 2 min in UV treated pool water. The ozonation of UV-treated pool water induced the formation of some DBPs that are not commonly reported in this medium, in particular trichloronitromethane, which is noteworthy for its genotoxicity, though this issue was removed by UV treatment when repeated combined UV/ozone treatment interchanging with chlorination was conducted over a 24-h period. The discovered reaction could form the basis for a new treatment method for swimming pools.
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SJR 2.601 SNIP 2.358
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.49 SJR 2.663 SNIP 2.563
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.665 SNIP 2.482 CiteScore 6.63
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.946 SNIP 2.702 CiteScore 6.13
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.676 CiteScore 6.02
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.914 SNIP 2.442 CiteScore 5.15
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.862 SNIP 2.355 CiteScore 5.43
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.592 SNIP 2.192
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.319 SNIP 2.224
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.073 SNIP 2.178
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.94 SNIP 2.184
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.902 SNIP 2.233
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.113 SNIP 2.334
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.209 SNIP 2.108
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.702 SNIP 1.908
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.568 SNIP 1.757
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.319 SNIP 1.69
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.399 SNIP 1.662
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.432 SNIP 1.55
Concentration of downstream effluents from pharmaceutical industry using Aquaporin Inside™ hollow fiber forward osmosis membranes - Influence of flow conditions on membrane performance

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Aquaporin A/S, Technical University of Denmark, GSK Vaccines S.r.l.
Authors: Camilleri Rumbau, M. S. (Forskerdatabase), Vargas, L. C. (Ekstern), Romagnoli, A. (Ekstern), Trzaskus, K. (Ekstern), Gad, E. (Ekstern), Hélix-Nielsen, C. (Intern)
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Place of publication: San Francisco, CA, USA
Article number: 06.42
Main Research Area: Technical/natural sciences
Conference: 11th International Congress on Membranes and Membrane Processes (ICOM 2017), San Francisco, CA, United States, 29/07/2017 - 29/07/2017
Forward osmosis, Pharmaceutical effluents, Flow patterns, Draw dosing
Electronic versions:
Abstract book
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2017

Converting wastewater into fertilizing irrigation

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Danish Technological Institute, Minor Change Group, Samse spildevand
Authors: Litty, K. (Ekstern), Lindholst, S. (Ekstern), Mikkelsen, N. (Ekstern), Moestrup, N. (Ekstern), Aagaard, J. (Ekstern), Rasmussen, P. E. (Ekstern), Heinen, N. (Ekstern), Haase, J. (Ekstern), Andersen, H. R. (Intern)
Pages: 26-26
Publication date: 2017

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Title of host publication: Abstract proceedings - 11th annual meeting danish water forum
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Editors: Flindt Jørgensen, L., Mosolff Larsen, T., Jensen, B. K.
Main Research Area: Technical/natural sciences
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Abstract proceedings book

Relations
Activities:
Copper dosing enhances nitrification in biofilters treating groundwater

Counter-diffusion biofilms have lower N₂O emissions than co-diffusion biofilms during simultaneous nitrification and denitrification: Insights from depth-profile analysis

General information
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Organisations: Department of Environmental Engineering, Urban Water Systems, Water Technologies, Krüger A/S
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The goal of this study was to investigate the effectiveness of a membrane-aerated biofilm reactor (MABR), a representative of counter-current substrate diffusion geometry, in mitigating nitrous oxide (N₂O) emission. Two laboratory-scale reactors with the same dimensions but distinct biofilm geometries, i.e., a MABR and a conventional biofilm reactor (CBR) employing co-current substrate diffusion geometry, were operated to determine depth profiles of dissolved oxygen (DO), nitrous oxide (N₂O), functional gene abundance and microbial community structure. Surficial nitrogen removal rate was slightly higher in the MABR (11.0 ± 0.80 g-N/(m² day) than in the CBR (9.71 ± 0.94 g-N/(m² day), while total organic carbon removal efficiencies were comparable (96.9 ± 1.0% for MABR and 98.0 ± 0.8% for CBR). In stark contrast, the dissolved N₂O concentration in the MABR was two orders of magnitude lower (0.011 ± 0.001 mg N₂O-N/L) than that in the CBR (1.38 ± 0.25 mg N₂O-N/L), resulting in distinct N₂O emission factors (0.0058 ± 0.0005% in the MABR vs. 0.72 ± 0.13% in the CBR). Analysis on local net N₂O production and consumption rates unveiled that zones for N₂O production and consumption were adjacent in the MABR biofilm. Real-time quantitative PCR indicated higher abundance of denitrifying genes, especially nitrous oxide reductase (nosZ) genes, in the MABR versus the CBR. Analyses of the microbial community composition via 16S rRNA gene amplicon sequencing revealed the abundant presence of the genera Thauera (31.2 ± 11%), Rhizobium (10.9 ± 6.6%), Stenotrophomonas (6.8 ± 2.7%), Sphingobacteria (3.2 ± 1.1%) and Brevundimonas (2.5 ± 1.0%) as potential N₂O-reducing bacteria in the MABR.

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Nanoporous networks of covalent organic polymers (COPs) are successfully grafted on the surfaces of activated carbons, through a series of surface modification techniques, including acyl chloride formation by thionyl chloride. Hybrid composites of activated carbon functionalized with COPs exhibit a core-shell formation of COP material grafted to the outer layers of activated carbon. This general method brings features of both COPs and porous carbons together for target-specific environmental remediation applications, which was corroborated with successful adsorption tests for organic dyes and metals.
Density and distribution of nitrifying guilds in rapid sand filters for drinking water production: Dominance of Nitrospira spp.

We investigated the density and distribution of total bacteria, canonical Ammonia Oxidizing Bacteria (AOB) (Nitrosomonas plus Nitrosospira), Ammonia Oxidizing Archaea (AOA), as well as Nitrobacter and Nitrospira in rapid sand filters used for groundwater treatment. To investigate the spatial distribution of these guilds, filter material was sampled at four drinking water treatment plants (DWTPs) in parallel filters of the pre- and after-filtration stages at different locations and depths. The target guilds were quantified by qPCR targeting 16S rRNA and amoA genes. Total bacterial densities (ignoring 16S rRNA gene copy number variation) were high and ranged from 109 to 1010 per gram (1015 to 1016 per m3) of filter material. All examined guilds, except AOA, were stratified at only one of the four DWTPs. Densities varied spatially within filter (intra-filter variation) at two of the DWTPs and in parallel filters (inter-filter variation) at one of the DWTPs. Variation analysis revealed random sampling as the most efficient strategy to yield accurate mean density estimates, with collection of at least 7 samples suggested to obtain an acceptable (below half order of magnitude) density precision. Nitrospira was consistently the most dominant guild (5–10% of total community), and was generally up to 4 orders of magnitude more abundant than Nitrobacter and up to 2 orders of magnitude more abundant than canonical AOBs. These results, supplemented with further analysis of the previously reported diversity of Nitrospira in the studied DWTPs based on 16S rRNA and nxrB gene phylogeny (Gülay et al., 2016; Palomo et al., 2016), indicate that the high Nitrospira abundance is due to their comammox (complete ammonia oxidation) physiology. AOA densities were lower than AOB densities, except in the highly stratified filters, where they were of similar abundance. In conclusion, rapid sand filters are microbially dense, with varying degrees of spatial heterogeneity, which requires replicate sampling for a sufficiently precise determination of total microbial community and specific population densities. A consistently high Nitrospira to bacterial and archaeal AOB density ratio suggests that non-canonical pathways for nitrification may dominate the examined RSFs.
RSF, Nitrifying guilds, AOB, NOB, AOA, Comammox, Nitrospira

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**Destruction of DBPs and their precursors in swimming pool water by combined uv-treatment and ozonation**

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Development and validation of a novel monitoring system for batch flocculant solids settling process

Secondary sedimentation is the main hydraulic bottleneck of effective pollution control WWTP under wetweather flow conditions. Therefore, online monitoring tools are required for control and optimization of the settling process under dynamic conditions. In this work we propose a novel monitoring system able to monitor batch settling tests by tracking the sludge blanket height and solid concentration along the column in the range of 1 to 8 g L⁻¹. The system could be efficiently applied to monitor the batch settling tests of several full scale treatment plants run under different operational conditions.

Diffusion and sorption of organic micropollutants in biofilms with varying thicknesses

Solid-liquid partitioning is one of the main fate processes determining the removal of micropollutants in wastewater. Little is known on the sorption of micropollutants in biofilms, where molecular diffusion may significantly influence partitioning kinetics. In this study, the diffusion and the sorption of 23 micropollutants were investigated in novel moving bed biofilm reactor (MBBR) carriers with controlled biofilm thickness (50, 200 and 500 μm) using targeted batch experiments (initial concentration = 1 μg L⁻¹, for X-ray contrast media 15 μg L⁻¹) and mathematical modelling. We assessed the influence of biofilm thickness and density on the dimensionless effective diffusivity coefficient f (equal to the biofilm-to-aqueous diffusivity ratio) and the distribution coefficient Kd,eq (L g⁻¹). Sorption was significant only for eight positively charged micropollutants (atenolol, metoprolol, propranolol, citalopram, venlafaxine, erythromycin, clarithromycin and roxithromycin), revealing the importance of electrostatic interactions with solids. Sorption equilibria were likely not reached within the duration of batch experiments (4 h), particularly for the thickest biofilm, requiring the calculation of the distribution coefficient Kd,eq based on the approximation of the asymptotic equilibrium concentration (t > 4 h). Kd,eq values increased with increasing biofilm thickness for all sorptive micropollutants (except atenolol), possibly due to higher porosity and accessible surface area in the thickest biofilm. Positive correlations between Kd,eq and micropollutant properties (polarity and molecular size descriptors) were identified but not for all biofilm thicknesses, thus confirming the challenge of improving predictive sorption models for positively charged compounds. A diffusion-sorption model was developed and calibrated against experimental data, and estimated f values also increased with increasing biofilm thickness. This indicates that diffusion in thin biofilms may be strongly limited (f ≪ 0.1) by the high biomass density (reduced porosity).
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Discovery and description of complete ammonium oxidizers in groundwater-fed rapid sand filters

Microbial communities are directly linked with process performance in several engineered systems. In the last century, intense study of microorganisms has contributed to optimize important environmental biotechnologies such as the activated sludge process or anaerobic digestion. However, less attention has been paid to the role of microorganisms in drinking water treatment technologies. In contrast, much effort has been devoted to eliminate potential pathogens in the drinking water treatment and supply systems. Nevertheless, the role of microorganisms in some drinking water treatment systems as biological filtration has long been acknowledged and recently been investigated. Biological filtration technology is widely used around the world and is especially important in Denmark as groundwater is the main source water for drinking water production. Because the groundwater has a relative high-quality, aeration followed by biological filtration is the only required treatment before distribution. In the last years, the microbial communities in rapid gravity sand filters, the typical biological filter used in Denmark, have been characterized, but little knowledge had been required about their physiological activity and roles in compound removal from the source water. This PhD project focused on a comprehensive investigation of the microbial communities in rapid sand filters beyond their purely taxonomical identification. For this purpose, samples collected from a rapid sand filter were subjected to metagenomics analysis and genome recovery to identify the genetic capacities of the dominant types in the microbial community. Fourteen near-complete population genomes representing the dominant community were recovered comprising the capacity to grow on the typical compounds found in groundwater. The identified population genomes contained capabilities to oxidize ammonium, nitrite, methane, hydrogen sulfide, iron and manganese as well as to assimilate organic compounds. A composite population genome was assigned to Nitrospira. This genus had previously been found in multiple rapid sand filters at an unexplained high abundance. Nitrospira spp. are known to perform the second step of nitrification: oxidation of nitrite to nitrate. The two-step nitrification process disclosed at the end of the 19th century was assumed to be carried out by two different functional groups, ammonia oxidizing prokaryotes and nitrite oxidizing bacteria. Strikingly, the Nitrospira composite population genome not only contained the genes to oxidize nitrite to nitrate, but also the genetic potential to execute the first step of nitrification. Exhaustive bioinformatics investigation ruled out the possibility of coexistence between the Nitrospira and Nitrosomonas species. Consequently, we detected the complete ammonium oxidation (comammox) pathway. At the same time, evidence of a single microbe’s capacity to carry out complete nitrification was obtained by three other groups; in all cases the comammox type belonged to the Nitrospira genus.

To further investigate the genomic capacities of comammox Nitrospira, the Nitrospira composite genome was separated into individual population genomes using a differential coverage binning approach. As a result, five individual genomes were recovered, four of them containing the complete ammonium oxidation pathway. These genomes together with 11 high-quality publically available Nitrospira genomes (seven comammox and four strict nitrite oxidizers) were subject to a comparative genomics analysis. This examination showed specific genomic features for comammox, strict nitrite oxidizers and the two comammox clades. Thus, comammox Nitrospira harbour a higher variety of genes related to adaptation to nutrient-limited environments. The two comammox clades differ in their ammonium uptake affinity systems. Additionally, comammox Nitrospira genomes lack the genetic capacity to use nitrite as the only nitrogen source. The evolutionary history of comammox Nitrospira was also examined based on protein dissimilarity, gene arrangement and reconciliation analysis. We detected a high probability of horizontal gene transfer events from betaproteobacterial ammonia oxidizers to comammox Nitrospira for genes belonging to the ammonium oxidation pathway as well as from comammox clade B to clade A for a subset of genes.

I investigated the abundance of comammox Nitrospira in rapid sand filters at 12 different waterworks in Denmark. As these new microorganisms are taxonomically similar to strict Nitrospira nitrite oxidizers, we developed specific primers to exclusively target comammox based on their gene encoding the ammonia monoxygenase subunit A. With these primers, we detected comammox Nitrospira as the dominant nitrifier in the biofilters with an abundance typically one order of magnitude higher than canonical ammonium oxidizing prokaryotes. Lastly, I carried out lab-scale experiments with filter material from the top and bottom layers of a rapid sand filter containing different proportions of comammox Nitrospira, and strict nitrite and ammonia oxidizing prokaryotes under different loading conditions. Specifically, I exposed the filter material to distinct ammonium loading, under presence or absence of external carbon source as well as under oxygen limitation. In relation to the nitrifying community three main findings were made: (i) simultaneous growth of comammox Nitrospira and ammonium oxidizing prokaryotes; (ii) lower fitness of ammonium oxidizing archaea at higher temperatures; (iii) selection of comammox clade A over clade B at increasing ammonium loadings at reference temperature. Overall, this PhD has provided insights into the genomic capacities of the main types in the microbial community of a groundwater-fed biological filter. Moreover, the previously observed high abundances of Nitrospira spp. in rapid sand filters, has now been explained, by the discovery of complete ammonium oxidizing (comammox) Nitrospira from metagenomics analysis. In addition, this thesis presents the first extensive analysis of the genomic capabilities of comammox Nitrospira compared to canonical ammonium and nitrite oxidizers.
Dramatic loss of comammox Nitrospira associated with long-term nitrite feeding

Until recently, nitrification was thought to be a strict two-step process where ammonia was first oxidized to nitrite by ammonia-oxidizing bacteria and/or archaea, and subsequently to nitrate by nitrite oxidizing bacteria (NOB). Recent studies in NOB metabolism, however, have revealed that certain Nitrospira are capable of performing both steps, resulting in complete ammonia oxidation (comammox) by single microorganisms. These comammox Nitrospira have been detected in drinking water (Pinto et al., 2015; Palomo et al., 2016) and aquaculture systems (van Kessel et al., 2015), as well as deep oil exploration wells (Daims et al., 2015). The discovery of comammox Nitrospira has significantly changed our understanding of biogeochemical nitrogen cycle. The goal of this experiment was to determine the extent of competition between comammox Nitrospira and canonical Nitrospira in ammonium scarce environment, with nitrite as the main energy source. Community assembly was monitored on well-established biofilms formed on the grains of rapid sand filter (RSF) for drinking water production. RSF sand was placed in laboratory scale column bioreactors and subjected to continuous feeding of tap water spiked with NO2- (1 mg-N/L) for 250 days. The biofilms were then characterized by Illumina MiSeq platform, targeting the 16S rRNA gene. The relative abundance of a putative comammox clade B Nitrospira sequence variant (with 100% 16S rRNA gene similarity to comammox CG24_A assembled genome) identified in the initial RSF sand (Palomo et al., unpublished) at a relative abundance of 12.4±1.1%, was not detected in 4 out of 6 replicates after 250 days. Similar trend was observed for other putative comammox clade B Nitrospira sequence variants. In contrast, we observed significant increase (padj<0.001) in canonical Nitrospira sequences (100% similarity to uncultured Nitrospira sp. clone KC836101 (Pester et al., 2014)). These observations indicate different behavior of Nitrospira in the absence of ammonia and point to a possible competitive advantage of canonical Nitrospira in environments where nitrite is the sole nitrogen, as well as energy source. In addition, the results suggest that other comammox Nitrospira could also be unable to grow in the only presence of nitrite as it was observed for comammox Ca. Nitrospira inopinata (Daims et al., 2015).
Dynamics of $\text{N}_2\text{O}$ production pathways analyzed by $^{15}\text{N}^{18}\text{O}$ isotope labeling

Nitrous oxide production associated with biological nitrogen transformations can contribute substantially to the CO2 footprint of both man-made and natural systems, but the pathways and regulation of N2O production are poorly understood. We developed a 15N/18O dual isotope labelling technique to distinguish and quantify these pathways in mixed communities. The use of 18O-O2 permits differentiation of hydroxylamine oxidation and nitrifier-denitrification driven N2O production by ammonium oxidizing bacteria. We analysed N2O production pathways during biological nitrogen removal at Lynetten wastewater treatment plant. Under anoxia, N2O accumulated due to denitrification, but N2O accumulation was ~3 and 1.7 times higher at 30 and 100 µM O2, respectively. Oxic N2O production was dominated by nitrifier-denitrification, reaching 73% of the total with the remainder due to hydroxylamine oxidation. Our results demonstrate three active pathways of N2O production, each with different environmental controls. The dual 15N/18O isotope labelling approach can contribute to the development of strategies to minimise N2O emissions from man-made and natural systems.

Effect of medium-pressure UV-lamp treatment on disinfection by-products in chlorinated seawater swimming pool waters

Several brominated disinfection by-products (DBPs) are formed in chlorinated seawater pools, due to the high concentration of bromide in seawater. UV irradiation is increasingly employed in freshwater pools, because UV treatment photodegrades harmful chloramines. However, in freshwater pools it has been reported that post-UV chlorination promotes the formation of other DBPs. To date, UV-based processes have not been investigated for DBPs in seawater pools. In this study, the effects of UV, followed by chlorination, on the concentration of three groups of DBPs were investigated in laboratory batch experiments using a medium-pressure UV lamp. Chlorine consumption increased following post-UV chlorination, most likely because UV irradiation degraded organic matter in the pool samples to more chlorine-reactive organic matter. Hailoacetionic acid (HAA) concentrations decreased significantly, due to photo-degradation, but the concentrations of trihalomethanes (THMs) and haloacetonitriles (HANs) increased with post-UV chlorination. Bromine incorporation in HAA and was significantly higher in the control samples chlorinated without UV irradiation but decreased significantly with UV treatment. Bromine incorporation was promoted in THM and HAN after UV and chlorine treatment. Overall, the accumulated bromine incorporation level in DBPs remained essentially unchanged in comparison with the control samples. Toxicity estimates increased with single-dose UV and chlorination, mainly due to increased HAN concentrations. However, brominated HANs are known in the literature to degrade following further UV treatment.
Effect of UV treatment on DBPs formation in chlorinated seawater swimming pools - a laboratory study

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Effect of UV treatment on formation of disinfection by-products in chlorinated seawater swimming pools

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Effect of UV treatment on formation of disinfection by-products in chlorinated seawater swimming pools

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Efficient pharmaceutical removal from (hospital) wastewater by staged-moving bed biofilm reactors (MBBRs) followed by ozonation

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Environmental impacts and resource losses of incinerating misplaced household special wastes (WEEE, batteries, ink cartridges and cables)
The contribution of misplaced special waste (sWEEE, lamps, CRT, batteries, ink cartridges and cables) to environmental impacts from incineration of residual household waste was quantified through life cycle assessment (LCA)-modelling. Misplaced special waste was quantified to constitute less than 1% of the net impact for most environmental impact categories, except for the toxic impact categories (4–28% of toxic impacts) and the impact on abiotic resource depletion. It was found that the main contributor (96%) to the toxic impact categories was related to the presence of mercury (Hg) from lamps and batteries. However as shown by sensitivity analysis, lack of good data on the transfer of rare and hazardous metals to the flue gas in the incineration process should receive further investigation before the environmental impacts from misplaced incinerated special waste can fully be concluded upon. Although the misplaced special waste is only 0.5% of residual household waste, it constitutes in the residual household waste the most significant fraction with respect to metal content when iron and aluminum are excluded. By extending the boundary of the LCA beyond the traditional “zero burden boundary”, we were able to quantify the impact of abiotic resources not recovered from incineration residues. This appeared to be a significant impact category, and the special waste contributed about 96% of this category although it by weight makes up only 0.5% of the waste. Furthermore, enhancing the recovery of iron (Fe) and aluminum (Al) from the ashes would not affect the loss of abiotic resources significantly. Only by recovering elements as platinum (Pt), copper (Cu), gold (Au), and silver (Ag) would it be possible to reduce the loss of abiotic resources from the system. These elements are primarily found in misplaced special waste (sWEEE, lamps, CRT, batteries, ink cartridges, and cables).

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Environmental performance of household waste management in Europe - an example of 7 countries
An attributional life cycle assessment (LCA) of the management of 1 ton of household waste was conducted in accordance
with ISO 14044:2006 and the ILCD Handbook for seven European countries, namely Germany, Denmark, France, UK,
Italy, Poland and Greece, representing different household waste compositions, waste management practices,
technologies, and energy systems. National data were collected from a range of sources regarding household waste
composition, household sorting efficiency, collection, waste treatments, recycling, electricity and heat composition, and
technological efficiencies. The objective was to quantify the environmental performance in the different countries, in order
to analyze the sources of the main environmental impacts and national differences which affect the results. In most of the
seven countries, household waste management provides environmental benefits when considering the benefits of
recycling of materials and recovering and utilization of energy. Environmental benefits come from paper recycling and, to a
lesser extent, the recycling of metals and glass. Waste-to-energy plants can lead to an environmental load (as in France)
or a saving (Germany and Denmark), depending mainly on the composition of the energy being substituted. Sensitivity
analysis and a data quality assessment identified a range of critical parameters, suggesting from where better data should
be obtained. The study concluded that household waste management is environmentally the best in European countries
with a minimum reliance on landfilling, also induced by the implementation of the Waste Hierarchy, though environmental
performance does not correlate clearly with the rate of material recycling. From an environmental point of view, this calls
for a change in the waste management paradigm, with less focus on where the waste is routed and more of a focus on the
quality and utilization of recovered materials and energy.

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Scopus rating (2015): SJR 1.53 SNIP 1.579 CiteScore 3.49
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.726 SNIP 1.78 CiteScore 3.65
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.672 SNIP 1.978 CiteScore 3.35
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.529 SNIP 1.707 CiteScore 2.89
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.595 SNIP 1.737 CiteScore 2.82
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.447 SNIP 1.826
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.247 SNIP 1.644
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.885 SNIP 1.397
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.813 SNIP 1.222
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.573 SNIP 1.339
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.648 SNIP 1.777
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.653 SNIP 1.437
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.517 SNIP 1.731
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.288 SNIP 0.954
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Bisinella_2016_Erratum_global_approach_uncertainty_LCA.pdf. Embargo ended: 15/02/2018
Establishment and calibration of consensus process model for nitrous oxide dynamics in water quality engineering

Research on biological nitrogen removal (BNR) in wastewater treatment plants (WWTP) has historically focused on achieving good effluent quality, with more recent attention to energy savings and carbon dioxide (CO2) footprints. Novel processes and operating conditions are being implemented that enhance cost and energy efficiency in BNR, while maintaining effluent quality. Now, increasing attention is placed on direct emissions of nitrous oxide (N2O) as by-product of BNR; N2O is a greenhouse gas (GHG) with a high warming potential and also an ozone depleting chemical compound. Several N2O production pathways have been identified from pure culture studies, while mechanisms are still being unravelled. Heterotrophic bacteria (HB) and ammonium oxidizing bacteria (AOB) are well known to produce N2O. However, the effect of environmental factors on N2O production is not yet well understood. Current process modelling efforts aim to reproduce experimental data with mathematical equations, structuring our understanding of the system. Various mechanistic models with different structures describing N2O production have been proposed, but no consensus exists between researchers. Hence, the existing plant-wide GHG models still lack a complete biological process model that can be integrated in a methodology that assesses N2O emissions and their impact on overall plant performance. A mathematical model structure that describes N2O production during biological nitrogen removal is proposed. Two autotrophic and one heterotrophic biological pathways are coupled with abiotic processes. The model stoichiometry and process rates synthesize a comprehensive literature review on the metabolism of microbes involved in nitrogen removal. The proposed model can describe all relevant NO and N2O production pathways with fewer parameters than present in other proposed models. A novel experimental design based on the developed model and on extant respirometric techniques is introduced. Monitoring dissolved oxygen and N2O allowed the isolation of individual processes and the estimation of parameters associated to oxygen consumption (endogenous activity, nitrite and ammonium oxidation) and N2O production (NN, ND and HD pathway contributions). To estimate parameters of the N2O model a rigorous procedure is presented as a case study. The calibrated model predicts the NO and N2O dynamics at varying ammonium, nitrite and dissolved oxygen levels in two independent systems: (a) an AOB-enriched biomass and (b) activated sludge (AS) mixed liquor biomass. A total of ten (a) and seventeen (b) parameters are identified with high accuracy (coefficients of variation < 25%). The critical validation of the model response and the estimated parameter values represent a novel and rigorous tool for N2O modelling studies. For the first time, uncertainty associated with parameter estimation from N2O models is reported; this procedure is recommended to be included with best-fit simulations. Additionally, modelling electron competition in heterotrophic processes is explored via an analogy to current intensity through resistors in electric circuits. While further model validation is required, this approach captured the electron competition during denitrification for four different carbon sources. Overall, a combination of modelling and experimental efforts to study N2O dynamics was successfully implemented. Results represent a step forward in the development of consensus process model for N2O emissions in WQE processes.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Department of Chemical and Biochemical Engineering, CAPEC-PROCESS
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Main Research Area: Technical/natural sciences
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Fertilizer driven forward osmosis as a low energy technology for sodium removal in greenhouse applications

General information
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Forward Osmosis in Wastewater Treatment Processes

In recent years, membrane technology has been widely used in wastewater treatment and water purification. Membrane technology is simple to operate and produces very high quality water for human consumption and industrial purposes. One of the promising technologies for water and wastewater treatment is the application of forward osmosis. Essentially, forward osmosis is a process in which water is driven through a semipermeable membrane from a feed solution to a draw solution due to the osmotic pressure gradient across the membrane. The immediate advantage over existing pressure driven membrane technologies is that the forward osmosis process per se eliminates the need for operation with high hydraulic pressure and forward osmosis has low fouling tendency. Hence, it provides an opportunity for saving energy and membrane replacement cost. However, there are many limitations that still need to be addressed. Here we briefly review some of the applications within water purification and new developments in forward osmosis membrane fabrication.
From biofilm ecology to reactors: a focused review

Biofilms are complex biostructures that appear on all surfaces that are regularly in contact with water. They are structurally complex, dynamic systems with attributes of primordial multicellular organisms and multifaceted ecosystems. The presence of biofilms may have a negative impact on the performance of various systems, but they can also be used beneficially for the treatment of water (defined herein as potable water, municipal and industrial wastewater, fresh/brackish/salt water bodies, groundwater) as well as in water stream-based biological resource recovery systems. This review addresses the following three topics: (1) biofilm ecology, (2) biofilm reactor technology and design, and (3) biofilm modeling. In so doing, it addresses the processes occurring in the biofilm, and how these affect and are affected by the broader biofilm system. The symphonic application of a suite of biological methods has led to significant advances in the understanding of biofilm ecology. New metabolic pathways, such as anaerobic ammonium oxidation (anammox) or complete ammonium oxidation (comammox) were first observed in biofilm reactors. The functions, properties, and constituents of the biofilm extracellular polymeric substance matrix are somewhat known, but their exact composition and role in the microbial conversion kinetics and biochemical transformations are still to be resolved. Biofilm grown microorganisms may contribute to increased metabolism of micro-pollutants. Several types of biofilm reactors have been used for water treatment, with current focus on moving bed biofilm reactors, integrated fixed-film activated sludge, membrane-supported biofilm reactors, and granular sludge processes. The control and/or beneficial use of biofilms in membrane processes is advancing. Biofilm models have become essential tools for fundamental biofilm research and biofilm reactor engineering and design. At the same time, the divergence between biofilm modeling and biofilm reactor modeling approaches is recognized.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Volkert, Inc, Arizona State University, Delft University of Technology, ETH Zurich, University of Michigan
Functional nanostructured materials for stormwater runoff treatment

Numerous heavy metal removal practices for stormwater runoff have been studied and applied; however, there is still room for improvement. Among these practices, adsorption has proven to be the most efficient way of removing heavy metals. Commonly used adsorbents have an innate sorption capacity in relation to high concentrations of heavy metal ions, but if they are to be used for stormwater runoff, high affinity with rapid sorption kinetics for low concentrations of heavy metals is necessary. Therefore, in this study, new types of functional nanostructured polymer sorbents for effective heavy metal removal from stormwater are suggested.

First, comparison studies of several existing polymer sorbents were conducted, to find decisive functional groups for removing heavy metals from the solution. To enhance the sorption kinetics and affinity of polymer sorbents in the presence of competing ions, sulphur functional groups and polar functional groups in the polymer networks were found to be imperative. Based on this result, new types of covalently connected polymer sorbents were devised and characterised. One of the novel polymer sorbents, disulphide-linked polymer (COP-63), was selected for perusing heavy metal sorption behaviour. Although COP-63 has a moderate surface area, it demonstrated cadmium removal efficiency equivalent to highly porous activated carbon (AC), while it also exhibited 16 times faster sorption kinetics compared to AC, owing to high affinity towards disulphide and thiol functionality. The chemisorption mechanism of sorbents was confirmed by sorption kinetics, the effects of pH and metal complexation. The metal ions copper, cadmium and zinc showed high binding affinity towards the polymer sorbent, even in the presence of competing cations in the form of calcium.

To retrofit polymer sorbents for a real stormwater filter, controlling the size of sorbents by formulating composites was applied. The first composites were obtained by grafting polymer onto granular-AC through acyl chlorination (DiS-AC), and the formulation of composites was confirmed by various characterisation techniques. DiS-AC demonstrated 89 L/g sorption affinity for cadmium, which is notably higher than conventional sorbents’ sorption affinity. Furthermore, within an hour, half of the trace amounts of cadmium ions were removed by the DiS-AC, even in a batch test. Other composites were obtained by embedding the polymer particles on the surface of an alginate bead (DiS-algi). Moreover, the sorption capacity of DiS-algi was 22.3 mg/g, and within 6 minutes, half of the cadmium had been removed with 31 L/mg of Langmuir sorption affinity, outperforming an AC filter.

Moreover, DiS-algi was used to build the reactive filtration column for simulating a real stormwater treatment filter. A breakthrough test of the reactive column showed the complete uptake of cadmium from a contaminated flow, lasting two hours until reaching the breakthrough point. The maximum sorption capacity of the reactive column was 877 µg/g. Furthermore, regeneration tests of the column verified its reusability. Based on the results of this PhD, novel polymer and composites sorbents are proposed for distinct uses. The devised functional nanostructured polymers confirmed their potential for efficient heavy metal removal, and the simulation of a real-life stormwater filter was successful. Therefore, the novel polymer sorbents herein proved to be viable materials for stormwater runoff filtration systems.

General information
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Organisations: Department of Environmental Engineering, Water Technologies, Department of Micro- and Nanotechnology, Surface Engineering, Korea Advanced Institute of Science and Technology, Seoul National University
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Publisher: Department of Environmental Engineering, Technical University of Denmark (DTU)
Future scenario development within life cycle assessment of waste management systems

Life Cycle Assessment (LCA) is an acknowledged tool for quantifying the sustainability of waste management solutions. However, the use of LCA for decision-making is hindered by the strong dependency of the LCA results on the assumptions regarding the future conditions in which the waste management solutions will operate. Future scenario methods from the management engineering field may provide valid approaches for formulating consistent assumptions on future conditions for the waste management system modelled with LCA. However, the standardized LCA procedure currently does not offer much guidance on how to model future scenarios in LCA.

This thesis highlights critical findings aiming at strengthening the role of LCA in decision support and strategic planning for waste management. In particular, the thesis thoroughly investigated the future scenario methods, the existing guidance on modelling of future scenarios in LCA, all peer-reviewed articles in the literature combining future scenarios and LCA, across sectors, and the specific modelling mechanisms occurring in LCA when assessing future scenarios. For each of these aspects, the thesis investigated the specific needs of the waste management field. The quantitative modelling implications were tested within real-scale LCA models focusing on the management of residual waste in Denmark. In a wide range of scenarios, this thesis addressed the influence on the LCA model results of realistic technology and waste composition uncertainties, as well as the effects of implementing future energy scenarios and design-stage technologies. The thesis underlines that future scenarios can be used to formulate consistent assumptions for waste management systems. However, in order to obtain well-founded quantitative results with LCA, the implementation of future scenarios should comply with the following conditions:

Future scenarios should include important aspects identified within the case-specific LCA model. Important aspects can be identified from a preliminary LCA, but should always be evaluated again after implementing the future scenarios in LCA.

Identification of important aspects (such as parameters of the modelled technologies, waste composition, and framework conditions) ultimately governing the LCA results of the future scenarios should be regarded as a fundamental part of the future scenario process and be communicated to the final receivers of the LCA. The main outcome of this thesis is a systematic framework that can be used to assess future scenarios in LCAs of waste management systems. The framework combines approaches developed during the PhD study in order to systematically address the modelling implications of combining future scenarios and LCAs of waste management systems.

The study developed a systematic definition of importance of LCA model parameters based on their input uncertainty and their sensitivity on results with a Global Sensitivity Analysis (GSA) approach. Within LCAs of waste management systems, the GSA approach allowed quantifying the importance of the waste composition versus the more commonly tested technology parameters. Less than 10 waste composition parameters as well as 5-6 technology parameters, out of a total of 750 waste and technology parameters in the LCA model, were found important for the results across all tested impact categories. These findings were used to improve existing step-wise approaches for quantification of uncertainty in LCA. Moreover, this PhD study provided a novel method to quantitatively determine the most robust waste management solution across several future scenarios combining results of uncertainty analysis and scenario analysis into a simple and conveyable score.

The systematic framework for future scenarios in LCA should start from a preliminary LCA carried out on the case-specific system and identifying the important aspects with the GSA approach. The future scenarios can be formulated with whichever future scenario technique in preference, including the important aspects identified in the preliminary LCA. Then, the future scenarios can be implemented in further LCAs. A subsequent determination of important parameters with GSA is fundamental for identifying the aspects of the model ultimately governing the future scenario results and any necessary revisions in the future scenarios or model data. Finally, sustainability on the long-term can be strengthened by the combined use of uncertainty and scenario analysis. This means that the LCA results can be communicated as probabilities of each individual waste solution being environmentally better compared to the others, together with a clear indication of which aspects and parameters critically affect the performance of the solution.

The proposed systematic framework can be adapted to LCAs carried out in all fields and can also be used to quantitatively carry out systematic scenario analyses on the assumptions of present-day LCAs.
Heterotrophs are key contributors to nitrous oxide production in mixed liquor under low C-to-N ratios during nitrification – batch experiments and modelling

Nitrous oxide (N2O), a by-product of biological nitrogen removal during wastewater treatment, is produced by ammonia-oxidizing bacteria (AOB) and heterotrophic denitrifying bacteria (HB). Mathematical models are used to predict N2O emissions, often including AOB as the main N2O producer. Several model structures have been proposed without consensus calibration procedures. Here, we present a new experimental design that was used to calibrate AOB-driven N2O dynamics of a mixed culture. Even though AOB activity was favoured with respect to HB, oxygen uptake rates indicated HB activity. Hence, rigorous experimental design for calibration of autotrophic N2O production from mixed cultures is essential. The proposed N2O production pathways were examined using five alternative process models confronted with experimental data inferred. Individually, the autotrophic and heterotrophic denitrification pathway could describe the observed data. In the best-fit model, which combined two denitrification pathways, the heterotrophic was stronger than the autotrophic contribution to N2O production. Importantly, the individual contribution of autotrophic and heterotrophic to the total N2O pool could not be unambiguously elucidated solely based on bulk N2O measurements. Data on NO would increase the practical identifiability of N2O production pathways.
How much can we trust data from the real world? Assessing the performance of online sensors for CSO monitoring when operated in non-ideal conditions

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Systems, Water Technologies, Technical University of Denmark
Authors: Skov, L. S. (Ekstern), Chhetri, R. K. (Intern), Vezzaro, L. (Intern)
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Place of publication: Prague, Czech Republic
Main Research Area: Technical/natural sciences
Hybrid Moving Bed Biofilm Reactor for the biodegradation of benzotriazoles and hydroxy-benzothiazole in wastewater

A laboratory scale Hybrid Moving Bed Biofilm Reactor (HMBBR) was used to study the removal of five benzotriazoles and one benzothiazole from municipal wastewater. The HMBBR system consisted of two serially connected fully aerated bioreactors that contained activated sludge (AS) and K3-biocarriers and a settling tank. The average removal of target compounds ranged between 41% (4-methyl-1H-benzotriazole; 4TTR) and 88% (2-hydroxybenzothiazole; OHBTH). Except for 4TTR, degradation mainly occurred in the first bioreactor. Calculation of biodegradation constants in batch experiments and application of a model for describing micropollutants removal in the examined system showed that AS is mainly involved in biodegradation of OHBTH, 1H-benzotriazole (BTR) and xylytriazole (XTR), carriers contribute significantly on 4TTR biodegradation, while both types of biomass participate on elimination of 5-chlorobenzotriazole (CBTR) and 5-methyl-1H-benzotriazole (5TTR). Comparison of the HMBBR system with MBBR or AS systems from literature showed that the HMBBR system was more efficient for the biodegradation of the investigated chemicals. Biotransformation products of target compounds were identified using ultra high-performance liquid chromatography, coupled with a quadrupole-time-of-flight high-resolution mass spectrometer (UHPLC-QToF-MS). Twenty two biotransformation products were tentatively identified, while retention time denoted the formation of more polar transformation products than the parent compounds.

General information

State: Published
Organisations: Department of Environmental Engineering, Water Technologies, National Kapodistrian University of Athens, University of the Aegean
Authors: Mazioti, A. A. (Ekstern), Stasinakis, A. S. (Ekstern), Psoma, A. K. (Ekstern), Thomaidis, N. S. (Ekstern), Andersen, H. R. (Intern)
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.96 SJR 1.787
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.31 SJR 1.742 SNIP 2.061
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.633 SNIP 1.931 CiteScore 5.54
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.814 SNIP 2.258 CiteScore 5.21
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.822 SNIP 2.43 CiteScore 5.09
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.953 SNIP 2.443 CiteScore 4.73
Impact of external carbon dose on the removal of micropollutants using methanol and ethanol in post-denitrifying Moving Bed Biofilm Reactors

Addition of external carbon sources to post-denitrification systems is frequently used in wastewater treatment plants to enhance nitrate removal. However, little is known about the fate of micropollutants in post-denitrification systems and the influence of external carbon dosing on their removal. In this study, we assessed the effects of two different types and availability of commonly used carbon sources - methanol and ethanol - on the removal of micropollutants in biofilm systems. Two laboratory-scale moving bed biofilm reactors (MBBRs), containing AnoxKaldnes K1 carriers with acclimated biofilm from full-scale systems, were operated in continuous-flow using wastewater dosed with methanol and ethanol, respectively. Batch experiments with 22 spiked pharmaceuticals were performed to assess removal kinetics. Acetylsulfadiazine, atenolol, citalopram, propranolol and trimethoprim were easily biotransformed in both MBBRs (biotransformation rate constants $k_{bio}$ between 1.2 and 12.9 L gbiomass(-1) d(-1)); 13 compounds were moderately biotransformed (rate constants between 0.2 and 2 L gbiomass(-1) d(-1)) and 4 compounds were recalcitrant. The methanol-dosed MBBR showed higher $k_{bio}$ (e.g., 1.5-2.5-fold) than in the ethanol-dosed MBBR for 9 out of the 22 studied compounds, equal $k_{bio}$ for 10 compounds, while 3 compounds (i.e., targeted sulfonamides) were biotransformed faster in the ethanol-dosed MBBR. While biotransformation of most of the targeted compounds followed first-order kinetics, removal of venlafaxine, carbamazepine, sulfamethoxazole and sulfamethizole could be described with a cometabolic model. Analyses of the microbial composition in the biofilms using 16S rRNA amplicon sequencing revealed that the methanol-dosed MBBR contained higher microbial richness than the one dosed with ethanol, suggesting that improved biotransformation of targeted compounds could be associated with higher microbial richness. During continuous-flow operation, at conditions representative of full-scale denitrification systems (hydraulic residence time = 2 h), the removal efficiencies of micropollutants were below 35% in both MBBRs, with the exception of atenolol and trimethoprim (>80%).
Overall, this study demonstrated that MBBRs used for post-denitrification could be optimized to enhance the biotransformation of a number of micropollutants by accounting for optimal carbon sources and extended residence time.

**General information**

State: Published  
Organisations: Department of Environmental Engineering, Water Technologies, Environmental Chemistry, Aarhus University  
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BFI (2018): BFI-level 2  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 2  
Scopus rating (2017): SJR 2.601 SNIP 2.358  
Web of Science (2017): Indexed yes  
BFI (2016): BFI-level 2  
Scopus rating (2016): CiteScore 7.49 SJR 2.663 SNIP 2.563  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 2  
Scopus rating (2015): SJR 2.665 SNIP 2.482 CiteScore 6.63  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 2  
Scopus rating (2014): SJR 2.946 SNIP 2.702 CiteScore 6.13  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 2  
Scopus rating (2013): SJR 2.956 SNIP 2.676 CiteScore 6.02  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 2  
Scopus rating (2012): SJR 2.914 SNIP 2.442 CiteScore 5.15  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 2  
Scopus rating (2011): SJR 2.862 SNIP 2.355 CiteScore 5.43  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 2  
Scopus rating (2010): SJR 2.592 SNIP 2.192  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 2  
Scopus rating (2009): SJR 2.319 SNIP 2.224  
Web of Science (2009): Indexed yes  
BFI (2008): BFI-level 2  
Scopus rating (2008): SJR 2.073 SNIP 2.178  
Web of Science (2008): Indexed yes  
Scopus rating (2007): SJR 1.94 SNIP 2.184  
Web of Science (2007): Indexed yes  
Scopus rating (2006): SJR 1.902 SNIP 2.233  
Web of Science (2006): Indexed yes
Importance of waste composition for Life Cycle Assessment of waste management solutions
The composition of waste materials has fundamental influence on environmental emissions associated with waste
treatment, recycling and disposal, and may play an important role also for the Life Cycle Assessment (LCA) of waste
management solutions. However, very few assessments include effects of the waste composition and waste LCAs often
rely on poorly justified data from secondary sources. This study systematically quantifies the influence and uncertainty on
LCA results associated with selection of waste composition data. Three archetypal waste management scenarios were
modelled with the waste LCA model EASETECH based on detailed waste composition data from the literature. The
influence from waste composition data on the LCA results was quantified with a step-wise Global Sensitivity Analysis
(GSA) approach involving contribution, sensitivity, uncertainty and discernibility analyses. The waste composition data
contributed significantly to the LCA results and the uncertainty associated with these results. The importance of 405
individual waste properties was evaluated in comparison with 345 technology parameters. Overall, less than 10 physico-
chemical properties dominated the output uncertainty of the LCA results, although these properties had low sensitivity in
the model. Moreover, the uncertainties associated with the physico-chemical properties were responsible for output
uncertainties that spanned from impacts to benefits. The GSA approach applied in this study constitutes a valuable tool for
systematically assessing the importance of waste composition and for consciously collecting and using waste composition
data within LCAs of waste management systems.

General information
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Organisations: Department of Environmental Engineering, Residual Resource Engineering, Department of Applied
Mathematics and Computer Science , Image Analysis & Computer Graphics, Atmospheric Environment, Water
Technologies
Authors: Bisinella, V. (Intern), Götze, R. (Intern), Conradsen, K. (Intern), Damgaard, A. (Intern), Christensen, T. H. (Intern)
, Astrup, T. F. (Intern)
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Main Research Area: Technical/natural sciences

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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SJR 1.467 SNIP 2.194
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Influence of humic acid addition on the degradation of pharmaceuticals by biofilms in effluent wastewater

The degradation of organic micropollutants in wastewater treatment is suspected to depend on co-degradation i.e. be dependent on concentrations of substrate. This complicates predicting and modelling their fate. The effect of humic acid, as a model for complex organic substrate, was investigated in relation to the biodegradation of pharmaceuticals by suspended biofilm carriers adapted to polishing effluent water from a tertiary sewage treatment plant. Twelve out of 22 investigated pharmaceuticals were significantly biodegradable. The biodegradation rate constants of ten of those...
compounds were increasing with increased humic acid concentrations. At the highest humic acid concentration (30 mgC/L), the biodegradation rate constants were four times higher than the biodegradation rate constants without added humic acid. This shows that the presence of complex substrate stimulates degradation via a co-metabolism-like mechanism and competitive inhibition does not occur. Increases of rate constant per mgC/L are tentatively calculated.

General information
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Organisations: Department of Environmental Engineering, Water Technologies, Aarhus University
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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.262 SJR 1.334
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.22 SJR 1.437 SNIP 1.482
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.452 SNIP 1.278 CiteScore 3.84
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.32 SNIP 1.652 CiteScore 3.61
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.175 SNIP 1.417 CiteScore 3.3
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.505 SNIP 1.641 CiteScore 3.62
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.212 SNIP 1.386 CiteScore 3.02
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.251 SNIP 1.45
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.88 SNIP 1.167
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.762 SNIP 1.1
Scopus rating (2007): SJR 0.717 SNIP 1.173
Scopus rating (2006): SJR 0.693 SNIP 1.221
Scopus rating (2005): SJR 0.614 SNIP 0.867
Scopus rating (2004): SJR 0.628 SNIP 0.933
Scopus rating (2003): SJR 0.398 SNIP 0.706
Scopus rating (2002): SJR 0.286 SNIP 0.693
Scopus rating (2001): SJR 0.221 SNIP 0.482
Scopus rating (2000): SJR 0.141 SNIP 0.194
Scopus rating (1999): SJR 0.132 SNIP 0.388
In-situ UV-Vis Probe to Monitor Algal Photobioreactors Treating Municipal Wastewater

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Technical University of Denmark, Swiss Federal Institute of Aquatic Science and Technology
Authors: Valverde Pérez, B. (Intern), Wágner, D. S. (Intern), Steidl, M. (Ekstern), Villez, K. (Ekstern), Plósz, B. G. (Intern)
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Intermittent Aeration Suppresses Nitrite-Oxidizing Bacteria in Membrane-Aerated Biofilms: A Model-Based Explanation

Autotrophic ammonium oxidation in membrane-aerated biofilm reactors (MABRs) can make treatment of ammonium-rich wastewaters more energy-efficient, especially within the context of short-cut ammonium removal. The challenge is to exclusively enrich ammonium-oxidizing bacteria (AOB). To achieve nitritation, strategies to suppress nitrite-oxidizing bacteria (NOB) are needed, which are ideally grounded on an understanding of underlying mechanisms. In this study, a nitrifying MABR was operated under intermittent aeration. During eight months of operation, AOB dominated, while NOB were suppressed. On the basis of dissolved oxygen (DO), ammonium, nitrite, and nitrate profiles within the biofilm and in the bulk, a 1-dimensional nitrifying biofilm model was developed and calibrated. The model was utilized to explore the potential mechanisms of NOB suppression associated with intermittent aeration, considering DO limitation, direct pH effects on enzymatic activities, and indirect pH effects on activity via substrate speciation. The model predicted strong periodic shifts in the spatial gradients of DO, pH, free ammonia, and free nitrous acid, associated with aerated and nonaerated phases. NOB suppression during intermittent aeration was mostly explained by periodic inhibition caused by free ammonia due to periodic transient pH upshifts. Dissolved oxygen limitation did not govern NOB suppression. Different intermittent aeration strategies were then evaluated for nitritation success in intermittently aerated MABRs: both aeration intermittency and duration were effective control parameters.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Ma, Y. (Intern), Domingo Felez, C. (Intern), Plósz, B. G. (Intern), Smets, B. F. (Intern)
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Pages: 6146-6155
Publication date: 2017
Main Research Area: Technical/natural sciences
Invasion in microbial communities: Role of community composition and assembly processes

Microbes contribute to all biogeochemical cycles on earth and are responsible for key biological processes that support the survival of plants and animals. There is increased interest in controlling and managing microbial communities in different ecosystems in order to make targeted microbiological processes more effective. In order to manage microbial communities, it is essential to understand the factors that shape and influence microbial community composition. In addition to abiotic factors, such as environmental conditions and resource availability, biotic factors also shape the dynamics of microbial community assembly. Biotic factors include interactions between different microbial groups as well as the community response to alien species – invaders.

Microbial invasions can have significant effects on the composition and functioning of resident communities. There is, however, lack of agreement on the core determinants of invasion in microbial communities. Current models and concepts for invasion in microbial ecology are largely based on the macro-ecology literature. Although attempts have been made to examine the applicability of these concepts to microbial communities, a general conceptual framework for microbial invasion applicable across ecosystems is missing. The overall aim of this PhD project was therefore to propose a conceptual framework to study microbial community invasion and to test this framework against experimental observations.

Based on a synthesis of earlier frameworks on invasion and community ecology, I defined invasion in a microbial community as the establishment of an alien microbial type in a resident community and have proposed simple criteria to define aliens, residents, and alien establishment, applicable across a wide variety of communities. I suggested the adoption of the community ecology framework advanced by Vellend (2010) to identify determinants of invasion. This framework lists the four fundamental processes that govern community assembly as: dispersal, selection, drift and diversification. We have suggested that it is important to determine which processes dominate the assembly of a resident community in order to understand what governs invasion in that community.

To test invasion in microbial communities while controlling the processes driving community assembly, I developed a high-throughput flow-through experimental microcosm system that enabled me to manipulate the relative importance of selection versus drift during initial community assembly. I used this new system to establish resident microbial biofilm communities dominated by nitrite-oxidizing bacteria, where the direction of selection as well as contribution of drift was manipulated through differential nitrite loading rates.

Subsequently, I experimentally characterized the community assembly processes in the biofilm communities, using replicate communities assembled under same conditions. Both total community and guild-level analyses provided evidence for contribution of neutral processes (drift) combined with selection. More precisely, I observed the deterministic enrichment of certain types of nitrite-oxidizing bacteria in the biofilms: elevated nitrite loading selected for a single Nitrotoga representative, while lower nitrite conditions selected for a number of Nitrospira.

I then repeated the assembly experiment and subjected the assembled biofilms to invasion by a Nitrotoga HW29 culture. I found no significant (negative) correlation between community diversity and invasion success, in contrast with the often cited diversity/invasibility relationship. Instead, I observed that at high phylogenetic similarity between invader and resident types, the effect of selection is surpassed by the effect of drift on invasion success. My results suggest that controlling invasion in communities that contain members that are phylogenetically similar to the invader is nearly impossible because stochastic processes determine the invasion outcome when selection towards invader and resident community is similar. In conclusion, during this PhD project I proposed a simple conceptual framework to study and characterize microbial communities, using replication of processes we can manipulate the relative importance of selection versus drift during initial community assembly. Both total community and guild-level analyses provided evidence for contribution of neutral processes (drift) combined with selection. More precisely, I observed the deterministic enrichment of certain types of nitrite-oxidizing bacteria in the biofilms: elevated nitrite loading selected for a single Nitrotoga representative, while lower nitrite conditions selected for a number of Nitrospira.

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**Liquid chromatography-tandem mass spectrometry determination of synthetic cathinones and phenethylamines in influent wastewater of eight European cities**

The popularity of new psychoactive substances (NPS) has grown in recent years, with certain NPS commonly and preferentially consumed even following the introduction of preventative legislation. With the objective to improve the knowledge on the use of NPS, a rapid and very sensitive method was developed for the determination of ten priority NPS (N-ethylcathinone, methylenedioxyxypyrvalerone (MDPV), methylone, butylone, methedrone, mephedrone, naphyrone, 25-C-NBOMe, 25-I-NBOMe and 25-B-NBOMe) in influent wastewater. Sample clean-up and pre-concentration was made by off-line solid phase extraction (SPE) with Oasis MCX cartridges. Isotopically labelled internal standards were used to correct for matrix effects and potential SPE losses. Following chromatographic separation on a C18 column within 6 min, the compounds were measured by tandem mass spectrometry in positive ionization mode. The method was optimised and validated for all compounds. Limits of quantification were evaluated by spiking influent wastewater samples at 1 or 5 ng/L. An investigation into the stability of these compounds in influent wastewater was also performed, showing that, following acidification at pH 2, all compounds were relatively stable for up to 7 days. The method was then applied to influent wastewater samples from eight European countries, in which methedrone, methylone and MDPV were detected. This reveals that although NPS use is not as extensive as for classic illicit drugs, the application of a highly sensitive analytical procedure makes their detection in wastewater possible. The developed analytical methodology forms the basis of a subsequent model-based back-calculation of abuse rate in urban areas (i.e. wastewater-based epidemiology).

**General information**

State: Published

Organisations: Department of Environmental Engineering, Water Technologies

Authors: Bade, R. (Ekstern), Bijlsma, L. (Ekstern), Sancho, J. V. (Ekstern), Baz-Lomba, J. A. (Ekstern), Castiglioni, S. (Ekstern), Castrignanò, E. (Ekstern), Causanilles, A. (Ekstern), Gracia-Lor, E. (Ekstern), Kasprzyk-Hordern, B. (Ekstern), Kinyua, J. (Ekstern), McCall, A. (Ekstern), van Nuijs, A. L. (Ekstern), Ort, C. (Ekstern), Plozs, B. G. (Intern), Ramin, P. (Intern), Rousis, N. I. (Ekstern), Ryu, Y. (Ekstern), Thomas, K. V. (Ekstern), de Voogt, P. (Ekstern), Zuccato, E. (Ekstern),
Low nitrous oxide production in intermittent-feed high performance nitritating reactors

Nitrous oxide (N₂O) production from autotrophic nitrogen removal processes, especially nitritating systems, is of growing concern. N₂O dynamics were characterized and N₂O production factors were quantified in two lab-scale intermittent-feed nitritating SBRs. 93 ± 14% of the oxidized ammonium was converted to nitrite, with the average total net N₂O production of 2.1 ± 0.7% of the ammonium oxidized. Operation with intermittent feeding appears an effective optimization approach to mitigate N₂O emissions from nitritating systems. Net N₂O production rates transiently increased with a rise in pH after each feeding, indicating a potential role of pH in N₂O production.

Low nitrous oxide production through nitrifier-denitrification in intermittent-feed high-rate nitritation reactors

Nitrous oxide (N₂O) production from autotrophic nitrogen conversion processes, especially nitritation systems, can be significant, requires understanding and calls for mitigation. In this study, the rates and pathways of N₂O production were quantified in two lab-scale sequencing batch reactors operated with intermittent feeding and demonstrating long-term and high-rate nitritation. The resulting reactor biomass was highly enriched in ammonia-oxidizing bacteria, and converted ∼93 ± 14% of the oxidized ammonium to nitrite. The low DO set-point combined with intermittent feeding was sufficient to maintain high nitritation efficiency and high nitritation rates at 20-26 °C over a period of ~300 days. Even at the high nitritation efficiencies, net N₂O production was low (∼2% of the oxidized ammonium). Net N₂O production rates transiently increased with a rise in pH after each feeding, suggesting a potential effect of pH on N₂O production. In situ application of 15N labeled substrates revealed nitrifier denitrification as the dominant pathway of N₂O production. Our study highlights operational conditions that minimize N₂O emission from two-stage autotrophic nitrogen removal systems.
Measuring biomarkers in wastewater as a new source of epidemiological information: Current state and future perspectives

The information obtained from the chemical analysis of specific human excretion products (biomarkers) in urban wastewater can be used to estimate the exposure or consumption of the population under investigation to a defined substance. A proper biomarker can provide relevant information about lifestyle habits, health and wellbeing, but its selection is not an easy task as it should fulfil several specific requirements in order to be successfully employed. This paper aims to summarize the current knowledge related to the most relevant biomarkers used so far. In addition, some potential wastewater biomarkers that could be used for future applications were evaluated. For this purpose, representative chemical classes have been chosen and grouped in four main categories: (i) those that provide estimates of lifestyle factors and substance use, (ii) those used to estimate the exposure to toxicants present in the environment and food, (iii) those that have the potential to provide information about public health and illness and (iv) those used to estimate the population size. To facilitate the evaluation of the eligibility of a compound as a biomarker, information, when available, on stability in urine and wastewater and pharmacokinetic data (i.e. metabolism and urinary excretion profile) has been reviewed. Finally, several needs and recommendations for future research are proposed.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Gracia-Lor, E. (Ekstern), Castiglioni, S. (Ekstern), Bade, R. (Ekstern), Been, F. (Ekstern), Casrignanò, E. (Ekstern), Covaci, A. (Ekstern), Gonzalez-Mariño, I. (Ekstern), Hapeshi, E. (Ekstern), Kasprzyk-Hordern, B. (Ekstern), Kinyua, J. (Ekstern), Lai, F. Y. (Ekstern), Letzel, T. (Ekstern), Lopardo, L. (Ekstern), Meyer, M. R. (Ekstern), O'Brien, J. (Ekstern), Ramin, P. (Intern), Rousis, N. I. (Ekstern), Ryu, Y. (Ekstern), Santos, M. M. (Ekstern), Senta, I. (Ekstern), Thomaidis, N. S. (Ekstern), Veloutsou, S. (Ekstern), Yang, Z. (Ekstern), Zuccato, E. (Ekstern), Bijlsma, L. (Ekstern)
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Web of Science (2017): Indexed yes
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.544 SNIP 2.125 CiteScore 6.49
Web of Science (2015): Indexed yes
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Scopus rating (2014): SJR 2.708 SNIP 2.303 CiteScore 6.54
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Membrane-aerated Nitrifying Biofilms: Continuous versus Intermittent Aeration

This study evaluated the process performance of a lab-scale membrane-aerated nitrifying biofilm under continuous versus intermittent aeration regimes. Effects of intermittent aeration on the competition between individual microbial communities and the emission of nitrous oxide (N2O) were specifically studied. The principle observation under continuous aeration was more efficient ammonium removal (4.3 gNH4+_N/m2/day) but also higher N2O emission (2.9% of the N loading) and minor anaerobic ammonium oxidizer (AMX) activity compared to intermittent aeration (3.1 gNH4+_N/m2/day, 0.3% of the N loading). AMX activity increased at the expense of decreasing nitrite oxidizer (NOB) activity with intermittent aeration.

Dissolved oxygen and pH microprofiles under each aeration regimes revealed that the dynamic variation of pH relevant effects could be the potential causes to these different performances. A high intermittency in aeration favors the suppression of NOB with positive effects on N2O emission reduction.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Technical University of Denmark
Metal stressors consistently modulate bacterial conjugal plasmid uptake potential in a phylogenetically conserved manner

The environmental stimulants and inhibitors of conjugal plasmid transfer in microbial communities are poorly understood. Specifically, it is not known whether exposure to stressors may cause a community to alter its plasmid uptake ability. We assessed whether metals (Cu, Cd, Ni, Zn) and one metalloid (As), at concentrations causing partial growth inhibition, modulate community permissiveness (that is, uptake ability) against a broad-host-range IncP-type plasmid (pKJK5). Cells were extracted from an agricultural soil as recipient community and a cultivation-minimal filter mating assay was conducted with an exogenous E. coli donor strain. The donor hosted a gfp-tagged pKJK5 derivative from which conjugation events could be microscopically quantified and transconjugants isolated and phylogenetically described at high resolution via FACS and 16S rRNA amplicon sequencing. Metal stress consistently decreased plasmid transfer frequencies to the community, while the transconjugal pool richness remained unaffected with OTUs belonging to 12 bacterial phyla. The taxonomic composition of the transconjugal pools was distinct from their respective recipient communities and clustered dependent on the stress type and dose. However, for certain OTUs, stress increased or decreased permissiveness by more than 1000-fold and this response was typically correlated across different metals and doses. The response to some stresses was, in addition, phylogenetically conserved. This is the first demonstration that community permissiveness is sensitive to metal(loid) stress in a manner that is both partially consistent across stressors and phylogenetically conserved.

The ISME Journal advance online publication, 2 August 2016; doi:10.1038/ismej.2016.98.
Microbial biotechnologies for potable water production
Sustainable Development Goal 6 requires the provision of safe drinking water to the world. We propose that increased exploitation of biological processes is fundamental to achieving this goal due to their low economic and energetic costs. Biological processes exist for the removal of most common contaminants, and biofiltration processes can establish a biologically stable product that retains high quality in distribution networks, minimizing opportunities for pathogen invasion.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Fowler, S. J. (Intern), Smets, B. F. (Intern)
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Main Research Area: Technical/natural sciences

Publication information
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Scopus rating (2016): CiteScore 3.56
Scopus rating (2015): CiteScore 3.59
Scopus rating (2014): CiteScore 3.19
Scopus rating (2013): CiteScore 3
ISI indexed (2013): ISI indexed no
Scopus rating (2012): CiteScore 2.7
ISI indexed (2012): ISI indexed no
Scopus rating (2011): CiteScore 1.92
Model-based identification of chemicals transformation pathways combined with reaction kinetics models– the case of heroin biomarkers in wastewater

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Department of Chemical and Biochemical Engineering, CAPEC-PROCESS, Environmental Chemistry
Authors: Ramin, P. (Intern), Valverde Pérez, B. (Intern), Polesel, F. (Intern), Gernaey, K. (Intern), Plósz, B. G. (Intern)
Number of pages: 4
Publication date: 2017
Event: Abstract from Frontiers International Conference on Wastewater Treatment (FICWTM2017), Palermo, Italy.
Main Research Area: Technical/natural sciences
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Modelling biotransformation of drug biomarkers by sewer biofilms

General information
State: Published
Organisations: Water Technologies, Department of Chemical and Biochemical Engineering, CAPEC-PROCESS, Department of Environmental Engineering, Environmental Chemistry, University of Bath
Authors: Ramin, P. (Intern), Polesel, F. (Intern), Valverde Pérez, B. (Intern), Brock, A. L. (Intern), Flores Alsina, X. (Intern), Gernaey, K. (Intern), Plósz, B. G. (Ekstern)
Number of pages: 4
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Event: Abstract from 10th International Conference on Biofilm Reactors, Dublin, Ireland.
Main Research Area: Technical/natural sciences
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Modelling of green microalgal growth and algal storage processes using wastewater resources
Recent research focuses on the recovery of nutrients, water and energy from wastewater. Microalgal cultivation on wastewater resources is considered as a more sustainable means to produce fertilizers or biofuels. Innovative systems that incorporate microalgal cultivation into conventional wastewater processes have been developed. The effective design, optimisation and control of these systems require modelling tools that can readily extend existing benchmark models with new sub-models. Several process models have been developed to simulate algal growth. Some models include only one variable, e.g., light, whereas others include multiple variables, such as pH, nitrogen, phosphorus and organic carbon. This chapter aims to collect and describe green microalgal process models that can be used in wastewater resource recovery systems together with their limitations. Some of the listed models have been developed according to the activated sludge modelling (ASM) framework to facilitate the integration with existing modelling frameworks in water treatment. This chapter presents in detail the recently developed ASM-A biokinetic green microalgal process model. The model includes phototrophic and heterotrophic algal growth and uptake and storage of nutrients, including both nitrogen and phosphorus.

General information
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Moving bed biofilm reactors (MBBRs) for removal of pharmaceuticals in biological wastewater treatment

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Environmental Chemistry, AnoxKaldnes AB
Authors: Torresi, E. (Intern), Polesel, F. (Intern), Smets, B. F. (Intern), Andersen, H. R. (Intern), Plósz, B. G. (Intern), Christensson, M. (Ekstern)
Number of pages: 1
Publication date: 2017
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N2O and NO dynamics in AOB-enriched and mixed-culture biomass: Experimental Observations and Model Calibration

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Organisations: Department of Environmental Engineering, Water Technologies, Department of Chemical and Biochemical Engineering
Authors: Domingo-Felez, C. (Intern), Plósz, B. G. (Intern), Sin, G. (Intern), Smets, B. F. (Intern)
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N2O and NO dynamics in AOB-enriched and mixed-culture biomass: Experimental Observations and Model Calibration

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Department of Chemical and Biochemical Engineering
Authors: Domingo-Felez, C. (Intern), Plósz, B. G. (Intern), Sin, G. (Intern), Smets, B. F. (Intern)
Number of pages: 1
Publication date: 2017
Event: Abstract from ICoN5: 5th International Conference on Nitrification, Vienna, Austria.
Niche differentiation and evolution of comammox Nitrospira through a comparative genomics analysis

Nitrification, the biological oxidation of ammonium to nitrate, is a fundamental process in the nitrogen cycle and plays an important role in natural and engineered systems. Throughout the last century, nitrification was assumed to be a two-step process executed by two different functional groups, ammonia oxidizing prokaryotes (AOP) and nitrite oxidizing bacteria (NOB). Recently, several articles have shown the capability of a single microorganism, belonging to the genus Nitrospira, to carry out the complete oxidation of ammonia to nitrate (comammox). Nitrospira spp. are widespread in both natural and engineered ecosystems associated with nitrogen cycling and different species are frequently observed to coexist in the same environment. Besides recent discoveries pointing towards versatile metabolism in some Nitrospira species, little is known about the functional potential of the two comammox Nitrospira clades, and the factors involved in niche-partitioning between comammox and canonical Nitrospira.

A comparative genomics analysis was conducted with five genomes recovered from a groundwater-fed rapid sand filter (including both comammox clades and a nitrite-oxidizing Nitrospira population genome) and high quality published Nitrospira genomes, to reveal distinct genomic features within Nitrospira. In addition, we investigated the evolution of the ammonia oxidation pathway in comammox Nitrospira. This analysis revealed distinct genetic capabilities of the different comammox clades and canonical Nitrospira which can help to explain the coexistence and niche partitioning of Nitrospira spp. These divergences range from the nitrogen source utilization capacity to the ability for electron donor versatility, and other characteristics such as stress response. With respect to the evolutionary history of comammox Nitrospira, our analysis indicates transfer events with betaproteobacterial ammonia oxidizers. In addition, transfer events between comammox clade A and clade B were also detected for genes belonging to the ammonium oxidation pathway.

Together, these results expand the actual knowledge of the ecology and evolution of the recently discovered comammox Nitrospira.

Niche partitioning within genus Nitrospira is affected by environmental copper concentration

Nitrification is a dominant process in groundwater-fed rapid sand filters (RSFs) used for drinking water purification. Near complete removal of ammonium and nitrite is required in the EU and Denmark due to strict regulatory limits that enable high water stability in the distribution system. Previous work has revealed that in poorly functioning filters, the addition of trace copper can increase the rate of nitrification, leading to increased removal of ammonium and nitrite to below regulatory levels. RSFs are a unique environment harboring diverse microbial communities including a range of nitrifying bacteria; Betaproteobacterial ammonia oxidizers (Nitrosomonas, Nitrosospira; AOB), ammonia oxidizing archaea (AOA), diverse heterotrophs potentially capable of ammonia and/or nitrite oxidation and a large fraction of Nitrospira spp.. This diversity points towards extensive niche partitioning within the nitrifying guild, and particularly within Nitrospira which generally comprises between 10 and 65% of the total filter community. Copper is a co-factor in the ammonia monooxygenase enzyme and is thus an essential and at times limiting nutrient in nitrifying environments. We sought to examine the effects of copper on niche partitioning within the genus Nitrospira in full-scale filters. Sand samples from the top of an after-filter that displayed incomplete ammonium oxidation at Nærørum waterworks were taken prior to Cu dosing treatment and 4 months following the commencement of low-level Cu dosing (~ μg Cu L⁻¹). Copper treatment had an immediate effect on nitrification, resulting in removal of ammonium and nitrite to below regulatory levels. DNA was extracted from sand samples and was subject to qPCR and amplicon based Illumina sequencing of Nitrospira nxrB (nitrite reductase B-subunit) and amoA genes using newly designed primers targeting clades A and B comammox. Quantitative PCR revealed that Cu addition resulted in a 4-fold
Increase of total Nitrospira, but a 5-fold decrease in the abundance of comammox Nitrospira. However, further examination of the qPCR melt curves and amoA sequence data revealed that the reduction in comammox Nitrospira resulted from the near complete loss of Clade B comammox, while Clade A comammox were present at similar absolute abundances as in the community prior to copper dosing. The reasons for the loss of Clade B comammox are currently unclear. Higher sensitivity to copper toxicity in Clade B relative to Clade A and nitrite-oxidizing Nitrospira seems unlikely due to the extremely low copper concentrations applied. An overall stimulation of the growth of nitrifying bacteria occurred once copper limitation was removed, likely resulting in the out-competition of Clade B Nitrospira ammonium oxidizers. These results suggest that copper availability plays a role in determining the diversity and distribution of Nitrospira spp. in nitrifying environments.

**General information**

State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Urban Water Systems
Authors: Fowler, J. (Intern), Dechesne, A. (Intern), Wagner, F. B. (Intern), Diwan, V. (Intern), Albrechtsen, H. (Intern), Smets, B. F. (Intern)
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Main Research Area: Technical/natural sciences
Electronic versions: AbstractICON_Fowler.pdf
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Nitrogen recovery from wastewater to produce microbial protein using methane oxidizing bacteria

**General information**

State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Residual Resource Engineering, Technical University of Denmark
Authors: Xing, W. (Ekstern), Valverde Pérez, B. (Intern), Pape, M. L. (Ekstern), De Francisci, D. (Intern), Smets, B. F. (Intern)
Number of pages: 2
Publication date: 2017
Event: Abstract from Conference on Sustainable Wastewater Treatment and Resource Recovery: Research, Planning, Design and Operation, Chongqing, China.
Main Research Area: Technical/natural sciences
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Electronic versions: Abstract_2017_NRR_ChongQing_F.pdf
Source: PublicationPreSubmission
Source-ID: 139066476
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2017

Nitrotoga is selected over Nitrospira in newly assembled biofilm communities from a tap water source community at increased nitrite loading

Community assembly is a central topic in microbial ecology: how do assembly processes interact and what is the relative contribution of stochasticity and determinism? Here, we exposed replicate flow-through biofilm systems, fed with nitrite-supplemented tap water, to continuous immigration from a source community, present in the tap water, to determine the extent of selection and neutral processes in newly assembled biofilm communities at both the community and the functional guild (of nitrite-oxidizing bacteria, NOB) levels. The community composition of biofilms assembled under low and high nitrite loading was described after 40 days of complete nitrite removal. The total community assembly, as well as the NOB guild assembly were largely governed by a combination of deterministic and stochastic processes. Furthermore, we observed deterministic enrichment of certain types of NOB in the biofilms. Specifically, elevated nitrite loading selected for a single Nitrotoga representative, while lower nitrite conditions selected for a number of Nitrospira. Therefore, even when focusing on ecologically coherent ensembles, assembly is the result of complex stochastic and deterministic processes that can only be interrogated by observing multiple assemblies under controlled conditions. This article is protected by copyright. All rights reserved.

**General information**

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Organisations: Department of Environmental Engineering, Water Technologies, Urban Water Systems
Authors: Kinnunen, M. (Intern), Gülay, A. (Intern), Albrechtsen, H. (Intern), Dechesne, A. (Intern), Smets, B. F. (Intern)
Nitrous oxide Production in Membrane-aerated Nitrifying Biofilms: Experimentation and Modelling

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Ma, Y. (Intern), Domingo-Felez, C. (Intern), Smets, B. F. (Intern)
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Main Research Area: Technical/natural sciences
Electronic versions:
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Novel Commercial Aquaporin Flat-Sheet Membrane for Forward Osmosis
Aquaporin proteins are of great interest to the membrane science community because of their unique characteristics of high water permeability and perfect molecular selectivity. Although these characteristics make aquaporins particularly valuable for desalination applications, none of these aquaporin-based membrane designs has been produced at a large scale. In this work, we report on the recently designed and commercially available Aquaporin Inside flat-sheet membrane designed for forward osmosis (FO) by Aquaporin A/S, Lyngby, Denmark. The Aquaporin Inside flat-sheet membrane is the first commercially available thin-film composite (TFC) FO membrane to incorporate aquaporin proteins into its polyamide-based selective layer. The membrane tested, which is a first-generation membrane, achieved water fluxes of 14.0 and 8.8 L m⁻² h⁻¹ with low reverse salt fluxes of 4.6 and 4.0 g m⁻² h⁻¹ in pressure-retarded osmosis (PRO) and FO modes, respectively, using 1.0 M sodium chloride as the draw solution and deionized water as the feed solution. The membrane structural parameter was calculated to be 630 μm, which is similar to those of existing commercial membrane options for FO. The Aquaporin Inside membrane was found to exhibit water and reverse solute flux performances similar to those of other commercially available varieties, although this membrane represents one of the few TFC membranes that is available to the academic community for FO testing at the time of this writing.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, University of Connecticut, Aquaporin A/S
Authors: Xia, L. (Ekstern), Andersen, M. F. (Ekstern), Hélix-Nielsen, C. (Intern), McCutcheon, J. R. (Ekstern)
Number of pages: 7
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Web of Science (2017): Indexed yes
**Novel pre-treatments to control bromate formation during ozonation**

Worldwide water shortage increase and water quality depletion from microbial and chemical compounds, pose significant challenges for today’s water treatment industry. Both the development of new advanced oxidation technologies, but also the enhancement of existing conventional technologies is of high interest. This study tested improvements to conventional ozonation that reduce the formation of the oxidation-by-product bromate, while maintaining the effectiveness for removal emerging contaminants (atrazine). MnO4−, ClO2−, ClO2, ClO−, CH3COOO−, HSO5− or S2O8−2 with NH4+ were tested as pre-treatments to ozonation of ground water. Each oxidant and NH4+ were added in a single stage or separately prior to ozonation. To the best of our knowledge, this is the first study that has tested all the above-mentioned oxidants for the same water matrix. Based on our results, the most promising pre-treatments were MnO4−-NH4+, ClO2−-NH4+ and ClO2-NH4+. MnO4−-NH4+ was the only pre-treatment that didn’t inhibit atrazine removal. When compared with the previously proposed Cl2/NH4+ pre-treatment, MnO4− + NH4+ was found as effective for preventing BrO3− formation, while atrazine removal was higher. In addition, MnO4− + NH4+ can be added in a single stage (compared to the 2 stage addition of Cl2/NH4+) without causing the formation of potentially harmful chlorination-by-products.
General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Technical University of Denmark, University of Santiago de Compostela
Authors: Morset, M. (Ekstern), Valverde Pérez, B. (Intern), Blum, J. (Intern), Domingo Felez, C. (Intern), Mauricio-Iglesias, M. (Ekstern), Smets, B. F. (Intern)
Number of pages: 1
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Main Research Area: Technical/natural sciences
Source: PublicationPreSubmission
Source-ID: 132025832
Publication: Research - peer-review › Poster – Annual report year: 2017

Operational strategies for mitigation of nitrous oxide emissions from a phase isolated fullscale WWTP

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, VEOLIA, Biofos A/S
Pages: 18-18
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Ozonation of recirculating aquaculture system based on system’s demand

General information
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Number of pages: 2
Publication date: 2017
Main Research Area: Technical/natural sciences
Electronic versions:
Spiliotopoulou_et_al._2017_Aquaculture_Europe_17.pdf
Source: PublicationPreSubmission
Source-ID: 148419649
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2018

Pathways and Controls of N₂O Production in Nitritation-Anammox Biomass
Nitrous oxide (N₂O) is an unwanted byproduct during biological nitrogen removal processes in wastewater. To establish strategies for N₂O mitigation, a better understanding of production mechanisms and their controls is required. A novel stable isotope labeling approach using 15N and 18O was applied to investigate pathways and controls of N₂O production by biomass taken from a full-scale nitritation-anammox reactor. The experiments showed that heterotrophic denitrification was a negligible source of N₂O under oxic conditions (≥0.2 mg O₂ L⁻¹). Both hydroxylamine oxidation and nitrifier denitrification contributed substantially to N₂O accumulation across a wide range of conditions with varying concentrations of O₂, NH₄⁺, and NO₂⁻. The O₂ concentration exerted the strongest control on net N₂O production with both production
pathways stimulated by low O2, independent of NO2- concentrations. The stimulation of N2O production from hydroxylamine oxidation at low O2 was unexpected and suggests that more than one enzymatic pathway may be involved in this process. N2O production by hydroxylamine oxidation was further stimulated by NH4+, whereas nitrifier denitrification at low O2 levels was stimulated by NO2- at levels as low as 0.2 mM. Our study shows that 15N and 18O isotope labeling is a useful approach for direct quantification of N2O production pathways applicable to diverse environments.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, University of Southern Denmark
Authors: Ma, C. (Ekster), Jensen, M. M. (Intern), Smets, B. F. (Intern), Thamdrup, B. (Ekster)
Number of pages: 11
Pages: 8981–8991
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Main Research Area: Technical/natural sciences

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BFI (2017): BFI-level 2
Scopus rating (2017): SJR 2.535 SNIP 1.941
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.559 SNIP 1.902
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.546 SNIP 1.838 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.003 CiteScore 5.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.952 SNIP 2.102 CiteScore 5.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.115 SNIP 2.043 CiteScore 5.17
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
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Scopus rating (2011): SJR 3.18 SNIP 1.945 CiteScore 5.16
ISI indexed (2011): ISI indexed yes
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BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.979 SNIP 1.726
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.86 SNIP 1.809
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.96 SNIP 1.935
Web of Science (2008): Indexed yes
Plasmid host range (permisseveness) in communities of activated sludge in wastewater treatment plant

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Li, L. (Intern), Dechesne, A. (Intern), Smets, B. F. (Intern)
Pages: 93-94
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Article number: P98
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Conference: Danish Microbiological Society 2017 Congress, Copenhagen, Denmark, 13/11/2017 - 13/11/2017
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Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2017

Plasmid host range (permisseveness) in microbial communities of activated sludge in wastewater treatment plant.

General information
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Organisations: Department of Environmental Engineering, Water Technologies
Authors: Li, L. (Intern), Dechesne, A. (Intern), Smets, B. F. (Intern)
Number of pages: 1
Publication date: 2017
Event: Abstract from Danish Microbiological Society, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2017
Prediction of required ozone dosage for pilot recirculating aquaculture systems based on laboratory studies

In recirculating aquaculture systems (RAS), the water quality changes continuously. Organic and inorganic compounds accumulate creating toxic conditions for the farmed organisms. Ozone improves water quality diminishing significantly both bacteria load and dissolved organic matter. However, in a non-meticulously designed system, residual ozone might reach the culture tanks causing significant harm to cultured species or excess costs. The aim of the study was to predict the suitable ozone dosage in pilot RAS, for water treatment purposes, based on laboratory studies. The ozone effect on water quality of freshwater RAS and system’s ozone demand was investigated. Bench-scale ozonation experiments revealed the ozone demand of the system to be 180 mg O₃/h. Three different ozone dosages were applied to four replicated systems with fixed feed loading (1.56 kg feed/m³ make up water). Results suggested that the optimal ozone dosage was 15g O₃/ kg feed. Selected water quality parameters were measured, assessing biofilters performance as well as nitrogen and carbon-based compound concentration change during ozonation. Overall, this study contributed to a better understanding of the challenges of an ozonated RAS leading to the optimal design of such systems.

General information
State: Published
Authors: Spiliotopoulou, A. (Intern), Rojas-Tirado, P. A. (Intern), Kaarsholm, K. M. S. (Intern), Martin, R. (Ekstern), Pedersen, L. (Intern), Andersen, H. R. (Intern)
Number of pages: 4
Publication date: 2017

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Ozonation, water quality, Recirculating aquaculture systems, Pilot-scale, Laboratory study

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Pressure retarded osmosis from hypersaline sources - A review

Salinity gradient power has been identified as a promising new renewable energy technology, but previous attempts to commercialize the technology have failed due to low energy densities and power densities when using seawater as the saline water. One way to overcome these challenges is to use concentrated saline waters, in this context termed hypersaline waters. Hypersaline waters have higher energy densities and very high power densities are possible. Use of desalination brines has already shown promising results in pilot scale, and solutions of higher salinity may offer a potential route for commercialization. The scope of this paper is to review the existing knowledge on the use of hypersaline waters in the salinity gradient process, pressure retarded osmosis. Although only few papers have had the specific aim of investigating hypersaline waters, concentrated solutions have been used in many papers. In this review, the experiences gained from these experiments are collected and used to evaluate both the potential and challenges of using hypersaline waters. In the second part of the review, an overview is made of where hypersaline resources can be found. Finally, we provide an outlook for hypersaline based salinity gradient energy and point to the areas that require further research.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Aalborg University
Authors: Bajraktari, N. (Intern), Hélix-Nielsen, C. (Intern), Madsen, H. T. (Ekstern)
Number of pages: 21
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Volume: 413
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BFI (2017): BFI-level 1
Purification and functional characterization of nine human Aquaporins produced in Saccharomyces cerevisiae for the purpose of biophysical characterization

The sparse number of high-resolution human membrane protein structures severely restricts our comprehension of molecular physiology and ability to exploit rational drug design. In the search for a standardized, cheap and easily handled human membrane protein production platform, we thoroughly investigated the capacity of S. cerevisiae to deliver high yields of prime quality human AQPs, focusing on poorly characterized members including some previously shown to be
difficult to isolate. Exploiting GFP labeled forms we comprehensively optimized production and purification procedures resulting in satisfactory yields of all nine AQP targets. We applied the obtained knowledge to successfully upscale purification of histidine tagged human AQP10 produced in large bioreactors. Glycosylation analysis revealed that AQP7 and 12 were O-glycosylated, AQP10 was N-glycosylated while the other AQPs were not glycosylated. We furthermore performed functional characterization and found that AQP 2, 6 and 8 allowed flux of water whereas AQP3, 7, 9, 10, 11 and 12 also facilitated a glycerol flux. In conclusion, our S. cerevisiae platform emerges as a powerful tool for isolation of functional, difficult-to-express human membrane proteins suitable for biophysical characterization.

General information
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Organisations: Technical University of Denmark, Department of Environmental Engineering, Water Technologies, University of Copenhagen, Aquaporin A/S
Authors: Pedersen, P. A. (Ekstern), Gourdon, P. E. (Ekstern), Gotfryd, K. (Ekstern), Hansen, K. M. (Ekstern), Hélix-Nielsen, C. (Intern), Bomholt, J. (Ekstern), Spulber, M. (Ekstern), Missel, J. W. (Ekstern), Bühring Bjørkskov, F. (Ekstern), Lyngaa Krabbe, S. (Ekstern), Nurup, C. N. (Ekstern)
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Main Research Area: Technical/natural sciences

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Journal: Scientific Reports
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Scopus rating (2017): SNIP 1.245 SJR 1.533
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.63 SJR 1.692 SNIP 1.354
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.034 SNIP 1.597 CiteScore 5.3
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.163 SNIP 1.554 CiteScore 4.75
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.998 SNIP 1.57 CiteScore 4.06
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.531 SNIP 0.962 CiteScore 2.44
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
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Removal efficiency and economic cost comparison of hydrated electron-mediated reductive pathways for treatment of bromate

Bromate, a potential carcinogen, is a well known highly persistent and environmentally recalcitrant contaminant. UV-254/sulfite-based advanced reductive pathways (ARPs) were proposed to eliminate bromate successfully from water. Experiments with N2, N2O, 2-chlorophenol, inorganic ions, and different pH (highly acidic to highly basic) proved that UV-254/sulfite successfully provides aqueous electron that effectively participate in bromate removal from water. Significant removal, 86%, of initially 39.0µM bromate was achieved by UV-254/sulfite under conditions that dominate aqueous electron based pathways. The high second-order rate constant of 5.3×109M−1s−1 determined proved high reactivity of aqueous electron with bromate. The kinetic and removal efficiency of bromate showed linear relationship with the rate of aqueous electron formation. An increase in kinetic and removal efficiency of bromate was observed with increasing initial sulfite concentration and decreasing bromate concentration. The impacts of different initial concentrations of the typical ions commonly found in water were studied in detail to extend the UV-254/sulfite-based process for potential practical applications. The lower molar absorptivity of bromate at 254nm determined proved insignificant removal of bromate under direct photolysis. The impacts of initial sulfite concentration on removal of bromate in UV-254/sulfite-based process also minimized role of direct photolysis. The cost evaluation and rapid decomposition of bromate into bromide proved UV-254/sulfite-based ARPs to be economical and highly rewarding in efficient decomposition of bromate and other inorganic oxyhalides.
Removal of micropollutants in Moving Bed Biofilm reactors (MBBRs): Microbial-diversity-and-functional-relationships

Numerous pollutants such as pharmaceuticals and personal care products are continuously released into municipal wastewater treatment plants (WWTP). Present at concentration of nano- to milligram per liter, they are defined as micropollutants. Micropollutants are only partially removed, possibly due to design and operational limitation of conventional WWTP. Eventually, micropollutant parent compounds and transformation products are discharged into receiving water bodies, possibly causing acute and chronic toxic effects on aquatic organisms even at very low concentrations. Therefore, research currently focuses on the enhancement of conventional WWTPs via physical-chemical and biological treatment processes. Biofilm-based treatment processes, such as the Moving Bed Biofilm Reactor (MBBR), were shown to harbour bio-catalytic potential that can enhance the biotransformation of a number of micropollutants compared to conventional activated sludge. In MBBRs, biofilm grow on plastic carriers kept in suspension in the reactor basin via mechanical mixing or aeration, offering a suit of benefits, amongst all comparably small footprint. Despite few existing evidences in aerobic MBBR, an in-depth understanding of the fate of micropollutants in such systems under different operational conditions is still required. In this context, this PhD thesis investigated different optimization strategies using MBBRs towards the removal of 23 commonly detected micropollutants (i.e., pharmaceuticals) in municipal wastewater. Specifically, I studied the impact of (i) biofilm thickness on the diffusion, sorption and biotransformation of the selected pharmaceuticals in nitrifying MBBR; and (ii) of organic carbon quality and availability on micropollutant biotransformation in anoxic pre- and post-denitrifying MBBRs. In both case, the influence of (i) and (ii) on the microbial activity (nitrification and denitrification) and microbial community composition and diversity were investigated. The existence of possible relationships between microbial diversity (analyzed via 16S rRNA amplicon sequencing) and biotransformation of micropollutants was evaluated to investigate which microbial processes and factors underlay the removal of micropollutants. The PhD objectives were evaluated in long- and short-term experiments in three laboratory-scale MBBR systems for pre-denitrification (MBBR1), nitrification (MBBR2) and post-denitrification (MBBR3). Biokinetics of nitrification, denitrification and micropollutant biotransformation rate constants (kBio, L g^-1 d^-1) were estimated through batch experiments using Activated Sludge Models (ASMs) and ASM for Xenobiotics (ASM-X), respectively. In the pre-denitrifying MBBR1 study, denitrification, biotransformation of micropollutants and microbial community were evaluated in three-stage (S) and single-stage (U) MBBR configurations. The three-stage configuration produced a prolonged exposure of the biofilm to a gradient of organic carbon loading and complexity, leading to a significant differentiation of denitrification and biotransformation kinetics in the three MBBR sub-reactors. The highest and lowest biotransformation kinetics were found in the first and the last stage, respectively (up to 4-fold decrease for selected compounds), suggesting a possible a correlation of micropollutant biotransformation with denitrification rates. The long term-operation with carbon availability and complexity gradient led to higher (p<0.05) biodiversity in the three-stage system, with a more diverse and even microbial community in the last stage. Specific taxa such as Candidate division WS6 and Deinococcales were selected in S, possibly due to oligotrophic conditions occurring in the last reactor stage. The influence of biofilm thickness was studied in nitrifying MBBR2 using newly developed Z-carriers that allow the control of defined biofilm thickness. The use of thinner biofilms (~50 µm), rather than thicker biofilms (>200 µm), had a positive effect on nitrification rates and on the biotransformation kinetics of a number of compound such as diclofenac (kBio up to 6 L g^-1 d^-1) and the three sulfonamide antibiotics. However, the biotransformation of more than 60% of targeted compounds was enhanced in thicker biofilms, that exhibited higher (p<0.05) microbial diversity and were more even. Additionally, a biofilm model was developed and calibrated to evaluate sorption and diffusion of micropollutants in nitrifying biofilms. Sorption was significant only for eight out of the targeted compounds. All compounds removed by sorption were predicted to carry a net positive charge at the experimental pH, suggesting the importance of electrostatic interactions on sorption in biofilms. Sorption coefficients Kd (L g^-1) and effective diffusivity coefficients f increased with increasing biofilm thickness, suggesting reduced diffusion.
limitation and higher surface area accessibility in the thickest, least dense biofilm (~500 µm). Two types of commonly
dosed degradable carbon sources (methanol and ethanol) were investigated in two parallel post-denitrifying systems
(MBBR3). The methanol-dosed MBBR exhibited in the enhancement of kBio (up to 2.5-fold) for a number of
micropollutants (nine out 23) compared to the ethanol-dosed MBBR, while for 10 compounds biokinetics were similar
between the two reactors. The higher denitrification rates exhibited by the ethanol-dosed MBBR during batch experiments
likely influenced the biotransformation of the sulfonamides antibiotics, in analogy with what observed in MBBR2. A strong
cometabolic effect (i.e., an enhancement of micropollutant biotransformation in the presence of organic carbon) was
observed for venlafaxine, carbamazepine, sulfamethoxazole and sulfamethizole. However, an increase in methanol or
ethanol loading to the MBBRs during continuous-flow experiment did not influence the removal of the targeted
micropollutants, most likely due to the short hydraulic residence time (2 hours) used in the study as well as in full-scale
reactors. Diversity-function relationships (assessed through Pearson correlation analyses) were tested by comparing
diversity estimators against biomass-normalized biotransformation rates. A positive influence of biodiversity for most of the
targeted compounds (~60%) was shown in MBBR2 study, while biotransformation of few compounds (diclofenac and
sulfonamides) was positively associated to microbial activity (i.e., nitrification). Similarly, a positive association (p<0.05)
with the specific denitrification rate was shown in MBBR1, while biotransformation of most of the detected pharmaceuticals
in wastewater did not associate or negatively associated with biodiversity. The relationship between biodiversity and
micropollutant biotransformation may depend on whether its biotransformation is catalysed by a narrow (i.e., performed by
few species) or broad processes. It is likely that for highly redundant microbial processes (such as denitrification),
micropollutant biotransformation may be catalysed by broadly distributed enzymes and pathways, and microbial diversity
provides no benefit. Conversely, increasing biodiversity under nitrifying conditions may be necessary to increase the
inclusion of microorganisms with specific functionality towards micropollutant biotransformation. Overall, the
biotransformation rates were significantly enhanced in MBBR3 compared to MBBR1 and MBBR2 for the majority of
micropollutants (~60%) suggesting the positive impact of easily degradable carbon sources (such as methanol or ethanol)
on micropollutant removal. Finally, the removal of compounds such propranolol atenolol, citalopram, venlafaxine (under
post-denitrifying conditions) and diclofenac (under aerobic conditions) was improved compared to conventional activated
sludge. It can be thus concluded that MBBRs can offer a suitable technology that can be optimized for the removal of
micropollutants in municipal wastewaters under a range of operating conditions (nitrifying, pre- and post-denitrifying).

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, AnoxKaldnes AB
Authors: Torresi, E. (Intern), Plósz, B. G. (Intern), Christensson, M. (Ekstern), Smets, B. F. (Intern)
Number of pages: 80
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Relations
Projects:
Removal of micropollutants in Moving Bed Biofilm reactors (MBBRs)
Publication: Research › Ph.D. thesis – Annual report year: 2017

Removal of pharmaceuticals in conventionally treated wastewater by a polishing Moving Bed Biofilm Reactor (MBBR) with
intermittent feeding
Previous studies have demonstrated that aerobic moving bed biofilm reactors (MBBRs) remove pharmaceuticals better
than activated sludge. Thus we used a MBBR system to polish the effluent of an activated sludge wastewater treatment
plant. To overcome that effluent contain insufficient organic matter to sustain enough biomass, the biofilm was
intermittently fed with raw wastewater.

The capacity of pharmaceutical degradation was investigated by spiking pharmaceuticals. Actual removal during treatment
was assessed by sampling the inlets and outlets of reactors. The removal of the majority of pharmaceuticals was
enhanced through the intermittent feeding of the MBBR. First-order rate constants for pharmaceutical removal, normalised
to biomass, were significantly higher compared to other studies on activated sludge and suspended biofilms, especially for
diclofenac, metoprolol and atenolol. Due to the intermittently feeding, degradation of diclofenac occurred with a half-life of
only 2.1 hours and was thus much faster than any hitherto described wastewater bioreactor treatment.

General information
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Organisations: Department of Environmental Engineering, Water Technologies, Veolia Water Technologies AB, Danish
Technological Institute, Veolia Water Solutions & Technologies, Aarhus University
Removal of pharmaceuticals in Moving Bed Biofilm Reactors – The impact of design and operating conditions

General information
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Organisations: Department of Environmental Engineering, Water Technologies, Environmental Chemistry, AnoxKaldnes AB
Authors: Torresi, E. (Intern), Polesel, F. (Intern), Smets, B. F. (Intern), Andersen, H. R. (Intern), Christensson, M. (Ekstern), Plósz, B. G. (Intern)
Number of pages: 4
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Main Research Area: Technical/natural sciences
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Oral presentation
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Removal of pharmaceuticals in pre-denitrifying MBBR – Influence of organic substrate availability in single- and three-stage configurations

Due to the limited efficiency of conventional biological treatment, innovative solutions are being explored to improve the removal of trace organic chemicals in wastewater. Controlling biomass exposure to growth substrate represents an appealing option for process optimization, as substrate availability likely impacts microbial activity, hence organic trace chemical removal. This study investigated the elimination of pharmaceuticals in pre-denitrifying moving bed biofilm reactors (MBBRs), where biofilm exposure to different organic substrate loading and composition was controlled by reactor staging. A three-stage MBBR and a single-stage reference MBBR (with the same operating volume and filling ratio) were operated under continuous-flow conditions (18 months). Two sets of batch experiments (day 100 and 471) were performed to quantify and compare pharmaceutical removal and denitrification kinetics in the different MBBRs. Experimental results revealed the possible influence of retransformation (e.g., from conjugated metabolites) and enantioselectivity on the removal of selected pharmaceuticals. In the second set of experiments, specific trends in denitrification and biotransformation kinetics were observed, with highest and lowest rates/rate constants in the first (S1) and the last (S3) staged sub-reactors, respectively. These observations were confirmed by removal efficiency data obtained during continuous-flow operation, with limited removal (<10%) of recalcitrant pharmaceuticals and highest removal in S1 within the three-stage MBBR. Notably, biotransformation rate constants obtained for non-recalcitrant pharmaceuticals correlated with mean specific denitrification rates, maximum specific growth rates and observed growth yield values. Overall, these findings suggest that: (i) the long-term exposure to tiered substrate accessibility in the three-stage configuration shaped the denitrification and biotransformation capacity of biofilms, with significant reduction under substrate limitation; (ii) biotransformation of pharmaceuticals may have occurred as a result of cometabolism by heterotrophic denitrifying bacteria.

General information
State: Published
Organisations: Department of Environmental Engineering, Environmental Chemistry, Water Technologies, Technical University of Denmark, Aarhus University, AnoxKaldnes AB
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Screening for illicit drugs in pooled human urine and urinated soil samples and studies on the stability of urinary excretion products of cocaine, MDMA, and MDEA in wastewater by hyphenated mass spectrometry techniques

Monitoring population drug use through wastewater-based epidemiology (WBE) is a useful method to quantitatively follow trends and estimate total drug consumption in communities. Concentrations of drug biomarkers might be low in wastewater due to dilution; and therefore analysis of pooled urine (PU) is useful to detect consumed drugs and identify targets of illicit drugs use. The aims of the study were (1) to screen PU and urinated soil (US) samples collected at festivals for illicit drug excretion products using hyphenated techniques; (2) to develop and validate a hydrophilic interaction liquid chromatography – mass spectrometry / mass spectrometry (HILIC-MS/MS) method of quantifying urinary targets of identified drugs in wastewater; and (3) to conduct a 24h stability study, using PU and US to better reflect the chemical environment for targets in wastewater. Cocaine (COC) and ecstasy-like compounds were the most frequently detected illicit drugs; an analytical method was developed to quantify their excretion products. Hydroxymethoxymethamphetamine (HMMA), 3,4-methylenedioxyxymethamphetamine (MDMA), 3,4-methylenedioxyamphetamine (MDA), HMMA sulfate (HMMA-S), benzoylecgonine (BE), and cocaethylene (CE) had 85–102% of initial concentration after 8h of incubation, whereas COC and ecgonine methyl ester (EME) had 74 and 67% after 8h, respectively. HMMA showed a net increase during 24h of incubation (107% ± 27, n = 8), possibly due to the cleavage of HMMA conjugates, and biotransformation of MDMA. The results suggest HMMA as analytical target for MDMA consumption in WBE, due to its stability in wastewater and its excretion as the main phase I metabolite of MDMA.

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Selective removal of heavy metal ions by disulfide linked polymer networks

Heavy metal contaminated surface water is one of the oldest pollution problems, which is critical to ecosystems and human health. We devised disulfide linked polymer networks and employed as a sorbent for removing heavy metal ions from contaminated water. Although the polymer network material has a moderate surface area, it demonstrated cadmium removal efficiency equivalent to highly porous activated carbon while it showed 16 times faster sorption kinetics compared to activated carbon, owing to the high affinity of cadmium towards disulfide and thiol functionality in the polymer network. The metal sorption mechanism on polymer network was studied by sorption kinetics, effect of pH, and metal complexation. We observed that the metal ions—copper, cadmium, and zinc showed high binding affinity in polymer network, even in the presence of competing cations like calcium in water.
Simple control rules for mitigating N₂O emissions in phase isolated fullscale WWTPs

General information
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Simple control strategy for mitigating N₂O emissions in phase isolated full-scale WWTPs

Nitrous oxide (N₂O) is a strong greenhouse gas (GHG) and ozone depleter, with a warming potential 300 times higher than carbon dioxide (CO₂). 1.2% of the total anthropogenic N₂O emissions are believed to originate from the wastewater treatment (WWT) sector. Conventional biological nutrient removal processes relying on nitrification and denitrification are known to produce N₂O. A one year long-term study of N₂O production and emissions was performed at Lynetten, Denmark’s largest WWTP. Nitrification and denitrification takes place by alternating process conditions as well as influent and effluent flows in 20 pairs of interconnected and surface aerated reactors. The long-term data revealed that the N₂O emissions contribute to as much as 30% of the total CO₂ footprint from the WWTP. High ammonium concentrations and long aeration phases lead to high N₂O production and emissions rates. Nitrification phases were identified to produce and emit most of the N₂O. High production and emissions were also associated with the afternoon loading peaks at the WWTP. During denitrification phases N₂O was produced initially but consumed consequently. An effective control strategy was implemented, whereby N₂O emissions were reduced from 0.8% to 0.3% of the nitrogen load during the mitigation period.
Sorption and diffusion of micropollutants on/in biofilms: experimental observations and a model-based interpretation

In this study we investigated the diffusion and sorption of 22 pharmaceuticals in/on nitrifying biofilms of different thickness. Experimental observations were subject to model-based interpretation and the assessment of a sorption coefficient $K_d$ and effective diffusivity coefficient $f$. Three biofilm depths were obtained by using Z-carriers (AnoxKaldnes) as support, which allows tight control of biofilm thickness. Biofilms of increasing thickness had increased porosity (and thus decreasing density). Sorption was significant for the positively charged compounds at experimental pH (with few exceptions) and $K_d$ increased with biofilm thickness. The effective diffusivity $f$ negatively correlated with biofilm density, suggesting that diffusion of micropollutants in thinner biofilms could be limited. Overall, this study elucidated how biofilm thickness can positively influence sorption of micropolliants on biofilm as well as how diffusion limitation is strongly impact by biofilm characteristics (density and porosity) and the specific chemical.

General information
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Organisations: Department of Environmental Engineering, Water Technologies, Environmental Chemistry, AnoxKaldnes AB
Authors: Torresi, E. (Intern), Polesel, F. (Intern), Christensson, M. (Ekstern), Trapp, S. (Intern), Smets, B. F. (Intern), Andersen, H. R. (Intern), Plósz, B. G. (Intern)
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Termination of nanoscale zero-valent iron reactivity by addition of bromate as a reducing reactivity competitor

Remediation of contaminated groundwater by nanoscale zero-valent iron (nZVI) is widely becoming a leading environmentally friendly solution throughout the globe. Since a wide range of various nZVI-containing materials have been developed for effective remediation, it is necessary to determine an appropriate way to terminate the reactivity of any nZVI-containing material for a practical experimental procedure. In this study, bimetallic Ni/Fe-NPs were prepared to enhance overall reduction kinetics owing to the catalytic reactivity of nickel on the surface of nZVI. We have tested several chemical strategies in order to terminate nZVI reactivity without altering the concentration of volatile compounds in the solution. The strategies include surface passivation in alkaline conditions by addition of carbonate, and consumption of nZVI by a reaction competitor. Four halogenated chemicals, trichloroethylene, 1,1,1-trichloroethane, atrazine, and 4-chlorophenol, were selected and tested as model groundwater contaminants. Addition of carbonate to passivate the nZVI surface was not effective for trichloroethylene. Nitrate and then bromate were applied to competitively consume nZVI by their faster reduction kinetics. Bromate proved to be more effective than nitrate, subsequently terminating nZVI reactivity for all four of the tested halogenated compounds. Furthermore, the suggested termination method using bromate was successfully applied to obtain trichloroethylene reduction kinetics. Herein, we report the simple and effective method to terminate the reactivity of nZVI by addition of a reducing reactivity competitor.

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Organisations: Department of Environmental Engineering, Department of Micro- and Nanotechnology, Surface Engineering, Water Technologies, Kumoh National Institute of Technology, Seoul National University of Science and Technology (SNUST)
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Main Research Area: Technical/natural sciences
The competitive edge: competition and biofilm composition, an individual-based modelling approach

General information
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Organisations: Department of Environmental Engineering, Water Technologies, University of Birmingham, Friedrich Schiller University
Authors: Cockx, B. (Intern), Clegg, R. J. (Ekstern), Lang, S. (Ekstern), Kreft, J. (Ekstern), Smets, B. F. (Intern)
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The effect of UV treatment on highly polluted and normal operated swimming pools
Water samples from 2 indoor public swimming pool facilities with significantly different organic matter concentrations in the recirculation were tested to evaluate UV-induced effects on water chemistry. The aim of the study was to investigate the impact of poor water quality due to increased organic carbon (TOC) and the potential effect of increased nitrate concentration on disinfection by-product (DBP) formation in pool water. Concentration change on total trihalomethanes (TTHM) was investigated utilising medium pressure UV treatment in conjunction with chlorine. Post-UV chlorine consumption increased, UV dose-dependently. The post-UV chlorination clearly induced TTHM formation in both polluted and normal operated pools. However, elevated TOC concentration did not increase significantly the DBP formation. Regarding the brominated fraction of the halogens in the formed TTHMs, it appeared to decrease when the sample was subjected to post-UV chlorination in the normal operated pool, having the opposite result in the highly polluted pool. The addition of nitrate (when subjected to irradiation it forms radicals) and the subsequent post-UV chlorination were contradicting with the radical mechanisms; nitrite shielded the water surface inhibiting the UV penetration and therefore less TTHMs were formed.

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Organisations: Department of Environmental Engineering, Water Technologies
Authors: Spiliotopoulou, A. (Intern), Kaarsholm, K. M. S. (Intern), Andersen, H. R. (Intern)
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DBP formation, Medium pressure UV lamp, polluted pool, Trihalomethane
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The effect of UV treatment on highly polluted and normal operated swimming pools
"It should be light blue, transparent" (Mario Andrada, spokesman, Olympic Games, Rio, 2016) was the comment for the "green lake". Swimming pools are sensitive recirculating systems. A malfunction in water treatment units or a poor operating decision could possibly lead to health-endangering or aesthetically unacceptable conditions for swimmers, with a lengthy and expensive remediation.

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Organisations: Department of Environmental Engineering, Water Technologies
Authors: Spiliotopoulou, A. (Intern), Kaarsholm, K. M. S. (Intern), Andersen, H. R. (Intern)
Number of pages: 1
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The Europe - China Water Innovation Balance – Findings from the PIANO project’s mapping

General information
State: Published
Organisations: Department of Management Engineering, Technology and Innovation Management, Department of Environmental Engineering, Water Resources Engineering, Water Technologies, Technical University of Denmark
Authors: Andersen, M. M. (Intern), McKnight, U. S. (Intern), Smets, B. F. (Intern), Liu, J. (Ekstern)
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Tracking and understanding AMR dynamics across European urban water systems

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Organisations: Department of Environmental Engineering, Water Technologies, University of Copenhagen, University of Newcastle, Newcastle University
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Transformation and sorption of illicit drug biomarkers in sewer biofilms
In-sewer transformation of drug biomarkers (excreted parent drugs and metabolites) can be influenced by the presence of biomass in suspended form as well as attached to sewer walls (biofilms). Biofilms are likely the most abundant and biologically active biomass fraction in sewers. In this study, 16 drug biomarkers were selected, including the major human metabolites of mephedrone, methadone, cocaine, heroin, codeine and tetrahydrocannabinol (THC). Transformation and sorption of these substances were assessed in targeted batch experiments using laboratory-scale biofilm reactors operated under aerobic and anaerobic conditions. A one-dimensional model was developed to simulate diffusive transport, abiotic and biotic transformation and partitioning of drug biomarkers. Model calibration to experimental results allowed estimating transformation rate constants in sewer biofilms, which were compared to those obtained using in-sewer suspended biomass. Our results suggest that sewer biofilms can enhance the transformation of most compounds.
Through scenario simulations, we demonstrated that the estimation of transformation rate constants in biofilm can be significantly biased if the boundary layer thickness is not accurately estimated. This study complements our previous investigation on the transformation and sorption of drug biomarkers in the presence of only suspended biomass in untreated sewage. A better understanding of the role of sewer biofilms—also relative to the in-sewer suspended solids—and improved prediction of associated fate processes can lead to more accurate estimation of daily drug consumption in urban areas in wastewater-based epidemiological assessments.

**General information**

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Organisations: Department of Environmental Engineering, Water Technologies, Department of Chemical and Biochemical Engineering, Environmental Chemistry, KWR Watercycle Research Institute, University of Amsterdam
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.546 SNIP 1.838 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.003 CiteScore 5.5
Web of Science (2014): Indexed yes
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Scopus rating (2013): SJR 2.952 SNIP 2.102 CiteScore 5.52
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BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.115 SNIP 2.043 CiteScore 5.17
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.18 SNIP 1.945 CiteScore 5.16
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.979 SNIP 1.726
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.86 SNIP 1.809
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.96 SNIP 1.935
Web of Science (2008): Indexed yes
Clindamycin is widely prescribed for its ability to treat a number of common bacterial infections. Thus, clindamycin enters wastewater via human excretion or disposal of unused medication and widespread detection of pharmaceuticals in rivers proves the insufficiency of conventional wastewater treatment plants in removing clindamycin. Recently, it has been discovered that attached biofilm reactors, e.g., moving bed biofilm reactors (MBBRs) obtain a higher removal of pharmaceuticals than conventional sludge wastewater treatment plants. Therefore, this study investigated the capability of MBBRs applied in the effluent of conventional wastewater treatment plants to remove clindamycin. First, a batch experiment was executed with a high initial concentration of clindamycin to identify the transformation products. It was shown that clindamycin can be removed from wastewater by MBBR and the treatment process converts clindamycin into the, possibly persistent, products clindamycin sulfoxide and N-desmethyl clindamycin as well as 3 other mono-oxygenated products. Subsequently, the removal kinetics of clindamycin and the formation of the two identified products were investigated in batch experiments using MBBR carriers from polishing and nitrifying reactors. Additionally, the presence of these two metabolites in biofilm-free wastewater effluent was studied. The nitrifying biofilm reactor had a higher biological activity with k-value of 0.1813 h⁻¹ than the reactor with polishing biofilm (k = 0.0161 h⁻¹) which again has a much higher biological activity for removal of clindamycin than of the suspended bacteria (biofilm-free control). Clindamycin sulfoxide was the main transformation product which was found in concentrations exceeding 10% of the initial clindamycin concentration after 1 day of MBBR treatment. Thus, MBBRs should not necessarily be considered as reactors mineralizing clindamycin as they perform transformation reactions at least to some extent.
Treatment of Arctic Wastewater by Chemical Coagulation, UV and Peracetic Acid Disinfection

Conventional wastewater treatment is challenging in the Arctic region due to the cold climate and scattered population. Thus, no wastewater treatment plant exists in Greenland and raw wastewater is discharged directly to nearby waterbodies without treatment. We investigated the efficiency of physico-chemical wastewater treatment, in Kangerlussuaq, Greenland. Raw wastewater from Kangerlussuaq was treated by chemical coagulation and UV disinfection. By applying 7.5 mg Al/L polyaluminium chloride (PAX XL100), 73% of turbidity and 28% phosphate was removed from raw wastewater. E. coli and Enterococcus were removed by 4 and 2.5 log, respectively, when UV irradiation of 0.70 kWh/m³ was applied to coagulated wastewater. Furthermore, coagulated raw wastewater in Denmark, which has a chemical quality similar to Greenlandic wastewater, was disinfected by peracetic acid or UV irradiation. Removal of heterotrophic bacteria by applying 6 mg/L and 12 mg/L peracetic acid was 2.8 and 3.1 log, respectively. Similarly, removal of heterotrophic bacteria by applying 0.21 kWh/m³ and 2.10 kWh/m³ for UV irradiation was 2.1 and greater than 4 log, respectively. Physico-chemical treatment of raw wastewater followed by UV irradiation and/or peracetic acid disinfection showed the potential for treatment of arctic wastewater.

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Organisations: Department of Environmental Engineering, Water Technologies, Department of Civil Engineering, ARTEK, Section for Arctic Engineering and Sustainable Solutions, Technical University of Denmark
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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.66 SJR 0.891 SNIP 1.109
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BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.99 SNIP 1.199 CiteScore 2.57
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.942 SNIP 1.179 CiteScore 2.34
ISI indexed (2013): ISI indexed yes
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Scopus rating (2012): SJR 1.127 SNIP 1.246 CiteScore 2.29
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.203 SNIP 1.171 CiteScore 2.3
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
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Scopus rating (2010): SJR 1.148 SNIP 1.107
Tuning biomimetic membrane barrier properties by hydrocarbon, cholesterol and polymeric additives

The barrier properties of cellular membranes are increasingly attracting attention as a source of inspiration for designing biomimetic membranes. The broad range of potential technological applications makes the use of lipid and lately also polymeric materials a popular choice for constructing biomimetic membranes, where the barrier properties can be controlled by the composition of the membrane constituent elements. Here we investigate the membrane properties reported by the light-induced proton pumping activity of bacteriorhodopsin (bR) reconstituted in three vesicle systems of different membrane composition. Specifically we quantify how the resulting proton influx and efflux rates are influenced by the membrane composition using a variety of membrane modulators. We demonstrate that by adding hydrocarbons to vesicles with reconstituted bR formed from asolectin lipids the resulting transmembrane proton fluxes changes proportional to the carbon chain length when compared against control. We observe a similar proportionality in single-component 1,2-Dioleoyl-sn-glycero-3-phosphocholine (DOPC) model membranes when using cholesterol. Lastly we investigate the effects of adding the amphiphilic di-block co-polymer polybutadiene-polyethyleneoxide (PB\textsubscript{12}-PEO\textsubscript{10}) to phospholipid membranes formed from DOPC, 1,2-Dioleoyl-sn-glycero-3-phosphatidylethanolamine (DOPE), and 1,2-Dioleoyl-sn-glycero-3-phosphatidylserine (DOPS). The proton pumping activity of bR (measured as a change in extravesicular pH) in mixed lipid/PB\textsubscript{12}-PEO\textsubscript{10} lipid systems is up to six-fold higher compared to that observed for bR containing vesicles made from PB\textsubscript{12}-PEO\textsubscript{10} alone. Interestingly, bR inserts with apparent opposite orientation in pure PB12-PEO10 vesicles as compared to pure lipid vesicles. Addition of equimolar amounts of lipids to PB\textsubscript{12}-PEO\textsubscript{10} results in bR orientation similar to that observed for pure lipids. In conclusion our results show how the barrier properties of the membranes can be controlled by the composition of the membrane. In particular the use of mixed lipid-polymer systems may pave the way for constructing biomimetic membranes tailored for optimal properties in various applications including drug delivery systems, biosensors and energy conservation technology.

General information
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Organisations: Department of Physics, Biophysics and Fluids, Quantum Physics and Information Technology, Department of Environmental Engineering, Water Technologies, University of Copenhagen, Lund University
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Number of pages: 12
Use of fluorescence spectroscopy to control ozone dosage in recirculating aquaculture systems

The aim of this study was to investigate the potential of fluorescence spectroscopy to be used as an ozone dosage determination tool in recirculating aquaculture systems (RASs), by studying the relationship between fluorescence intensities and dissolved organic matter (DOM) degradation by ozone, in order to optimise ozonation treatment. Water samples from six different Danish facilities (two rearing units from a commercial trout RAS, a commercial eel RAS, a pilot RAS and two marine water aquariums) were treated with different O3 dosages (1.0–20.0 mg/L ozone) in bench-scale experiments, following which fluorescence intensity degradation was eventually determined. Ozonation kinetic experiments showed that RAS water contains fluorescent organic matter, which is easily oxidised upon ozonation in relatively low concentrations (0–5 mg O3/L). Fluorescence spectroscopy has a high level of sensitivity and selectivity in relation to associated fluorophores, and it is able to determine accurately the ozone demand of each system. The findings can potentially be used to design offline or online sensors based on the reduction by ozone of natural fluorescent-dissolved organic matter in RAS. The suggested indirect determination of ozone delivered into water can potentially contribute to a safer and more adequate ozone-based treatment to improve water quality.
UV-Vis spectrophotometry for Wastewater Resource Recovery with Algae Photobioreactors

Wastewater-based epidemiology to assess pan-European pesticide exposure

Human biomonitoring, i.e. the determination of chemicals and/or their metabolites in human specimens, is the most common and potent tool for assessing human exposure to pesticides, but it suffers from limitations such as high costs and biases in sampling. Wastewater-based epidemiology (WBE) is an innovative approach based on the chemical analysis of specific human metabolic excretion products (biomarkers) in wastewater, and provides objective and real-time information on xenobiotics directly or indirectly ingested by a population. This study applied the WBE approach for the first time to evaluate human exposure to pesticides in eight cities across Europe. 24 h-composite wastewater samples were collected from the main wastewater treatment plants and analyzed for urinary metabolites of three classes of pesticides, namely triazines, organophosphates and pyrethroids, by liquid chromatography-tandem mass spectrometry. The mass loads (mg/day/1000 inhabitants) were highest for organophosphates and lowest for triazines. Different patterns were observed among the cities and for the various classes of pesticides. Population weighted loads of specific biomarkers indicated higher exposure in Castellon, Milan, Copenhagen and Bristol for pyrethroids, and in Castellon, Bristol and Zurich for organophosphates. The lowest mass loads were found in Utrecht and Oslo. These results were in agreement with several national statistics related to pesticides exposure such as pesticides sales. The daily intake of pyrethroids was estimated in each city and it was found to exceed the acceptable daily intake (ADI) only in one city (Castellon, Spain). This was the first large-scale application of WBE to monitor population exposure to pesticides. The results indicated that WBE can give new information about the "average exposure" of the population to pesticides, and is a useful complementary biomonitoring tool to study population-wide exposure to pesticides.
Accelerated Molecular Dynamics Simulations of Phosphate Binding Proteins

General information
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Organisations: Department of Environmental Engineering, Water Technologies
Authors: Truelsen, S. F. (Intern)
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  Web of Science (2017): Indexed Yes
  BFI (2016): BFI-level 1
  Scopus rating (2016): CiteScore 3.06 SJR 1.988 SNIP 1.005
  Web of Science (2016): Indexed yes
  BFI (2015): BFI-level 1
  Scopus rating (2015): SJR 2.13 SNIP 1.134 CiteScore 3.3
  Web of Science (2015): Indexed yes
  BFI (2014): BFI-level 1
  Scopus rating (2014): SJR 2.21 SNIP 1.15 CiteScore 3.33
  Web of Science (2014): Indexed yes
  BFI (2013): BFI-level 1
  Scopus rating (2013): SJR 2.245 SNIP 1.156 CiteScore 3.64
  ISI indexed (2013): ISI indexed yes
  Web of Science (2013): Indexed yes
  BFI (2012): BFI-level 1
A conceptual framework for invasion in microbial communities

There is a growing interest in controlling—promoting or avoiding—the invasion of microbial communities by new community members. Resource availability and community structure have been reported as determinants of invasion success. However, most invasion studies do not adhere to a coherent and consistent terminology nor always include rigorous interpretations of the processes behind invasion. Therefore, we suggest that a consistent set of definitions and a rigorous conceptual framework are needed. We define invasion in a microbial community as the establishment of an alien microbial type in a resident community and argue how simple criteria to define aliens, residents, and alien establishment can be applied for a wide variety of communities. In addition, we suggest an adoption of the community ecology framework advanced by Vellend (2010) to clarify potential determinants of invasion. This framework identifies four fundamental processes that control community dynamics: dispersal, selection, drift and diversification. While selection has received ample attention in microbial community invasion research, the three other processes are often overlooked. Here, we elaborate on the relevance of all four processes and conclude that invasion experiments should be designed to elucidate the role of dispersal, drift and diversification, in order to obtain a complete picture of invasion as a community process.

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A conceptual framework for invasion in microbial communities

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A consilience model to describe N₂O production during biological N removal
Nitrous oxide (N₂O), a potent greenhouse gas, is produced during biological nitrogen conversion in wastewater treatment operations. Complex mechanisms underlie N₂O production by autotrophic and heterotrophic organisms, which continue to be unravelled. Mathematical models that describe nitric oxide (NO) and N₂O dynamics have been proposed. Here, a first comprehensive model that considers all relevant NO and N₂O production and consumption mechanisms is proposed. The model describes autotrophic NO production by ammonia oxidizing bacteria associated with ammonia oxidation and with nitrite reduction, followed by NO reduction to N₂O. It also considers NO and N₂O as intermediates in heterotrophic denitrification in a 4-step model. Three biological NO and N₂O production pathways are accounted for, improving the capabilities of existing models while not increasing their complexity. Abiotic contributions from NH₂OH and HNO₂ reactions are also included. The consilient model structure can theoretically predict NO and N₂O emissions under a wide range of operating conditions and will help develop mitigation strategies.

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Authors: Domingo Felez, C. (Intern), Smets, B. F. (Intern)
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Scopus rating (2017): SNIP 1.141 SJR 1.127
Web of Science (2017): Indexed Yes
Scopus rating (2016): CiteScore 1.07 SJR 0.841 SNIP 1.032
Web of Science (2016): Indexed yes
Original language: English
Electronic versions:
C6EW00179C.pdf
DOIs:
10.1039/C6EW00179C
Source: FindIt
Source-ID: 2347240923
Publication: Research - peer-review › Journal article – Annual report year: 2016
An innovative way to determine on-site ozone delivery efficiency

General information
State: Published
Authors: Spiliotopoulou, A. (Intern), Martin, R. (Ekstern), Andersen, H. R. (Intern)
Number of pages: 2
Publication date: 2016
Event: Abstract from 11th International Conference on Recirculating Aquaculture (ICRA) and 2016 Aquaculture Innovation Workshop (AIW), Virginia, United States.
Main Research Area: Technical/natural sciences
Electronic versions:
Abstract + Powerpoint presentation

Bibliographical note
Oral Presentation
Source: PublicationPreSubmission
Source-ID: 126631383
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

A novel bioflocculation method to separate microalgal biomass cultivated on wastewater resources

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Technical University of Denmark
Authors: Wágner, D. S. (Intern), Radovici, M. (Ekstern), Valverde Perez, B. (Intern), Plósz, B. G. (Intern)
Number of pages: 2
Publication date: 2016
Event: Abstract from 2nd Young Water Professionals Denmark Conference and Workshop, Aarhus, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
YWPDK_2nd_conf_abstract.pdf
Source: PublicationPreSubmission
Source-ID: 123735445
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

A novel way to verify the ozone dosing in the field

General information
State: Published
Authors: Spiliotopoulou, A. (Intern), Martin, R. (Ekstern), Andersen, H. R. (Intern)
Number of pages: 4
Publication date: 2016
Event: Abstract from International Ozone Association Pan American Group, Las Vegas, United States.
Main Research Area: Technical/natural sciences
Electronic versions:
Abstract + Powerpoint presentation
Source: PublicationPreSubmission
Source-ID: 126631370
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

Assessing motility in environmental communities - a novel method

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Geological Survey of Denmark and Greenland, Aarhus University
Authors: Scheel Krüger, U. (Ekstern), Badawi, N. (Ekstern), Aamand, J. (Ekstern), Nybroe, O. (Forskerdatabase), Smets, B. F. (Intern), Dechesne, A. (Intern)
Pages: 87-87
Publication date: 2016
Beskrivelse af udfordringer ved og strategier for håndtering af og oprensning af spildevand fra skifergasproduktion

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Andersen, H. R. (Intern)
Pages: 101-104
Publication date: 2016

Biofilm Thickness Influences Biodiversity in Nitrifying MBBRs-Implications on Micropollutant Removal

In biofilm systems for wastewater treatment (e.g., moving bed biofilms reactors-MBBRs) biofilm thickness is typically not under direct control. Nevertheless, biofilm thickness is likely to have a profound effect on the microbial diversity and activity, as a result of diffusion limitation and thus substrate penetration in the biofilm. In this study, we investigated the impact of biofilm thickness on nitrification and on the removal of more than 20 organic micropollutants in laboratory-scale nitrifying MBBRs. We used novel carriers (Z-carriers, AnoxKaldnes) that allowed controlling biofilm thickness at 50, 200, 300, 400, and 500 μm. The impact of biofilm thickness on microbial community was assessed via 16S rRNA gene amplicon sequencing and ammonia monoxygenase (amoA) abundance quantification through quantitative PCR (qPCR). Results from batch experiments and microbial analysis showed that (i) the thickest biofilm (500 μm) presented the highest specific biotransformation rate constants (kbio, L g(-1) d(-1)) for 14 out of 22 micropollutants; (ii) biofilm thickness positively associated with biodiversity, which was suggested as the main factor for the observed enhancement of kbio; (iii)
the thinnest biofilm (50 μm) exhibited the highest nitrification rate (gN d(-1) g(-1)), amoA gene abundance and kbio values for some of the most recalcitrant micropollutants (i.e., diclofenac and targeted sulfonamides). Although thin biofilms favored nitrification activity and the removal of some micropollutants, treatment systems based on thicker biofilms should be considered to enhance the elimination of a broad spectrum of micropollutants.
Bioflocculation of green microalgae using activated sludge and potential for biogas production

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Residual Resource Engineering, Technical University of Denmark
Authors: Radovici, M. (Ekstern), Wágner, D. S. (Intern), Angelidaki, I. (Intern), Valverde Pérez, B. (Intern), Plósz, B. G. (Intern)
Number of pages: 1
Publication date: 2016
Event: Poster session presented at 13th IWA Leading Edge Conference on Water and Wastewater Technologies, Jerez da la Frontera, Spain.
Main Research Area: Technical/natural sciences
Electronic versions:
LET_poster_final.pdf
Source: PublicationPreSubmission
Source-ID: 125031600
Publication: Research - peer-review › Poster – Annual report year: 2016

Can we enhance the biotransformation of pharmaceutical micropollutants by controlling biofilm thickness in MBBR?

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Environmental Chemistry, AnoxKaldnes AB
Authors: Torresi, E. (Intern), Polesel, F. (Intern), Andersen, H. R. (Intern), Smets, B. F. (Intern), Christensson, M. (Ekstern), Plósz, B. G. (Intern)
Number of pages: 5
Publication date: 2016
Event: Abstract from IFAT - 2016, Munich, Germany.
Main Research Area: Technical/natural sciences
Electronic versions:
Abstract_extended_EWA_symposium_Elena_Torresi.pdf
Challenges in microbial ecology: Building predictive understanding of community function and dynamics

The importance of microbial communities (MCs) cannot be overstated. MCs underpin the biogeochemical cycles of the earth's soil, oceans and the atmosphere, and perform ecosystem functions that impact plants, animals and humans. Yet our ability to predict and manage the function of these highly complex, dynamically changing communities is limited. Building predictive models that link MC composition to function is a key emerging challenge in microbial ecology. Here, we argue that addressing this challenge requires close coordination of experimental data collection and method development with mathematical model building. We discuss specific examples where model-experiment integration has already resulted in important insights into MC function and structure. We also highlight key research questions that still demand better integration of experiments and models. We argue that such integration is needed to achieve significant progress in our understanding of MC dynamics and function, and we make specific practical suggestions as to how this could be achieved.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Number of pages: 12
Pages: 2557-2568
Publication date: 2016
Main Research Area: Technical/natural sciences
Characterization of membrane foulants at ambient temperature anaerobic membrane bioreactor treating low-strength industrial wastewater

The large volume of industrial low-strength wastewaters has a potential for biogas production through conventional anaerobic digestion (AD), limited though by the need of heating and concentrating of the wastewaters. The use of anaerobic membrane bioreactor (AnMBR) combining membrane filtration with anaerobic biological treatment at low temperature could not only reduce the operational cost of AD, but also alleviate environmental problems. However, at low temperature the AnMBR may suffer more fouling due to the increased extracellular polymeric substances production excreted by bacteria hampering the application of the process for the industrial wastewater treatment. In order to solve or reduce the fouling problem it is necessary to have a good insight into the processes that take place both on and in the membrane pores during filtration. Therefore, the objective of this study is to contribute to a better understanding of organic and biofouling in AnMBR. An AnMBR consisting of external PVDF membrane was operated at 25°C and fed with synthetic dairy wastewater. Intensity, morphology and composition of foulants were determined using Scanning Electron Microscopy coupled with X-ray Energy Dispersive Spectrometry (EDS), Fourier Transform Infrared Spectrometry (ATR-FTIR), Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES), Ion chromatography (IC), zeta potential, and adenosine triphosphate measurements. Based on membrane autopsies, it can be concluded that prevailing fouling is mainly of biological and organic origin. SEM observations demonstrated presence of numerous bacteria incorporated with the fouling layer composed of mainly proteins, carbohydrates and lipids as revealed by ATR-FTIR measurements. Furthermore the amounts of ions found by EDS & ICP-OES analysis do not support scaling layer formation.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Lund Institute of Technology, University of Maribor
Authors: Zarebska, A. (Intern), Kjerstadius, H. (Ekstern), Petrinic, I. (Ekstern), Buksek, H. (Ekstern), Korenak, J. (Ekstern), Jansen, J. L. C. (Ekstern), Hélix-Nielsen, C. (Intern)
Number of pages: 1
Publication date: 2016

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Place of publication: Lappeenranta, Finland
Publisher: Lappeenranta University of Technology Press
Main Research Area: Technical/natural sciences
Conference: 16th Nordic Filtration Symposium , Lappeenranta, Finland, 24/08/2016 - 24/08/2016
Anaerobic membrane bioreactor, Wastewater, Fouling
Electronic versions:
Source: PublicationPreSubmission
Source-ID: 125759275
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2016
Co-digestion of microalgae and activated sludge following a novel bioflocculation method

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Residual Resource Engineering, Technical University of Denmark
Authors: Wágner, D. S. (Intern), Radovici, M. (Ekstern), Angelidaki, I. (Intern), Valverde Perez, B. (Intern), Plósz, B. G. (Intern)
Number of pages: 1
Publication date: 2016
Event: Poster session presented at Young Algaeneers Symposium, 2016, Malta.
Main Research Area: Technical/natural sciences
Electronic versions: poster_YAS_final.pdf
Source: PublicationPreSubmission
Source-ID: 123735348
Publication: Research - peer-review › Poster – Annual report year: 2016

Combined Sewer Overflow pretreatment with chemical coagulation and a particle settler for improved peracetic acid disinfection

Full scale disinfection by peracetic acid (PAA) was achieved on Combined Sewer Overflow (CSO) water, which was pre-treated physically by a fast settling-filtration unit. Disinfection of untreated CSO water using PAA was compared to treatment using a particle separator (HydroSeparator®) and additional coagulation with poly-aluminum-chloride. Disinfection for Enterococcus increased with the applied dose of PAA and additional improvement was achieved when it was preceded by chemical coagulation with 5 mg L−1 poly-aluminum-chloride. When Enterococcus was reduced by treatment in the HydroSeparator, followed by PAA treatment during a CSO event, the treatment was sufficient to maintain microbial quality in the recipient water.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Bonnerup Consult ApS
Authors: Chhetri, R. K. (Intern), Bonnerup, A. (Ekstern), Andersen, H. R. (Intern)
Pages: 372-379
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Industrial and Engineering Chemistry
Volume: 37
ISSN (Print): 1226-086X
Ratings:
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.412 SJR 1.111
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.3 SJR 1.148 SNIP 1.494
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.931 SNIP 1.414 CiteScore 3.74
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.865 SNIP 1.445 CiteScore 3.25
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.691 SNIP 1.118 CiteScore 2.19
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.795 SNIP 1.299 CiteScore 2.31
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.85 SNIP 1.176 CiteScore 2.25
Community Structure in Methanogenic Enrichments Provides Insight into Syntrophic Interactions in Hydrocarbon-Impacted Environments

The methanogenic biodegradation of crude oil involves the conversion of hydrocarbons to methanogenic substrates by syntrophic bacteria and subsequent methane production by methanogens. Assessing the metabolic roles played by various microbial species in syntrophic communities remains a challenge, but such information has important implications for bioremediation and microbial enhanced energy recovery technologies. Many factors such as changing environmental conditions or substrate variations can influence the composition and biodegradation capabilities of syntrophic microbial communities in hydrocarbon-impacted environments. In this study, a methanogenic crude oil-degrading enrichment culture was successively transferred onto the single long chain fatty acids palmitate or stearate followed by their parent alkanes, hexadecane or octadecane, respectively, in order to assess the impact of different substrates on microbial community composition and retention of hydrocarbon biodegradation genes. 16S rRNA gene sequencing showed that a reduction in substrate diversity resulted in a corresponding loss of microbial diversity, but that hydrocarbon biodegradation genes (such as assA/masD encoding alkylsuccinate synthase) could be retained within a community even in the absence of hydrocarbon substrates. Despite substrate-related diversity changes, all communities were dominated by hydrogenotrophic and acetotrophic methanogens along with bacteria including Clostridium sp., members of the Deltaproteobacteria, and a number of other phyla. Microbial co-occurrence network analysis revealed a dense network of interactions amongst syntrophic bacteria and methanogens that were maintained despite changes in the substrates for methanogenesis. Our results reveal the effect of substrate diversity loss on microbial community diversity, indicate that many syntrophic interactions are stable over time despite changes in substrate pressure, and show that syntrophic interactions amongst bacteria themselves are as important as interactions between bacteria and methanogens in complex methanogenic communities.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, University of Calgary
Authors: Fowler, J. (Intern), Toth, C. R. A. (Ekstern), Gieg, L. M. (Ekstern)
Number of pages: 13
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Frontiers in Microbiology
Volume: 7
Article number: 562
ISSN (Print): 1664-302X
Ratings:
BFI (2018): BFI-level 1
Comparative measurement and quantitative risk assessment of alcohol consumption through wastewater-based epidemiology: An international study in 20 cities

Quantitative measurement of drug consumption biomarkers in wastewater can provide objective information on community drug use patterns and trends. This study presents the measurement of alcohol consumption in 20 cities across 11 countries through the use of wastewater-based epidemiology (WBE), and reports the application of these data for the risk assessment of alcohol on a population scale using the margin of exposure (MOE) approach. Raw 24-h composite wastewater samples were collected over a one-week period from 20 cities following a common protocol. For each sample a specific and stable alcohol consumption biomarker, ethyl sulfate (EtS) was determined by liquid chromatography coupled to tandem mass spectrometry. The EtS concentrations were used for estimation of per capita alcohol consumption in each city, which was further compared with international reports and applied for risk assessment by MOE. The average per capita consumption in 20 cities ranged between 6.4 and 44.3 L/day/1000 inhabitants. An increase in alcohol consumption during the weekend occurred in all cities, however the level of this increase was found to differ. In contrast to conventional data (sales statistics and interviews), WBE revealed geographical differences in the level and pattern of actual alcohol consumption at an inter-city level. All the sampled cities were in the "high risk" category (MOE).

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Ryu, Y. (Ekstern), Barceló, D. (Ekstern), Barron, L. P. (Ekstern), Bijlsma, L. (Ekstern), Castiglioni, S. (Ekstern), de Voogt, P. (Ekstern), Emke, E. (Ekstern), Hernández, F. (Ekstern), Lai, F. Y. (Ekstern), Lopes, A. (Ekstern), de Alda, M. L. (Ekstern), Mastroianni, N. (Ekstern), Munro, K. (Ekstern), O'Brien, J. (Ekstern), Ort, C. (Ekstern), Plósz, B. G. (Intern), Reid, M. J. (Ekstern), Yargeau, V. (Ekstern), Thomas, K. V. (Ekstern)
Number of pages: 7
Pages: 977-983
Publication date: 2016
Main Research Area: Technical/natural sciences
Comparison of pharmaceutical, illicit drug, alcohol, nicotine and caffeine levels in wastewater with sale, seizure and consumption data for 8 European cities

BACKGROUND:
Monitoring the scale of pharmaceuticals, illicit and licit drugs consumption is important to assess the needs of law enforcement and public health, and provides more information about the different trends within different countries. Community drug use patterns are usually described by national surveys, sales and seizure data. Wastewater-based epidemiology (WBE) has been shown to be a reliable approach complementing such surveys.

METHOD:
This study aims to compare and correlate the consumption estimates of pharmaceuticals, illicit drugs, alcohol, nicotine and caffeine from wastewater analysis and other sources of information. Wastewater samples were collected in 2015 from 8 different European cities over a one week period, representing a population of approximately 5 million people. Published pharmaceutical sale, illicit drug seizure and alcohol, tobacco and caffeine use data were used for the comparison.

RESULTS:
High agreement was found between wastewater and other data sources for pharmaceuticals and cocaine, whereas amphetamines, alcohol and caffeine showed a moderate correlation. Methamphetamine and 3,4-methylenedioxymethamphetamine (MDMA) and nicotine did not correlate with other sources of data. Most of the poor correlations were explained as part of the uncertainties related with the use estimates and were improved with other complementary sources of data.

CONCLUSIONS:
This work confirms the promising future of WBE as a complementary approach to obtain a more accurate picture of substance use situation within different communities. Our findings suggest further improvements to reduce the uncertainties associated with both sources of information in order to make the data more comparable.
Computational fluid dynamic analysis of concentration polarization and water flux optimization in spiral wound modules

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Aschmoneit, F. J. (Intern), Hélix-Nielsen, C. (Intern)
Number of pages: 2
Publication date: 2016
Event: Abstract from 9th International Membrane Science & Technology Conference, Adelaide, Australia.
Main Research Area: Technical/natural sciences
Electronic versions:
abstractFinal.pdf
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

Computational fluid dynamic analysis of concentration polarization and water flux optimization in spiral wound modules

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Aschmoneit, F. J. (Intern), Hélix-Nielsen, C. (Intern)
Number of pages: 9
Computational fluid dynamic analysis of concentration polarization and water flux optimization in spiral wound modules

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Aschmoneit, F. J. (Intern), Hélix-Nielsen, C. (Intern)
Pages: 245-248
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Place of publication: Adelaide, Australia
Main Research Area: Technical/natural sciences
Conference: 9th International Membrane Science & Technology Conference, Adelaide, Australia, 05/12/2016 - 05/12/2016
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2016

Control structure design for resource recovery using the enhanced biological phosphorus removal and recovery (EBP2R) activated sludge process
Nowadays, wastewater is considered as a set of resources to be recovered rather than a mixture of pollutants that should be removed. Many resource recovery schemes have been proposed, involving the use of novel technologies whose controllability is poorly studied. In this paper we present a control structure for the novel enhanced biological phosphorus removal and recovery (EBP2R) process, which is currently under development. The aim of the EBP2R is to maximize phosphorus recovery through optimal green micro-algal cultivation, which is achieved by controlling the nitrogen to phosphorus ratio (N-to-P ratio) fed to the algae. Process control structures are developed for a sequencing batch reactor (SBR) and a continuous flow reactor system (CFS). Results, obtained using the Benchmark Simulation Model No. 1 (BSM1) dynamic input disturbance time series, suggest that the SBR can maintain a stable N-to-P ratio in the effluent (16.9 ± 0.07) and can recover about 72% of the influent phosphorus. The phosphorus recovered by the CFS is limited by the influent nitrogen (65% of the influent phosphorus load). Using the CFS configuration the effluent N-to-P ratio cannot be effectively controlled (16.45 ± 2.48). Therefore, it is concluded that the SBR is the most effective reactor configuration for the EBP2R process. Importantly, the designed control structures rely on control loops that do not require chemical dosing for nutrient management, thereby reducing the environmental footprint of the EBP2R process. The proposed control strategies can be applied to other phosphorus recovery schemes where short sludge age EBPR systems play an important role.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Department of Chemical and Biochemical Engineering, CAPEC-PROCESS, Technical University of Denmark
Authors: Valverde Perez, B. (Intern), Fuentes-Martinez, J. M. (Ekstern), Flores Alsina, X. (Intern), Gernaey, K. (Intern), Huusom, J. K. (Intern), Plósz, B. G. (Intern)
Pages: 447-457
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Chemical Engineering Journal
Volume: 296
ISSN (Print): 1385-8947
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
De novo biofilm community assembly from tap water source communities favors Nitrotoga over Nitrospira under elevated nitrite surface loading

Four main processes are considered to drive microbial community assembly: selection, drift, dispersal and speciation. These processes occur simultaneously, but the extent to which each process contributes to community assembly is unclear in natural communities. We exposed a high-throughput flow-through biofilm system to continuous immigration from a tap water metacommunity while applying different nitrite surface loading rates. After 63 days of operation, we extracted biofilms and analyzed the community composition via Illumina MiSeq targeting the 16S rRNA gene. Previous studies have shown that Nitrospira is the dominant nitrite oxidizing genus in low nitrite environments. Hence, we postulated that by elevating the nitrite surface loading we would select for NOB with lower nitrite affinity than Nitrospira. We observed different dominant NOB species under different loading rates. While in the metacommunity, Nitrotoga and Nitrospira were found at near equal abundances, in the biofilm community, elevated nitrite loading strongly selected for Nitrotoga over Nitrospira. The biofilms were also significantly different in their alpha-diversity (p<0.001) and beta-diversity, and the evenness and richness of the biofilm community decreased significantly (p=0.004) compared to the metacommunity. These observations indicate that the selection towards Nitrotoga and Nitrospira dominated community assembly under different nitrite loadings. Lastly, we compared our observations of community composition with that predicted by neutral community assembly model. The predictions did not match the community structure observed in the biofilms (p=0.31),
providing further evidence of the importance of selection during community assembly.

**General information**

State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Urban Water Systems
Authors: Kinnunen, M. (Intern), Dechesne, A. (Intern), Albrechtsen, H. (Intern), Smets, B. F. (Intern)
Number of pages: 1
Publication date: 2016
Event: Abstract from 16th International Symposium on Microbial Ecology, Montreal, Canada.
Main Research Area: Technical/natural sciences
Electronic versions:
Abstract_final_ISME.pdf

**Bibliographical note**

Poster presentation
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

**Depth investigation of rapid sand filters for drinking water production reveals strong stratification in nitrification biokinetic behavior**

The biokinetic behavior of NH4 + removal was investigated at different depths of a rapid sand filter treating groundwater for drinking water preparation. Filter materials from the top, middle and bottom layers of a full-scale filter were exposed to various controlled NH4 + loadings in a continuous-flow lab-scale assay. NH4 + removal capacity, estimated from short term loading up-shifts, was at least 10 times higher in the top than in the middle and bottom filter layers, consistent with the stratification of Ammonium Oxidizing Bacteria (AOB). AOB density increased consistently with the NH4 + removal rate, indicating their primarily role in nitrification under the imposed experimental conditions. The maximum AOB cell specific NH4 + removal rate observed at the bottom was at least 3 times lower compared to the top and middle layers. Additionally, a significant up-shift capacity (4.6 and 3.5 times) was displayed from the top and middle layers, but not from the bottom layer at increased loading conditions. Hence, AOB with different physiological responses were active at the different depths. The biokinetic analysis predicted that despite the low NH4 + removal capacity at the bottom layer, the entire filter is able to cope with a 4-fold instantaneous loading increase without compromising the effluent NH4 +.

Ultimately, this filter up-shift capacity was limited by the density of AOB and their biokinetic behavior, both of which were strongly stratified.

**General information**

State: Published
Organisations: Department of Environmental Engineering, Urban Water Systems, Water Technologies
Authors: Tatari, K. (Intern), Smets, B. F. (Intern), Albrechtsen, H. (Intern)
Number of pages: 9
Pages: 402-410
Publication date: 2016
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Water Research
Volume: 101
ISSN (Print): 0043-1354
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SJR 2.601 SNIP 2.358
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.49 SJR 2.663 SNIP 2.563
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.665 SNIP 2.482 CiteScore 6.63
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.946 SNIP 2.702 CiteScore 6.13
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Destruction of disinfection byproducts and their precursors in swimming pool water by combined UV treatment and ozonation

Both UV treatment and ozonation are used to reduce different types of disinfection byproducts (DBP) in swimming pools. UV treatment is most common as it is particularly efficient in removing the repulsive chlorine like smelling chloramines (combined chlorine). UV treatment of a pool water increased chlorine reactivity and formation of chlor-organic DBP such as trihalomethanes. Based on the similar selective reactivity of ozone and chlorine we hypothesized that the created...
reactivity towards chlorine by UV treatment of dissolved organic matter in pool water might also be expressed as an increased reactivity towards ozone and that ozonation might saturate the chlorine reactivity created by UV treatment and mitigate the increased DBP formation. By experimentally treating pool water samples, we found that UV treatment makes pool water highly reactive to ozone. The created reactivity towards chlorine decreases dose dependently with ozone dosage prior to contact with chlorine. Furthermore, the kinetics of ozone in UV treated pool water changed drastically from a half-life in excess of 20 min to complete consumption in less than 2 min. We discovered that ozonation in UV treated pool water induced formation of some DBPs that are not commonly reported in pool water where trichloronitromethane is noteworthy as it is genotoxic. Therefore, we performed repeated treatment experiments consisting of combined UV/ozone treatment intersected with chlorination for 24 h the genotoxicity created during the ozone treatment was removed by the UV treatments. Based on the experimental results, a treatment system is proposed with a UV system placed in a side stream to the recirculation flow followed by an ozone dosing point and a small reaction chamber with a volume that allow 1-2 min reaction time before returning to the main recirculation flow. This side-stream UV/ozone treatment will improve the swimming pool water quality.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Cheema, W. A. (Intern), Kaarsholm, K. M. S. (Intern), Andersen, H. R. (Intern)
Number of pages: 1
Publication date: 2016
Event: Abstract from 2016 IUVA World Congress, Vancouver, Canada.
Main Research Area: Technical/natural sciences
Electronic versions:
Abstract + Powerpoint
Source: PublicationPreSubmission
Source-ID: 134618136
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2017

Development of solid supports for electrochemical study of biomimetic membrane systems
Biomimetic membranes are model membrane systems used as an experimental tool to study fundamental cellular membrane physics and functionality of reconstituted membrane proteins. By exploiting the properties of biomimetic membranes resembling the functions of biological membranes, it is possible to construct biosensors for high-throughput screening of potential drug candidates. Among a variety of membrane model systems used for biomimetic approach, lipid bilayers in the form of black lipid membranes (BLMs) and lipo-polymersomes (vesicle structures composed of lipids and polymers), both with reconstituted membrane spanning proteins, are attractive tools. However, BLMs suffer from intrinsic fragility, therefore, requiring techniques to increase their robustness and stability. This PhD thesis presents strategies to construct solid supports for electrochemical studies of two biomimetic membrane systems, BLMs and protein-loaded lipopolymersomes.

The solid support for BLMs was constructed as a reusable device comprising an ethylene tetrafluoroethylene (ETFE) aperture array supported by an in situ polymerized hydrogel covalently attached to both the ETFE and a gold electrode microchip. The hydrogel facilitated BLM formation without the need of manual painting and increased membrane stability in comparison with freestanding membranes. The functionality of the hydrogel supported BLMs (hsBLMs) were demonstrated by electrochemical impedance spectroscopic (EIS) characterization of incorporated ion transporter valinomycin. The presented work also includes a comprehensive EIS analysis and cryological scanning electron microscopic (cryo-SEM) imaging of hydrogels formulated in various molar ratios (1:100; 1:200; 1:400) of the cross-linker poly(ethylene glycol)dimethacrylate (PEGDMA) and 2-hydroxyethylmethacrylate (HEMA) monomers.

Lipo-polymersomes have proved to be suitable for reconstitution of a model G-protein coupled receptor (GPCR) - bacteriorhodopsin (bRh). The bRh-loaded lipopolymersomes were interfaced to gold electrodes using two different strategies, layer-by-layer deposited polyelectrolyte cushion directly on a gold electrode microchip and on a polyethersulfone (PES) support grafted by in situ polymerized hydrogel. Both strategies proved to be suitable for immobilization of functional bRh loaded lipopolymersomes. Amperometric monitoring showed that the PES membrane support facilitated recording of a steady-state photocurrent while only a transient photocurrent peak was recorded on the polyelectrolyte cushion without a PES membrane.

This PhD thesis also comprises the design and fabrication process of a modular microfluidic system with automated fluid delivery (micropumps and valves), providing a possibility for future applications of biomimetic membranes in the form of hsBLMs and polymersomes.

This thesis presents both strategies for formulation robust biomimetic membrane systems and devices, which could be developed further to construct biosensor technology for high-throughput screening of drug candidates.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Bioanalytics, Department of Environmental Engineering, Water Technologies
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Publication date: 2016
Does reactor staging influence microbial structure and functions in biofilm systems? The case of pre-denitrifying MBBRs

To date, a number of treatment technologies and configurations have been tested to improve the elimination of conventional and trace (e.g., pharmaceutical residues) pollutants via biological wastewater treatment. Bioreactor staging and the moving bed biofilm reactor (MBBR) technology have emerged as promising bioengineered solutions (Plósz et al., 2010) for this purpose. In this study, we combined the two solutions and investigated microbial functions (heterotrophic denitrification, pharmaceutical removal) and structure of the microbial community in staged MBBRs for pre-denitrification. A three-stage MBBR system (S1+S2+S3), fed with pre-clarified wastewater, was operated at laboratory-scale with (i) controlled biomass exposure to organic substrate (COD); and (ii) enhanced the physical retention of biomass, thus inducing adaptation to different substrate exposure conditions. During long-term operation (~500 days) of the three-stage MBBR under continuous-flow conditions, biofilm samples were collected to assess the temporal evolution of the microbial structure in terms of functional gene abundance and biodiversity. A set of batch experiments (day 471) was performed to assess denitrification and pharmaceutical removal in each MBBR, following prolonged biofilm exposure to specific COD availability.

Results from batch experiments showed declining denitrification potential and pharmaceutical biotransformation rate constants (k_bio, L gTSS-1 d-1) from MBBR S1 (exposed to highest COD availability) to S3 (exposed to lowest availability). These findings indicate that the exposure to tiered substrate availability influenced the capacity of utilizing a different range of carbon sources in each MBBR, thus impacting denitrification and pharmaceutical biotransformation. Preliminary analysis on the microbial community based on qPCR (quantitative polymerase chain reaction) showed differences in the abundance of genes (nirS, nirK, nosZ) encoding for denitrifying enzymes in the three staged MBBRs. Further microbial characterization through 16sRNA sequencing (Illumina) is currently under investigation to determine whether differences in microbial functions should be associated to differences in the microbial diversity in the three MBBRs.
Ecological patterns, diversity and core taxa of microbial communities in groundwater-fed rapid gravity filters

Here, we document microbial communities in rapid gravity filtration units, specifically serial rapid sand filters (RSFs), termed prefiltration units (PFs) and after-filtra-tion units (AFs), fed with anoxic groundwaters low in organic carbon to prepare potable waters. A comprehensive 16S rRNA-based amplicon sequencing survey revealed a core RSF microbiome comprising few bacterial taxa (29–30 genera) dominated by Nitrospirae, Proteobacteria and Acidobacteria, with a strikingly high abundance (75–87±18%) across five examined waterworks in Denmark. Lineages within the Nitrospira genus consistently comprised the second most and most abundant fraction in PFs (27±23%) and AFs (45.2±23%), respectively, and were far more abundant than typical proteobacterial ammonium-oxidizing bacteria, suggesting a physiology beyond nitrite oxidation for Nitrospira. Within the core taxa, sequences closely related to types with ability to oxidize ammonia, nitrite, iron, manganese and methane as primary growth substrate were identified and dominated in both PFs (73.6±1%) and AFs (61.4±21%), suggesting their functional importance. Surprisingly, operational taxonomic unit richness correlated strongly and positively with sampling location in the drinking water treatment plant (from PFs to AFs), and a weaker negative correlation held for evenness. Significant spatial heterogeneity in microbial community composition was detected in both PFs and AFs, and was higher in the AFs. This is the first comprehensive documentation of microbial community diversity in RSFs treating oligotrophic groundwaters. We have identified patterns of local spatial heterogeneity and dispersal, documented surprising energy–diversity relationships, observed a large and diverse Nitrospira fraction and established a core RSF microbiome.

General information
State: Published
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Web of Science (2017): Indexed yes
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Web of Science (2016): Indexed yes
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Scopus rating (2014): SJR 5.369 SNIP 2.288 CiteScore 8.42
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Scopus rating (2013): SJR 5.012 SNIP 2.271 CiteScore 8.62
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Web of Science (2012): Indexed yes
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ECOLOGICAL PATTERNS OF NITRIFIERS IN THE URBAN WATER CYCLE

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Organisations: Department of Environmental Engineering, Water Technologies, Urban Water Systems
Authors: Diwan, V. (Intern), Dechesne, A. (Intern), Smets, B. F. (Intern), Albrechtsen, H. (Intern)
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EFFECT OF OXIDATION OF SWIMMING POOL WATER ON FORMATION OF VOLATILE DISINFECTION BY-PRODUCTS - A LABORATORY STUDY
Oxidation experiments were performed using unchlorinated tap water used for filling municipal swimming pools, actual pool water and pool water polluted by addition of fresh tap water and artificial body fluid to evaluate ozone kinetics and water quality effects on formation of volatile disinfection byproducts during subsequent chlorination. The ozone reaction was observed to behave according to first order kinetics. For tap water half-life was 4 min whilst polluted and unpolluted pool water exhibited half-life of 8 and 11 min, respectively. When ozone dosage was repeated half-life of ozone was approximated 17-19 min in all samples. Subsequent chlorination revealed ozone removed reactivity of dissolved organic carbon toward chlorine for tap and polluted pool water, decreasing formation rate of trihalomethanes (TTHM). In pool water higher rates of TTHM formation was observed after the initial ozone dosage, however this decreased with subsequent treatments. For tap and polluted pool water, ozone reacted directly with the pollutants resulting in a short ozone half-life, removing reactivity towards chlorine oxidation and preventing TTHM production. Conversely for pool water samples, due to the long half-life of ozone,
the molecule decomposed to hydroxyl radicals. These in turn reacted with aqueous organic matter increasing chlorine reactivity and rates of TTHM formation. Formation of other non-regulated volatile byproducts (e.g. dichloracetonitrile, trichloropropanone and trichloronitromethane) was observed to increase in pool water with ozone treatment. Thus, ozonation dosage regimes should be designed such that ozone mostly oxidizes fresh pollutants before chlorine is able to react with it.

General information
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Authors: Hansen, K. M. S. (Intern), Spiliotopoulou, A. (Intern), Cheema, W. A. (Intern), Andersen, H. R. (Intern)
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BFI (2013): BFI-level 1
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Enhanced performance of a biomimetic membrane for Na2CO3 crystallization in the scenario of CO2 capture

Membrane assisted crystallization (MACr) offers an innovative platform for crystallizing Na2CO3, allowing its reuse after CO2 capture from flue gases by an alkaline solution (i.e., NaOH). In this study, the biomimetic aquaporin Inside™ membrane AIM60 was employed to enhance water removal, facilitating Na2CO3 crystallization. The water channel in the
active layer, comprising aquaporin proteins, and the strong wettability of membrane substrate assist a better performance. For instance, the water flux of AIM60 membrane for concentrating a 1.89mol\textperml Na2CO3 solution (osmotic pressure of 94.8bar) in forward osmosis (FO) mode was 6.62Lm\textpermg-2h\textpermg-1 and 3.25Lm\textpermg-2h\textpermg-1 in pressure retarded osmosis (PRO) mode when a 5.13mol\textperml NaCl solution (osmotic pressure of 304.9bar) was employed as the draw solution. This demonstrates that the AIM60 FO membrane outperformed the previously reported dense reverse osmosis membrane (0.21Lm\textpermg-2h\textpermg-1 in FO mode and 0.16Lm\textpermg-2h\textpermg-1 in PRO mode) and a porous hydrophobic hollow fiber membrane (0.08Lm\textpermg-2h\textpermg-1) under the same operating conditions. Crystallization utilizing the AIM60 membrane in an osmotic crystallizer was achieved without noticeable membrane scaling or degradation. Furthermore, a proper control of the supersaturation level induces crystallization of Na2CO3·10H2O crystals with a purity of 99.94%. Hence, the aquaporin Inside™ FO membrane may be a promising alternative to existing methods for Na2CO3 crystallization for its application in a CO2 capture scenario.
Environmental Phosphorus Recovery Based on Molecular Bioscavengers: From Quantum Mechanics to Continuum Physics

Phosphorus is a ubiquitous element of all known life and as such it is found throughout numerous key molecules related to various cellular functions. The supply of phosphorus is tightly linked to global food security, since phosphorus is used to produce agricultural fertilizers, without which it would not be possible to feed the world population. Sadly, the current supply of phosphorus is based on the gradual depletion of limited fossil reserves, and some estimates predict that within 15-25 years we will consume more phosphorus than we can produce. There is therefore a strong international pressure to develop sustainable phosphorus practices as well as new technologies for phosphorus recovery. Nature has spent billions of years refining proteins that interact with phosphates. This has inspired the present work where the overall ambitions are: to facilitate the development of a recovery technology based on biological phosphorus...
scavengers, to examine fundamental molecular system aspects relevant for such a technology, and to motivate the use of computational techniques throughout an iterative design process of such a technology. A wide spectrum of computational methods, from atomic-scale quantum calculations to macro-scale fluid simulations, are employed to hint at the potential of a recovery technology based on molecular bioscavengers.

As a first approach, data mining is used to obtain statistical information about how proteins in nature interact with phosphate groups, thereby revealing characteristic amino acid distributions of the binding sites. Quantum mechanical methods are used to investigate how phosphate moieties are described using electronic structure methods, and molecular dynamics in combination with quantum mechanics are used to show how the dynamical interaction between phosphates and proteins can be described – it is found that certain commonly used computational methods, including B3LYP, are ill-suited for characterizing interactions with phosphate groups, but nevertheless that phosphate-protein interactions can efficiently be quantified using other methods, e.g. wB97XD or PM6. Finally, it is shown how computational fluid dynamics can be used to optimize large-scale industrial processes using an open-source model, which we have made freely available online to the membrane community, and the advantages/disadvantages of different potential physical implementations of the proposed scavenger technology are discussed.

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Organisations: Department of Environmental Engineering, Water Technologies
Authors: Gruber, M. F. (Intern), Hélix-Nielsen, C. (Intern)
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Establishing drinking water biofilms with varying alpha-diversity?

General information
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Organisations: Department of Environmental Engineering, Water Technologies, Urban Water Systems
Authors: Kinnunen, M. (Intern), Dechesne, A. (Intern), Gülay, A. (Intern), Albrechtsen, H. (Intern), Smets, B. F. (Intern)
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Evaluating robustness of a diesel-degrading bacterial consortium isolated from contaminated soil
It is not known whether diesel-degrading bacterial communities are structurally and functionally robust when exposed to different hydrocarbon types. Here, we exposed a diesel-degrading consortium to model either alkanes, cycloalkanes or aromatic hydrocarbons as carbon sources to study its structural resistance. The structural resistance was low, with changes in relative abundances of up to four orders of magnitude, depending on hydrocarbon type and bacterial taxon. This low resistance is explained by the presence of hydrocarbon-degrading specialists in the consortium and differences in growth kinetics on individual hydrocarbons. However, despite this low resistance, structural and functional resilience were high, as verified by re-exposing the hydrocarbon-perturbed consortium to diesel fuel. The high resilience is either due to the short exposure time, insufficient for permanent changes in consortium structure and function, or the ability of some consortium members to be maintained during exposure on degradation intermediates produced by other members. Thus, the consortium is expected to cope with short-term exposures to narrow carbon feeds, while maintaining its structural and functional integrity, which remains an advantage over biodegradation approaches using single species cultures.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Department of Environmental Engineering, Water Technologies, Poznan University of Technology, Poznan University Of Life Sciences,
Evaluation of a membrane bioreactor system as post-treatment waste water treatment for better removal of micropollutants

Organic micropollutants such as pharmaceuticals are persistent pollutants that are only partially degraded in waste water treatment plants (WWTPs). In this study, a membrane bioreactor (MBR) system was used as a polishing step on a full-scale WWTP, and its ability to remove micropollutants was examined together with the development and stability of the microbial community. Two stages of operation were studied during a period of 9 months, one with (S1) and one without (S2) the addition of exogenous organic micropollutants. Ibuprofen and naproxen had the highest degradation rates with values of 248 μg/gVSS·h and 71 μg/gVSS·h, whereas diclofenac was a more persistent OMP (7.28 μg/gVSS·h). Mineralization of 14C-labeled organic micropollutants' in batch kinetic experiments indicates that higher removal rates (~0.6 ng/mgSS·h) with a short lag phase can be obtained when artificial addition of organic micropollutants was performed. Similar microbial populations dominated S1 and S2, despite the independent operations. Hydrogenophaga, Nitrospira, p55-a5, the actinobacterial Tetrasphaera, Propionicimonas, Fodinicola, and Candidatus Microthrix were the most abundant groups in the polishing MBR. Finally, potential microbial candidates for ibuprofen and naproxen degradation are proposed.

General information
State: Published
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Scopus rating (2017): SJR 2.601 SNIP 2.358
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Scopus rating (2016): CiteScore 7.49 SJR 2.663 SNIP 2.563
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.665 SNIP 2.482 CiteScore 6.63
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.946 SNIP 2.702 CiteScore 6.13
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.676 CiteScore 6.02
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Scopus rating (2012): SJR 2.914 SNIP 2.442 CiteScore 5.15
ISI indexed (2012): ISI indexed yes
Fate of cocaine drug biomarkers in sewer system: the role of suspended solids in biotransformation and sorption
Biochemical processes determining the fate of micropollutants in wastewater are not limited to treatment plants (WWTPs), occurring also in sewer systems after discharge by excretion. In-sewer processes are associated mainly to the presence of biofilm attached on pipelines and suspended solids in raw sewage. Among existing micropollutants, in-sewer fate assessment is specifically relevant to illicit drugs, impacting the calculation of consumption levels in catchments according to the wastewater-based epidemiology approach (Zuccato et al., 2005). However, there is still a knowledge gap on the fate of illicit drugs in sewer systems. This study aims at assessing the role of suspended solids on the biotransformation and sorption in raw sewage of eight illicit drug biomarkers (cocaine, heroin, methadone, mephedrone, ketamine, methamphetamine, MDMA and THC and their urinary metabolites).

Separate sets of batch experiments were performed to assess biotransformation and sorption of illicit drugs under aerobic and anaerobic conditions, prevailing in sewer systems. Biotransformation experiments were started by spiking a mixture of standards in methanol to batch reactors (final concentration of 10 μg L^-1). Nine samples (240 ml) were taken over 48 h. Immediately after collection, samples were spiked with deuterated standards (final concentration 360 ngL^-1) and stored at -20°C. Control experiments were also performed using mineral water under same experimental conditions of biotransformation experiments. Sorption experiments were performed according to the same procedure and with inactivation of biomass using sodium azide (0.05% v/v). Sample preparation and analysis consisted of solid phase extraction (SPE) with Oasis HLB cartridges followed by liquid chromatography coupled to high resolution mass spectrometry. The Activated Sludge Model for Xenobiotics (ASM-X) (Plósz et al., 2013) was used to simulate biotransformation and sorption of spiked chemicals. Monte Carlo method employing Latin Hypercube Sampling (LHS) of parameter space was used to estimate first-order abiotic (kabiotic, d^-1) and pseudo-first-order biotransformation rate.
constants (kbio, L g⁻¹ d⁻¹), with root mean square normalized error as objective function. Sorption coefficients (Kd) were calculated from the decrease of aqueous concentrations during experiments.

Experimental and modelling results are illustrated in Figure 1 and Table 1, which summarize experimental results and estimated parameter values for cocaine (COC) and its major metabolites benzoylcegonine (BE), ecgonine-methyl-ester (EME) and cocaethylene (CE). Our results suggest the formation of BE from COC and CE. COC transformation to CE and EME was assumed negligible (Plósz et al., 2013; Bisceglia and Lippa, 2014). A comparison of results from different experiments showed that abiotic transformation was overall prevalent under both redox conditions. Under anaerobic condition, in particular, transformation was almost completely associated to abiotic processes. Biotransformation rate constants (kbio) could not be estimated and should be considered negligible. These evidences are in agreement with earlier studies illustrating that chemical hydrolysis plays a major role in the transformation of cocaine biomarkers (Bisceglia and Lippa 2014). In addition, limited sorption for EME (Kd=0.7 L g⁻¹) and BE (Kd=0.1 L g⁻¹) and no sorption for COC and CE were observed.

General information
State: Published
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Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

Flux behaviour under different operational conditions in osmosis process
The transport of water molecules across a semi-permeable membrane is driven by the osmotic pressure difference between feed and draw solution. Two different operational modes can be distinguished, namely FO mode when the active membrane layer is facing the wastewater (feed), and PRO mode when the active membrane layer is facing draw solution. Osmosis process can be affected by several factors, such as operating conditions (temperature and cross flow velocity), feed and draw solution properties, and membrane characteristics. These factors can significantly contribute to the efficiency of the process itself. In order to implement the osmosis process on an industrial scale, process economy need to be taken into consideration, as well as the desired final product quality. Membrane performance can be evaluated based on the water permeability and the selectivity of the membrane. The permeability coefficient (A) defined as the water flux through the membrane will be experimentally determined. Likewise selectivity of the membrane (B) will be measured, which will tell us about membrane retention properties of certain substances dissolved in feed solution. The aim of the study is to determine water flux and reverse salt flux through the semi-permeable membrane at FO and PRO modes using two types of membranes and using three different draw solutions (NaCl, MgCl₂, and CaCl₂). The process efficiency at different conditions will be assessed based on physical and chemical analysis such as pH, conductivity, and total dissolved solids. Taken together our results can contribute understanding of the how performance of asymmetric FO membranes can be enhanced by feed and draw properties, membrane characteristics and operational conditions.

General information
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Organisations: Department of Environmental Engineering, Water Technologies, University of Maribor
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Forward osmosis, Membrane characterisation, Draw solutions, Cross flow velocity
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Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

Forward osmosis treatment of effluents from anaerobic digestion: correlation between membrane performance and biogas potential
Generation of synthetic influent data to perform (micro)pollutant wastewater treatment modelling studies

The use of process models to simulate the fate of micropollutants in wastewater treatment plants is constantly growing. However, due to the high workload and cost of measuring campaigns, many simulation studies lack sufficiently long time series representing realistic wastewater influent dynamics. In this paper, the feasibility of the Benchmark Simulation Model No. 2 (BSM2) influent generator is tested to create realistic dynamic influent (micro)pollutant disturbance scenarios. The presented set of models is adjusted to describe the occurrence of three pharmaceutical compounds and one of each of its metabolites with samples taken every 2-4h: the anti-inflammatory drug ibuprofen (IBU), the antibiotic sulfamethoxazole (SMX) and the psychoactive carbamazepine (CMZ). Information about type of excretion and total consumption rates forms the basis for creating the data-defined profiles used to generate the dynamic time series. In addition, the traditional influent characteristics such as flow rate, ammonium, particulate chemical oxygen demand and temperature are also modelled using the same framework with high frequency data. The calibration is performed semi-automatically with two different methods depending on data availability. The 'traditional' variables are calibrated with the Bootstrap method while the pharmaceutical loads are estimated with a least squares approach. The simulation results demonstrate that the BSM2 influent generator can describe the dynamics of both traditional variables and pharmaceuticals. Lastly, the study is complemented with: 1) the generation of longer time series for IBU following the same catchment principles; 2) the study of the impact of in-sewer SMX biotransformation when estimating the average daily load; and, 3) a critical discussion of the results, and the future opportunities of the presented approach balancing model structure/calibration procedure complexity versus predictive capabilities.
Harvesting microalgae using activated sludge can decrease polymer dosing and enhance methane production via co-digestion in a bacterial-microalgal process

Third generation biofuels, e.g. biofuels production from algal biomass, have gained attention due to increased interest on global renewable energy. However, crop-based biofuels compete with food production and should be avoided. Microalgal cultivation for biofuel production offers an alternative to crops and can become economically viable when combined with the use of used water resources. Besides nutrients and water, harvesting microalgal biomass represents one of the major costs related to biofuel production and thus efficient and cheap solutions are needed. In bacterial-algal systems, there is the potential to produce energy by co-digesting the two types of biomass. We present an innovative approach to recover
microalgal biomass via a two-step flocculation using bacterial biomass after the destabilisation of microalgae with conventional cationic polymer. A short solids retention time (SRT) enhanced biological phosphorus removal (EBPR) system was combined with microalgal cultivation. Two different bacterial biomass removal strategies were assessed whereby bacterial biomass was collected from the solid-liquid separation after the anaerobic phase and after the aerobic phase. Microalgal recovery was tested by jar tests where three different chemical coagulants in coagulation-flocculation tests (AlCl3, PDADMAC and Greenfloc 120) were assessed. Furthermore, jar tests were conducted to assess the microalgal biomass recovery by a two-step flocculation method, involving chemical coagulants in the first step and bacterial biomass used in the second step to enhance the flocculation. Up to 97% of the microalgal biomass was recovered using 16 mg polymer/g algae and 0.1 g algae/g bacterial biomass. Moreover, the energy recovery by the short-SRT EBPR system combined with microalgal cultivation was assessed via biomethane potential tests. Up to 560 ± 24 mL CH4/gVS methane yield was obtained by co-digesting bacterial biomass collected after the anaerobic phase and microalgal biomass. The energy recovery in terms of methane production obtained in the short-SRT EBPR system is about 40% of the influent chemical energy.

General information
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Organisations: Department of Environmental Engineering, Water Technologies, Residual Resource Engineering, Technical University of Denmark
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Web of Science (2017): Indexed Yes
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Scopus rating (2016): CiteScore 4.45 SJR 1.465 SNIP 1.141
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BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.963 SNIP 1.618 CiteScore 5.53
Scopus rating (2014): SJR 1.902 SNIP 1.598 CiteScore 4.96
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How preparation and modification parameters affect PB-PEO polymersome properties in aqueous solution
The effect of formation and modification methods on the physical properties of polymersomes is critical for their use in applications relying on their ability to mimic functional properties of biological membranes. In this study, we compared two formation methods for polymersomes made from polybutadiene-polyethylene oxide diblock copolymers: detergent-mediated film rehydration (DFR) and solvent evaporation (SE). DFR-prepared polymersomes showed a three times higher permeability compared to SE-prepared polymersomes as revealed by stopped-flow light scattering. SE-prepared polymersomes broke down faster to structures <50 nm diameter when processed with extrusion, which was more pronounced at 5 mg mL⁻¹, compared to 10, 20, and 25 mg mL⁻¹. Our results indicate that the bilayer of SE-prepared polymersomes has a lower apparent fluidity. We also investigated the role of n-octyl-β-d-glucopyranoside (OG), a detergent typically used for reconstitution of membrane proteins into lipid bilayers. Specifically, we compared dialysis and biobeads for OG removal to investigate the influence of these methods on bilayer conformation and polymer
rearrangement following detergent removal. There was no significant difference found between method, temperature, or time within each method. Our findings provide insight on how biocompatible polymersome production affects the physical properties of the resulting polymersomes.

General information
State: Published
Organisations: Department of Environmental Engineering, Department of Micro- and Nanotechnology, Amphiphilic Polymers in Biological Sensing, Water Technologies, Aquaporin A/S, University of Copenhagen
Authors: Habel, J. E. O. (Intern), Ogbonna, A. (Ekstern), Larsen, N. (Ekstern), Krabbe, S. (Ekstern), Almdal, K. (Intern), Helix-Nielsen, C. (Intern)
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Web of Science (2015): Indexed yes
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Scopus rating (2014): SJR 1.503 SNIP 1.412 CiteScore 3.91
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Web of Science (2013): Indexed yes
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Scopus rating (2012): SJR 1.067 SNIP 1.168 CiteScore 2.29
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Scopus rating (2011): SJR 0.788 SNIP 0.906 CiteScore 1.74
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BFI (2010): BFI-level 1
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BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.156 SNIP 1.005
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.143 SNIP 1.112
Scopus rating (2007): SJR 1.24 SNIP 1.132
Scopus rating (2006): SJR 1.267 SNIP 1.245
Scopus rating (2005): SJR 1.202 SNIP 1.054
Scopus rating (2004): SJR 1.287 SNIP 1.243
Web of Science (2004): Indexed yes
Hybridized reactive iron-containing nano-materials for water purification

Groundwater is an important source for drinking water in all corners of the globe, and in places like Denmark, it is the primary source for drinking water. Climate change and population growth will only lead to further dependence on groundwater as the supply for drinking water. However, the expanding population and industrialization of human civilization also leads to environmental consequences affecting groundwater sources. Storm-water and agricultural runoff, industrial spillage and dumping, acid mine drainage, and leakage from landfills are a few prime examples of routes of contamination for pollutants to enter groundwater systems. In order to make these contaminated water sources viable for human consumption, the use of reactive iron (i.e. Fe0 or zero-valent iron), and in particular nanoscale zero-valent iron (nZVI), is being employed to reductively degrade and/or adsorb many of these pollutants. However, the use of nZVI, as it currently stands, has its limitations. These limitations are primarily rapid oxidation and aggregation, resulting in loss of reactivity and applicability. Therefore, development of new materials incorporating nZVI and improving synthesis strategies to increase the applicability of nZVI is paramount to its future success as a remediation technique. This PhD project has investigated various materials aimed at solving the reactivity loss of reactive iron to create a robust treatment system capable of treating polluted waters. This PhD project also investigated and developed a procedure to appropriately measure the reactivity of reactive iron for a universal testing method.

Coating of nZVI is a common solution to combating the limitations of the material, in that the coating can surround the nZVI particle and prevent it from interacting with other particles while still allowing for interaction with the aqueous pollutant. This study employed a synthetic organo-functionalized magnesium-based aminoclay (MgAC) for this exact purpose. By varying the ratio of MgAC to nZVI and monitoring the change in physical characteristics and reactivity, a composite material was formed that improved the overall functionality of nZVI. It was determined that the reactive iron (vs. oxidized iron) content, colloidal stability, particle size, and nitrate degradation could all be best enhanced at a weight ratio of 7.5:1 of MgAC:Fe. Another solution, although less common, to combating the limitations, is to entrap or impregnate a porous material with nZVI. This way acts in a similar manner, except that the nZVI is bound within a complex matrix rather than coated with a protective barrier. A variety of porous polymeric networks, termed covalent organic polymers (COPs), were impregnated with nZVI and evaluated similarly as with the MgAC. All COPs exhibited high uptake of nZVI, approximately 10% by mass. Reactivity quantification proved to be difficult when degrading an azo dye, due to the very high propensity of the COPs to adsorb both the dye and its degradation products. However, these COPs acted as extremely efficient carriers of nZVI for maintaining colloidal stability. In one case, the COP used (COP-19) increased the colloidal stability of nZVI by two orders of magnitude. Building on the application of these composite materials, investigating how best to handle the synthesized materials can prolong their lifetime. To do this, three washing and storage strategies of the MgAC coated nZVI were investigated. They were: washing the particles immediately after synthesis with a NaHCO3 buffer, washing the particles after storing with a NaHCO3 buffer, and washing the particles immediately after synthesis with a MgAC solution. For all the particle reactivity tests done, it was apparent that washing the particles after storing was detrimental to the material. The colloidal stability, reactive iron, and reactivity towards nitrate dropped rapidly through one week of storage. The other strategies, where washing was done immediately was able to preserve the three aforementioned properties much more efficiently though one week of storage, with MgAC washed particles faring better of the two. This pre-washing technique removes residual reactants in the synthesis mixture that can corrode the iron, and furthermore, pre-washing with MgAC adds more of the stabilizer to the material that protects the nZVI even more. Moreover, by looking deeper into the characteristics of uncoated nZVI, depending on the washing method, allowed for more insight to the nature of the mechanisms taking place during storage. It was observed that washing nZVI with MilliQ water after synthesis created an environment where the particles were slightly more oxidized from the start, which led to an increased formation of an iron-hydroxide shell during storage. Not washing nZVI or washing with the reductant NaBH4 prohibited initial oxidation, leading to subsequent iron-oxide formation during storage. This is important, because the hydroxide shell promotes more electron transfer, whereas the oxide shell acts as a depassivation layer. The increased electron transfer then allowed for higher reactivity during storage, up to one week. To make comparison and quantification for researchers, a simple and effective method to assess the reactivity of nZVI is extremely important. And, as it is now, most of the reactivity characterization methods are often analytically intensive, requiring expensive equipment, and often don’t respond uniformly to different nZVI-based materials. This study sought to...
solve this problem, by developing a simple colorimetric assay that is capable to taking a degradation product produced by nZVI reacting with a compound, and creating a color reaction detectable with a simple spectrophotometer. This was done by utilizing the indophenol reaction, which uses phenol and selected other reagents to produce a blue color. Phenol can be produced from the dehalogenation of 4-chlorophenol by nZVI, and to a greater extent by bimetallic nickel-nZVI. That simple method was then optimized to reduce reagent volumes, nickel concentration, and to broaden the range of detectable compounds. These compounds capable of being used in the color assay with the same set of reagents were ultimately aniline, ammonium, and phenol; all of which can be produced by the degradation reaction from nZVI. Finally, to compare the applicability of the colorimetric assay to common halogenated groundwater contaminants; it was compared to the dehalogenation of TCE, TCA, and atrazine. The colorimetric assay performed similarly to the degradation of those chlorinated compounds; meaning the assay can be a simple tool to assess the reactivity of any nZVI when ultimately targeting more difficult to analyze compounds in real-world sources.

Ultimately, the primary goal of this PhD study was to develop a robust nanocomposite material containing nZVI for water treatment systems. Taking the lessons learned from initial composite work using MgAC and COPs, the final material combined granular activated carbon with COP and nZVI. After a lengthy process in developing a method to chemically graft COP material to the surface of activated carbon, it was possible to impregnate that composite material with nZVI. Because of the activated carbon backbone, the final material proved to be an extremely robust material with the structural integrity to be used in a packed-bed column that is common when treating high volumes of water. Although, continued optimization of the material is necessary, preliminary results when adsorbing and degrading contaminants were very promising, outperforming activated carbon alone and just the carbon impregnated with nZVI. Also, a bonus effect was achieved in the process. In that the entire composite material, in particular the COP attached to the surface of the carbon, acted as a protective barrier from the effects of oxidation. The carbon-COP-nZVI composites exhibited nearly 100% reactive iron content upon synthesis, compared to much lower amounts in other reported nZVI composites or the carbon-nZVI produced in this study having only 80% reactive iron content.

The results of this PhD concluded in various advances in the application and assessment of nZVI and nZVI composite materials. Various composite materials provided increased colloidal stability and reactivity for nZVI. Various washing and storage strategies elucidated better methods for delivering nZVI to a water contaminant and the underlying mechanisms taking place in the nZVI corrosion process. Finally, novel materials combining three different technologies were developed to eventually lead to a robust water treatment system capable of degrading typically hard to remediate water pollutants.

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Organisations: Department of Environmental Engineering, Water Technologies, Department of Micro- and Nanotechnology, Surface Engineering, Korea Advanced Institute of Science & Technology, Seoul National University
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Publisher: Technical University of Denmark, DTU Environment
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Hybridized reactive iron-containing nano-materials for water purification
Publication: Research › Ph.D. thesis – Annual report year: 2016

Identifying novel nitrifying bacteria in rapid gravity sand filters using stable isotope probing

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Urban Water Systems, University of Southern Denmark
Authors: Fowler, J. (Intern), Gülay, A. (Intern), Tatari, K. (Intern), Thamdrup, B. (Ekstern), Albrechtsen, H. (Intern), Serensen, S. J. (Ekstern), Smets, B. F. (Intern)
Number of pages: 3
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Event: Abstract from MEWE and biofilms IWA specialist conference, Copenhagen, Denmark.
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Impact of influent quality on green microalgal cultivation with used water resources – experimental assessment combined with image analysis

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Technical University of Denmark
Authors: Wágner, D. S. (Intern), Valverde Pérez, B. (Intern), Cazzaniga, C. (Ekstern), Steidl, M. (Ekstern), Dechesne, A. (Intern), Plósz, B. G. (Intern)
Number of pages: 1
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Main Research Area: Technical/natural sciences
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Improving the prediction of in-sewer transformation of illicit drug biomarkers by identifying a new modelling framework

In the context of wastewater-based epidemiology, uncertainties associated with in-sewer transformation are often not considered. However, sewer systems are biological reactors in which the concentration of organic pollutants (primary pollutants, e.g. COD, and secondary pollutants, e.g. illicit drugs) is altered during transport. Although reduced stability of several drug biomarkers was shown in raw sewage and biofilm, evidence on the type of transformation (biotic or abiotic) and the effect of different redox conditions on transformation is currently insufficient. In this study, the biotransformation and abiotic transformation of 16 illicit drugs were assessed in wastewater and mineral water, respectively. The targeted illicit drugs were: cocaine and its metabolites benzoylecgonine, ecgonine methyl ester, and cocaethylene; heroin and its metabolite norcodeine; methadone and its metabolite 2-ethylidene-1,5-dimethyl-3,3-diphenylpyrrolidine (EDDP); mephedrone; and tetrahydrocannabinol (THC) and its metabolites 11-hydroxy-Δ9-THC (THCOH), and 11-nor-9-carboxy-Δ9-THC (THCCOOH). All the transformation studies were performed using batch experiments under both aerobic and anaerobic conditions, while concomitantly assessing the degradation of primary pollutants. Furthermore, sorption to suspended solids and to reactor walls was also considered and quantified. The transformation of primary pollutants and illicit drugs in wastewater was simulated using Wastewater Aerobic/anaerobic Transformations in Sewers model (WATS)1 extended with the Activated Sludge Model for Xenobiotic trace chemicals (ASM-X)2. In addition, abiotic and biotic transformation pathways (based on available literature studies and statistical analysis) were considered for each drug biomarker. Our results suggest that ignoring the dynamics of biomass growth would result in significant overestimation (up to 385%) of aerobic biotransformation rate constants, whereas no significant difference was observed for anaerobic rate constants. Furthermore, abiotic transformation was found to be the main transformation mechanism for THC (aerobic conditions); mephedrone, methadone, cocaine, ecgonine methyl ester, cocaethylene, THCOH and THCCOOH (anaerobic conditions). By use of the proposed model the uncertainty of predicting illicit drug concentration at the excretion point can be reduced and hence the accuracy of back-calculation of illicit drug use in catchments can be improved.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Environmental Chemistry
Authors: Ramin, P. (Intern), Brock, A. L. (Intern), Polesel, F. (Intern), Torresi, E. (Intern), Plósz, B. G. (Intern)
Number of pages: 1
Publication date: 2016
Event: Abstract from International Conference on Emerging Contaminants (EmCon2016) and Micropollutants (WiOW2016) in the Environment, Sydney, Australia.
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Electronic versions:
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Increased levels of the oxidative stress biomarker 8-iso-prostaglandin F2α in wastewater associated with tobacco use

Wastewater analysis has been demonstrated to be a complementary approach for assessing the overall patterns of drug use by a population while the full potential of wastewater-based epidemiology has yet to be explored. F2-isoprostanes are a prototype wastewater biomarker to study the cumulative oxidative stress at a community level. In this work, 8-iso-prostaglandin F2α (8-iso-PGF2α) was analysed in raw 24 h-composite wastewater samples collected from 4 Norwegian and 7 other European cities in 2014 and 2015. Using the same samples, biomarkers of alcohol (ethyl sulfate) and tobacco (trans-3'-hydroxycotinine) use were also analysed to investigate any possible correlation between 8-iso-PGF2α and the consumption of the two drugs. The estimated per capita daily loads of 8-iso-PGF2α in the 11 cities ranged between 2.5 and 9.9 mg/day/1000 inhabitants with a population-weighted mean of 4.8 mg/day/1000 inhabitants. There were no temporal trends observed in the levels of 8-iso-PGF2α, however, spatial differences were found at the inter-city level correlating to the degree of urbanisation. The 8-iso-PGF2α mass load was found to be strongly associated with that of trans-3'-hydroxycotinine while it showed no correlation with ethyl sulfate. The present study shows the potential for 8-iso-PGF2α as a wastewater biomarker for the assessment of community public health.
Influence of dissolved organic carbon on biodegradation of pharmaceuticals by suspended biofilms in wastewater

**General information**

State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Aarhus University
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Number of pages: 2
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2nd Young Water Professionals Denmark Conference and Workshop

Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2017

Influence of feed composition and membrane fouling on forward osmosis performance

Clean water is a basic human need. However, rapid population growth and climate change result in an increase of water demand, whereas the resources of potable water are shrinking. One of the solutions could be to use membrane technology to reclaim clean and safe drinking water from wastewater. Nonetheless, the existing membrane technologies often face fouling problem that lowers the economic viability of the membrane application in industrial scale.

Recent development in the membrane technology indicates that forward osmosis (FO) has a high potential for wastewater treatment, producing high quality water [1]. Compared to other pressure driven membrane processes, forward osmosis (FO) membranes suffered less severe fouling due to the lack of hydraulic pressure [2]. Furthermore, novel biomimetic membranes incorporating Aquaporins, highly selective water channels, became commercially available. These membranes were reported to achieve remarkable results in terms of water flux and solute rejection, though little is known whether they are suitable for wastewater treatment.

The objective of this study is to investigate 1) which types of wastewater can be treated by FO using biomimetic Aquaporin membranes, 2) which draw solution is most suitable for this application and 3) the extent and nature of the fouling.

All experiments were conducted in a bench-scale FO setup using NaCl, MgCl2, NaOAc as a draw solution and different anaerobic digestion effluents as a feed. The effluents were characterised at the beginning and at the end of each experiment, regarding their total solids (TS), volatile solids (VS), total suspended solids (TSS), particle size distribution, Total Kjeldahl Nitrogen (TKN), Total available nitrogen (TAN), total organic carbon (TOC) and total phosphate (TP). The fouled membranes were analysed by Scanning Electron Microscope with Energy-dispersive X-ray spectroscopy (SEM-EDS), Fourier transform infrared spectroscopy (FTIR), ATP analysis and inductively coupled plasma optical emission spectrometry (ICP-OES). Our preliminary experimental results indicate that there is a correlation between the effluent composition and the fouling potential. Taken together our results can contribute understanding of how fouling can be mitigated by considering various feed pretreatment methods.

**General information**

State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Technical University of Denmark
Authors: Schneider, C. (Intern), Sathyadev Rajmohan , R. (Ekstern), Zarebska, A. (Intern), Hélix-Nielsen, C. (Intern)
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Forward osmosis, Biomimetic membrane, Fouling, Wastewater treatment
Influence of mechanical wastewater pretreatment on membrane fouling during municipal wastewater treatment by forward osmosis

General information
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Organisations: Department of Environmental Engineering, Water Technologies, University of Maribor
Authors: Zarebska, A. (Intern), Petrinic, I. (Ekstern), Korenak, J. (Ekstern), Buksek, H. (Ekstern), Ciszewska-Kaluzka, A. (Ekstern), Hélix-Nielsen, C. (Intern)
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Main Research Area: Technical/natural sciences
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Influences of mechanical pre-treatment on the non-biological treatment of municipal wastewater by forward osmosis
Municipal wastewater treatment commonly involves mechanical, biological and chemical treatment steps as state-of-the-art technologies for protecting the environment from adverse effects. The biological treatment step consumes the most energy and can create greenhouse gases. This study investigates municipal wastewater treatment without the biological treatment step, including the effects of different pre-treatment configurations, e.g., direct membrane filtration before forward osmosis. Forward osmosis was tested using raw wastewater and wastewater subjected to different types of mechanical pre-treatment, e.g., microsieving and microfiltration permeation, as a potential technology for municipal wastewater treatment. Forward osmosis was performed using thin-film-composite, Aquaporin Inside(TM) and HTI membranes with NaCl as the draw solution. Both types of forward osmosis membranes were tested in parallel for the different types of pre-treated feed and evaluated in terms of water flux and solute rejection, i.e., biochemical oxygen demand and total and soluble phosphorus contents. The Aquaporin and HTI membranes achieved a stable water flux with rejection rates of more than 96% for biochemical oxygen demand and total and soluble phosphorus, regardless of the type of mechanical pre-treated wastewater considered. This result indicates that forward osmosis membranes can tolerate exposure to municipal waste water and that the permeate can fulfill the Swedish discharge limits for small- and medium-sized wastewater treatment plants.

General information
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Organisations: Department of Environmental Engineering, Water Technologies, Lund University, Aquaporin A/S
Authors: Hey, T. (Ekstern), Zarebska, A. (Intern), Bajraktari, N. (Intern), Vogel, J. (Ekstern), Hélix-Nielsen, C. (Intern), La Cour Jansen, J. (Ekstern), Jönsson, K. (Ekstern)
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Web of Science (2015): Indexed yes
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Scopus rating (2010): SJR 0.496 SNIP 0.468
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Scopus rating (2009): SJR 0.394 SNIP 0.414
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Scopus rating (2008): SJR 0.424 SNIP 0.578
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Scopus rating (2007): SJR 0.402 SNIP 0.586
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.477 SNIP 0.544
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.506 SNIP 0.677
Web of Science (2005): Indexed yes
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Scopus rating (2003): SJR 0.545 SNIP 0.644
Scopus rating (2002): SJR 0.68 SNIP 0.731
Scopus rating (2001): SJR 0.579 SNIP 0.889
Scopus rating (2000): SJR 0.656 SNIP 0.771
Scopus rating (1999): SJR 0.624 SNIP 0.763

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Relations
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Organisations: Department of Environmental Engineering, Water Technologies, Department of Bio and Health Informatics, Metagenomics, Aarhus University
Authors: Palomo, A. (Intern), Fowler, J. (Intern), Gülay, A. (Intern), Rasmussen, S. (Intern), Schramm, A. (Ekstern), Sicheritz-Pontén, T. (Intern), Smets, B. F. (Intern)
Pages: 20-21
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Conference: MEWE and biofilms IWA specialist conference, Copenhagen, Denmark, 04/09/2016 - 04/09/2016
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Kinetics of nitrate adsorption and reduction by nano-scale zero valent iron (NZVI): Effect of ionic strength and initial pH
Kinetic models for pollutants reduction by Nano-scale Zero Valent Iron (NZVI) were tested in this study to gain a better understanding and description of the reaction. Adsorption kinetic models and a heterogeneous catalytic reaction kinetic equation were proposed for nitrate removal and for ammonia generation, respectively. A widely used pseudo-first-order reaction model was a poor fit for nitrate removal in an iron-limiting condition and for ammonia generation in an excess iron condition. However, in this study, pseudo-first-order and pseudo-second-order adsorption kinetic equations were a good fit for nitrate removal; in addition, a Langmuir-Hinshelwood kinetic equation was able to successfully describe ammonia generation, regardless of the NZVI dose, the ionic strength, and the initial pH. These results strongly indicate that nitrate reduction by NZVI is a heterogeneous catalytic reaction, and that that the kinetic models can be used in diverse conditions. The kinetic parameters correlate well with the reaction condition, unless the NZVI dose was greatly increased or unless the NZVI surface was significantly changed at a very high initial pH.

General information
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Organisations: Department of Environmental Engineering, Water Technologies, Kyung Hee University, Korea Advanced Institute of Science & Technology
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Pages: 175-187
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Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 0.321 SNIP 0.692 CiteScore 0.71
Scopus rating (2014): SJR 0.347 SNIP 0.919 CiteScore 0.8
Scopus rating (2013): SJR 0.342 SNIP 0.86 CiteScore 0.71
ISI indexed (2013): ISI indexed yes
Scopus rating (2012): SJR 0.272 SNIP 0.787 CiteScore 0.53
ISI indexed (2012): ISI indexed yes
Scopus rating (2011): SJR 0.191 SNIP 0.756 CiteScore 0.5
Life cycle assessment as development and decision support tool for wastewater resource recovery technology

Life cycle assessment (LCA) has been increasingly used in the field of wastewater treatment where the focus has been to identify environmental trade-offs of current technologies. In a novel approach, we use LCA to support early stage research and development of a biochemical system for wastewater resource recovery. The freshwater and nutrient content of wastewater are recognized as potential valuable resources that can be recovered for beneficial reuse. Both recovery and reuse are intended to address existing environmental concerns, for example, water scarcity and use of non-renewable phosphorus. However, the resource recovery may come at the cost of unintended environmental impacts. One promising recovery system, referred to as TREN, consists of an enhanced biological phosphorus removal and recovery system (EBP2R) connected to a photobioreactor. Based on a simulation of a full-scale nutrient and water recovery system in its potential operating environment, we assess the potential environmental impacts of such a system using the EASETECH model. In the simulation, recovered water and nutrients are used in scenarios of agricultural irrigation-fertilization and aquifer recharge. In these scenarios, TREN reduces global warming up to 15% and marine eutrophication impacts up to 9% compared to conventional treatment. This is due to the recovery and reuse of nutrient resources, primarily nitrogen. The key environmental concerns obtained through the LCA are linked to increased human toxicity impacts from the chosen end use of wastewater recovery products. The toxicity impacts are from both heavy metals release associated with land application of recovered nutrients and production of AlCl3, which is required for advanced wastewater treatment prior to aquifer recharge. Perturbation analysis of the LCA pinpointed nutrient substitution and heavy metals content of algae biofertilizer as critical areas for further research if the performance of nutrient recovery systems such as TREN is to be better characterized. Our study provides valuable feedback to the TREN developers and identifies the importance of system expansion to include impacts outside the immediate nutrient recovery system itself. The study also show for the first time the successful evaluation of urban-to-agricultural water systems in EASETECH.

General information
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Scopus rating (2015): SJR 2.665 SNIP 2.482 CiteScore 6.63
Linking nitrifiers diversity to the flux of their key resources
Low-sludge age EBPR process for resource recovery – microbial and biochemical process characterization

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State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Technical University of Denmark
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Measuring community-wide conjugative plasmid permissiveness

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Measuring community-wide conjugative plasmid permissiveness

Rapid gravity sand filtration is a drinking water production technology widely used around the world. Microbially catalyzed processes dominate the oxidative transformation of ammonia, reduced manganese and iron, methane and hydrogen sulfide, which may all be present at millimolar concentrations when groundwater is the source water. In this study, six metagenomes from various locations within a groundwater-fed rapid sand filter (RSF) were analyzed. The community gene catalog contained most genes of the nitrogen cycle, with particular abundance in genes of the nitrification pathway. Genes involved in different carbon fixation pathways were also abundant, with the reverse tricarboxylic acid cycle pathway most abundant, consistent with an observed Nitrospira dominance. From the metagenomic data set, 14 near-complete genomes were reconstructed and functionally characterized. On the basis of their genetic content, a metabolic and geochemical model was proposed. The organisms represented by draft genomes had the capability to oxidize ammonium, nitrite, hydrogen sulfide, methane, potentially iron and manganese as well as to assimilate organic compounds. A composite Nitrospira genome was recovered, and amo-containing Nitrospira genome contigs were identified. This finding, together with the high Nitrospira abundance, and the abundance of atypical amo and hao genes, suggests the potential for complete ammonium oxidation by Nitrospira, and a major role of Nitrospira in the investigated RSFs and potentially other nitrifying environments.
Metagenomics and single-cell genomics reveal high abundance of comammox Nitrospira in a rapid gravity sand filter treating groundwater

The recent discovery of complete ammonia oxidizing (comammox) Nitrospira has revealed that the metabolic division of labor in nitrification is not obligate as was assumed during the last century. Despite the detection and enrichment of comammox Nitrospira from different nitrifying environments, the ecological relevance of comammox remains unknown. In this study, we analyzed the microbial communities from various locations within a groundwater-fed rapid sand filter (RSF), where Nitrospira were at very high relative abundances. Through metagenomics, a highly abundant composite multi-genome of Nitrospira genus was recovered harboring metabolic capacity for complete ammonia oxidation. We developed a cell extraction strategy that enables the disruption of Nitrospira cell clusters attached to the mineral coating of the sand. Individual cells were identified via fluorescent in situ hybridization (FISH) with Nitrospira-specific 16S rRNA probes and sorted via fluorescence-activated cell sorting (FACS). Sorted cells were screened and selected Nitrospira spp. were subject to whole-genome sequencing. The single cell genomes confirmed the genomic presence of a complete ammonia oxidation pathway and revealed clear taxonomic differences with the recently described comammox Nitrospira genomes. The high abundance of comammox Nitrospira spp. together with the low abundance of canonical ammonia oxidizing prokaryotes in the investigated RSF system suggests the essential role of this novel comammox Nitrospira in the RSFs and potentially other nitrifying environments.

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Microbes in biological processes for municipal landfill leachate treatment: Community, function and interaction

Landfill leachate (LFL) contains high strength of ammonium and complex organic substances including biodegradable volatile fatty acids (VFAs), refractory aquatic humic substances (AHS) and micro-scale xenobiotic organic chemicals (XOCs), which promotes the diverse microbial community in LFL treatment bioreactors. These microbes cooperate to remove nitrogen, biodegrade organic matters, eliminate the toxicity of XOCs and produce energy. In these diverse microbes, some show dominant in the bioreactor and are prevalent in many kinds of LFL treatment bio-processes, such as Brocadia from the phylum of Planctomycetes, Nitrosomonas sp., the phylum of Proteobacteria, Bacteroidetes and Firmicutes. The bioreactor's operational parameters influence the microbial community, inversely affect the bioreactor's performance. It is practical to accumulate desirable microbes by managing the bioreactor's running condition. High ammonium loading, low DO (<2 mg l\(^{-1}\)) and optimal pH value are the practical way to accumulate the desirable AOB and realize the partial nitrification. Nitrite and organic matters inhibit the anaerobic ammonium oxidation bacteria (AnAOB). In anaerobic LFL treatment bioreactors, Methanosaeta and Methanosarcina can outcompete sulfur reducing bacteria and homoacetogens to be the dominant Archaea. Nitrite oxidizing bacteria (NOB), heterotrophic denitrifying bacteria and AnAOB compete nitrite and influenced each other. How to manage NOB, heterotrophic denitrifying bacteria and AnAOB in good cooperation condition is still an issue and need further study.

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Microbial and biochemical process characterization of a low-sludge age EBPR process for resource recovery

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Microbial biodiversity enhances micropollutants biotransformation in Moving Bed Biofilm Reactors (MBBR) with controlled biofilm thickness

General information
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Microbial granulation for lactic acid production

This work investigated the formation of microbial granules to boost the productivity of lactic acid (LA). The flocculated form of LA-producing microbial consortium, dominated by Lactobacillus sp. (91.5% of total sequence), was initially obtained in a continuous stirred-tank reactor (CSTR), which was fed with 2% glucose and operated at a hydraulic retention time (HRT) of 12 h and pH 5.0 ± 0.1 under a thermophilic condition (50°C). The mixed liquor in the CSTR was then transferred to an up-flow anaerobic sludge blanket reactor (UASB). The fermentation performance and granulation process were monitored with a gradual decrease of HRT from 8.0 to 0.17 h, corresponding to an increase in the substrate loading from 60 to 2,880 g glucose L−1 d−1. As the operation continued, the accumulation of biomass in the UASB was clearly observed, which changed from flocculent to granular form with decrease in HRT. Up to the HRT decrease to 0.5 h, the LA concentration was maintained at 19–20 g L−1 with over 90% of substrate removal efficiency. However, further decrease of HRT resulted in a decrease of LA concentration with increase in residual glucose. Nevertheless, the volumetric LA productivity continuously increased, reaching 67 g L-fermenter−1 h−1 at HRT 0.17 h. The size of LA-producing granules and hydrophobicity gradually increased with decrease in HRT, reaching 6.0 mm and 60%, respectively. These biogranules were also found to have high settling velocities and low porosities, ranging 2.69–4.73 cm s−1 and 0.39–0.92, respectively. This article is protected by copyright. All rights reserved
Microbial granulation management: Simple changes in reactor operation enable control of granular properties and the engineering of microbial communities in wastewater applications

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Organisations: Department of Environmental Engineering, Water Technologies
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Modelling and control of nitrogen and phosphorus removing systems

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Organisations: Department of Environmental Engineering, Water Technologies, Department of Chemical and Biochemical Engineering, CAPEC-PROCESS, Krüger A/S, University of Santiago de Compostela
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Modelling Illicit Drug Fate in Sewers for Wastewater-Based Epidemiology
With increasing consumption of illicit drugs, in particular cocaine and cannabis, in recent decades, the negative social and public health impact has also propagated. Following drug consumption and human metabolism, fractions of unchanged parent drugs and metabolites are excreted into toilets. After transport in sewers, these chemicals enter wastewater treatment plants (WWTPs). Monitoring campaigns are normally performed at WWTP influent to collect representative samples. Following quantitative chemical analysis, measured drug loads are used to estimate population-normalized parent drug consumption based on a candidate biomarker (the parent drug itself or one of the human metabolites). This approach has gained increasing attention in the past decade and is termed wastewater-based epidemiology. It has been shown that this emerging approach can improve and complement survey-based methods.

Sewer systems can be considered as biological reactors, in which the concentration of organic chemicals present in wastewater can be impacted by in-sewer processes during hydraulic residence time. Illicit drug biomarkers, as trace organic chemicals in the range of nanograms to micrograms per liter, are subject to physical, chemical or biological processes in sewers (fate processes). The occurrence of these processes may lead to significant change of drug loads at WWTP influent compared to source release points. Therefore, not accounting for these variations may negatively affect drug use estimates. However, due to a lack of sufficient evidence on potential in-sewer sorption and transformation of drug biomarkers, these processes are often neglected by wastewater-based epidemiologists. The motivation of this thesis was to overcome this substantial knowledge gap by: (i) providing new evidence on sorption and transformation of drug biomarkers in raw wastewater and sewer biofilms; and (ii) developing modelling tools – by combining and extending existing modelling frameworks – to predict such processes. To achieve this goal, a substantial part of this thesis was dedicated to the experimental assessment and modelling of in-sewer processes by means of laboratory scale studies under the conditions representative to sewer systems. Eventually, the prediction of in-sewer processes at the catchment level was carried out and back-calculation of drug consumption was performed using measured data from a monitoring campaign.

Overall, the methodology used in this thesis combined different aspects, namely: (i) optimal experimental design; (ii) mathematical formulation of processes; (iii) model calibration; (iv) uncertainty analysis and model parameters identifiability; (v) model validation; and (vi) model application for back-calculation at catchment level. In this thesis, 16 drug biomarkers were selected based on their ubiquitous occurrence in wastewater, and include cocaine, mephedrone, methadone, heroin, codeine and tetrahydrocannabinol (THC) and their respective major human metabolites.

In-sewer processes, namely, sorption and transformation of these chemicals were assessed in raw wastewater (suspended biomass) and sewer biofilms in targeted batch experiments. These experiments were conducted under aerobic and anaerobic conditions. Annular rotating biofilm reactors were used to simulate shear conditions prevailing in sewers and were operated over 14 months. Abiotic transformation (e.g., hydrolysis) was also evaluated using mineral water and sorption to suspended solids and biofilms were additionally assessed. Overall, two sets of experiments were performed and used for model calibration and model validation purposes.

To predict the fate of drug biomarkers in raw wastewater, simultaneous evaluation and modelling of substrate utilization and microbial growth processes was performed. It was hypothesized that active biomass dynamics during batch experiments (due to high substrate availability and significant microbial growth) can significantly impact the prediction of biotransformation rates. For this purpose, the Wastewater Aerobic/anaerobic Transformations in Sewers (WATS) model was combined with the Activated Sludge Model for Xenobiotics (ASM-X) to predict the fate of drug biomarkers together with the primary metabolic processes. Two new processes were considered, namely sorption-desorption to reactor wall and abiotic transformation. As for sewer biofilms, the extended ASM-X model was further modified by accounting for...
diffusive mass transfer limitation of biomarkers from the bulk phase into the biofilms and within the biofilm matrix. Selected model parameters were estimated with the Bayesian optimization method DREAM(ZS). A calibration methodology was developed with focus on uncertainty propagation among model parameters, e.g. from abiotic transformation rates to biotransformation rates. Subsequently, uncertainty analysis was performed to assess the impact of variability of model parameters on model output. Moreover, different transformation pathways were tested for the selected biomarkers and new pathways were identified based on mass balance, uncertainty analysis, and feasibility of transformations (according to an existing pathway database). Results from the experimental and modelling assessment indicated that by ignoring primary metabolic processes in raw wastewater would impose significant overestimation (up to 385%) of transformation rates under aerobic conditions, whereas no difference was found under anaerobic conditions. Abiotic transformation processes were the dominant removal mechanism for many of the selected chemicals (e.g., cocaine: 80-100%, batch experiments with raw wastewater) under both aerobic and anaerobic conditions. Several biomarkers underwent substantial biotransformation e.g., almost complete removal of heroin and morphine-3-glucuronide after 12 h in batch experiments with raw wastewater. It was further observed that sewer biofilms can enhance biotransformation of a number of selected chemicals, such as benzoylcgonine and 6-monoacetyl morphine. Overall, redox conditions were found to have an influence on biotransformation rates (especially for methadone) and, to a lesser extent, on abiotic transformation rates. Only a few chemicals, such as 11-hydroxy-THC, were found to sorb onto suspended solids and sewer biofilms. Validation of calibrated models with an independent dataset was successful for most compounds, the main exception being methadone under aerobic conditions.

To demonstrate the impact of in-sewer processes on estimation of daily drug use at catchment level, a generic scenario analysis was performed to assess the uncertainties associated with in-sewer processes and sampling. It was found that ignoring in-sewer processes for cocaine and its metabolite benzoylcgonine can add up to 11% (median value for a large catchment) error in daily cocaine consumption estimates. This error was 43% and 11% for estimates of daily heroin use with 6-monoacetyl morphine and morphine as candidate biomarkers, respectively. In contrary, sampling error (flow-proportional sampling mode) was the highest in the smallest catchment – up to 17% for cocaine. Subsequently, measured cocaine and benzoylcgonine loads from a 2-week monitoring campaign at the Lynetten WWTP influent (Copenhagen, Denmark) was used to estimate cocaine consumption in two upstream catchments by accounting for in-sewer fate processes. Significant differences in consumption trends were observed between weekdays, weekends, holidays and a street music festival. On average, twice as high cocaine consumption was found during festival period as compared to normal weekdays. Wastewater-based epidemiology is a truly interdisciplinary approach in which engineering tools, including models developed and tested in this thesis, can be beneficial for the accurate estimation of drug consumption in urban areas.

General information
State: Published
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Modelling two-stage WWT systems: a faster road towards resource recovery
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Modelling the Fate of Xenobiotic Trace Chemicals via Wastewater Treatment and Agricultural Resource Reuse

As a result of widespread human activities, pharmaceuticals and biocides are ubiquitously present at trace levels in the environment. Large amounts of these substances, also identified as xenobiotic trace chemicals (XTCs), are released daily from households and healthcare facilities, following human consumption and disposal; (ii) husbandry and other analogous facilities, following veterinary consumption; and (iii) industrial facilities. A significant fraction of these emissions reaches municipal wastewater treatment plants (WWTPs), where XTCs undergo incomplete removal partly due to WWTP design limitations. These chemicals are thus eventually released to the environment, e.g. in freshwater bodies receiving WWTP effluents, representing a threat to living organisms.

WWTPs have been generally identified as a major point source of XTC emissions to the environment. Nevertheless, due to the high number of marketed and consumed chemicals, and to the uncertainties associated to sampling and analytical methodologies, quantifying the elimination of XTCs during wastewater treatment still remains a challenge. Developing robust modelling tools to predict the fate of XTCs in WWTPs can help overcoming this challenge. However, in-depth understanding of mechanisms and processes, determining XTCs removal during wastewater treatment, is still required. This PhD thesis aimed at filling knowledge gaps in the field of XTC fate modelling during and beyond wastewater treatment. We aimed at improving the comprehension of XTC fate, and thus the predictive capabilities of fate models: (i) at process scale, with a focus on sorption and biological transformation of XTCs in biological treatment systems; (ii) in full-scale WWTPs, assessing the impact of retransformation and WWTP operation on XTC elimination; and (iii) in integrated WWTP-agricultural systems. Different modelling tools, suiting the specific purposes of our investigations, were developed, extended and/or innovatively applied. Fate models used as reference in this thesis include: the Activated Sludge Modelling framework for Xenobiotics (ASM-X); the generic WWTP model SimpleTreat Activity; and the dynamic soil-plant model for fate prediction in agricultural systems.

Experimental and model-based observations were combined to assess sorption of ionizable XTCs onto activated sludge and XTC biotransformation in moving bed biofilm reactors (MBBRs). Most XTCs are in fact multispecies chemicals, being present in neutral and/or ionized form in wastewater. We demonstrated that pH conditions and, to a lesser extent, iron salt dosing for chemical phosphorus removal can significantly affect solid-liquid partitioning of the zwitterionic antibiotic ciprofloxacin onto activated sludge. Electrostatic interactions and complexion are thus dominating sorption mechanisms. Under a range of pH, redox and iron salt dosing conditions, non-linear sorption (n=0.62–1.33) was observed. Extensions to traditional partitioning models were accordingly proposed for ciprofloxacin and other zwitterionic XTCs, accounting for: (i) high non-linearity of XTC sorption; or (ii) ionization with changing pH and different sorption potential of ionized species. Furthermore, XTCs are typically present in ng L-1 to μg L-1 concentrations in wastewater, being referred to as non-growth substrates, and their biological degradation can be associated with microbial growth processes. In this PhD thesis, we assessed the influence of primary metabolic processes on XTC biotransformation in MBBR biofilm. Our investigation was performed by comparing biotransformation kinetics in pre-denitrifying MBBRs operated in single-stage and three-stage configurations. The latter configuration produced a prolonged biofilm exposure to organic electron donor (COD) loading and complexity tiered by segregated and integrated biofilm reactors, which significantly influenced kinetics of heterotrophic denitrification and XTC biotransformation. Biotransformation rate constants for a number of non-recalcitrant XTCs were found correlated to the denitrification potential of MBBR biofilm, suggesting that XTC degradation occurred via microbial co-metabolism. In addition, enhanced biotransformation kinetics was shown for a number of XTCs (sulfamethoxazole, erythromycin, atenolol) as compared to previous findings for conventional activated sludge. A number of factors have been described to influence the elimination of XTCs in full-scale WWTPs. Specifically, relevant impact was attributed to (i) solid residence time (SRT), at which biological treatment is operated; and (ii) the formation of XTCs due to, e.g., deconjugation of human metabolites. Many XTCs are in fact excreted by humans in the form of conjugates, which can undergo biotic retransformation to parent chemicals. In this PhD thesis, we specifically assessed the influence of retransformation processes and SRT on the fate of sulfamethoxazole in full-scale WWTPs. A methodology based on the comparison of ASM-X predictions and literature data was used. We demonstrated that the impact of retransformation during secondary wastewater treatment is determined by: (i) the size of WWTP catchments, with major in-sewer retransformation expected in large catchments; (ii) the type of catchment (hospital or urban catchment). This evidence accordingly suggests an integrated approach to XTC fate assessment in wastewater systems (sewer networks and WWTPs). Furthermore, improved elimination of sulfamethoxazole was found and predicted in WWTPs operated at SRT greater than 16 d. Beyond this critical SRT, enhanced biotransformation kinetics may occur due to the enrichment of slow-growing organisms (e.g., specialist degraders) or mixed substrate utilization strategies. This finding supported our experimental evidence of enhanced sulfamethoxazole biotransformation kinetics in denitrifying MBBRs.

As a result of incomplete biodegradation in WWTPs, XTCs persist in effluents and sewage sludge. Reuse of municipal biosolids and treated wastewater or use of freshwater for agricultural purposes eventually leads to XTC uptake into food crops. In this PhD thesis, we developed and tested a generic simulation tool to predict the fate of XTCs from consumption, through wastewater treatment and eventually to the uptake by winter wheat for a number of geographical scenarios in the European Union. The tool combined was specifically addressed for fate prediction of ionizable XTCs (the biocide triclosan, the diuretic furosemide and the antibiotic ciprofloxacin). Furosemide was found rather persistent to wastewater treatment and eventually to the uptake by winter wheat for a number of geographical scenarios in the European Union. The diuretic furosemide and the antibiotic ciprofloxacin). Furosemide was found rather persistent to wastewater treatment and eventually to the uptake by winter wheat for a number of geographical scenarios in the European Union. The diuretic furosemide and the antibiotic ciprofloxacin).
presented simulation tool can thus be used for pre-screening and priority setting of chemicals, and to explore the impact of additional XTC emission pathways (e.g., manure application, irrigation with reclaimed WWTP effluent) in terms of food crop accumulation.

**General information**
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**Nanoscale zero-valent iron impregnation of covalent organic polymer grafted activated carbon for water treatment**
The use of nanoscale zero valent iron (nZVI) has quickly become a leading research material for the treatment of typically hard to degrade contaminants found in groundwater. These contaminants include antibiotics, pesticides, halogenated organics, heavy metals, among others. However, the effectiveness of nZVI has its limitations, due to its high reactivity and subsequent loss of degradative ability. Therefore, nZVI must be stabilized in a matrix allowing for the maintaining of reactivity, as well as the protection from the effects of the surrounding environment.

By employing a nanoporous polymeric network already previously proven to stabilize nZVI and a long-standing water treatment material,1 activated carbon; we have developed an advanced material that allows for the not only the stabilization of nZVI, but also the improved degradation of various water contaminants. This was done by performing a series of surface modification techniques to the surface of the activated carbon, then physically grafting the covalent organic polymer to the carbon in a shell-like manner, and ultimately synthesizing nZVI in situ within the pores of both the activated carbon and the polymeric network. Not only does this enhanced version of activated carbon utilize the outstanding adsorptive properties of both activated carbon and the polymeric network, but it also employs the degradation capability of nZVI. In this way, a new breed of materials is being developed, working in a synergistic manner for the purpose of the remediation of contaminants found in the groundwater.

We confirmed the existence of the polymeric shell with a variety of chemical characterization techniques; including Fourier transform infrared spectroscopy (FTIR), elemental analysis, X-ray photoelectron spectroscopy (XPS), transmission electron microscopy (TEM), and scanning electron microscopy (SEM). We also monitored the degradation and/or adsorption of various contaminants (e.g. chlorinated organics like trichloroethylene and trichloroethane, and heavy metals like cadmium and nickel) to produce the kinetics of the interactions.

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Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2016
Open-source CFD model for optimization of forward osmosis and reverse osmosis membrane modules

Osmotic membrane separation processes are based on using semi-permeable membranes to remove solutes from a given feed solution. This can happen either as Reverse Osmosis (RO) where a hydraulic pressure is applied to drive separation across the membrane, or as Forward Osmosis (FO) where osmotic pressure difference between a feed solution and a draw solution is used to drive the separation process. In both systems, concentration polarization in the vicinity of membrane surfaces are one of the major concerns in terms of separation efficiency, as this phenomenon effectively reduces the driving forces for the separation processes. In this work we present an optimized computational fluid dynamics (CFD) model capable of efficiently running steady-state and transient simulations of both RO and FO at low computational cost. Use of the model is demonstrated for FO by showing how it can provide theoretical insight into the flow phenomena present in the commonly used lab-scale membrane module CF042. We demonstrate how the model can be used to investigate the way in which various flow and geometry parameters influence module performance. Our results indicate that varying the inlet angles, or the number of inlets, have very little influence on the total mass transfer across the membrane. The model can also be used for investigating mass-transfer for various spacer types, densities and configurations and this is demonstrated in an “analysis of how spacer geometry affects “dead volumes” with low flow in the module. The open source CFD code is provided free-of-charge, so that it might be readily used by the membrane community in prototyping their own custom-designed membrane chambers/modules, or characterize existing chambers/modules. With the optimized solver code presented here simulations in geometries containing millions of cells will converge within 24 h using just a single CPU. (C) 2015 Elsevier B.V. All rights reserved.
Optical Biosensors to Explore Biological Systems

The study of live biological systems requires the use of advanced techniques that provide high structural and chemical information and at the same time, avoid damage to the system and modification of the structural/chemical features. Techniques based on interaction with light have shown their capability to work in biosensor devices. For example, Raman spectroscopy can be non-invasive and can provide 1 μm of spatial resolution in 1 second of collection time, well suited for sensing. Moreover, it may give information at the single cell and even approaching the single molecule scale. Here we present the capability of different light-based techniques for biosensing.

As the first example, surface enhanced Raman spectroscopy (SERS) is performed in onion using silver plasmonic nanostructures. Our studies detect different molecular compounds present in the plant based on their SERS signals. SERS imaging allows us to monitor the location of nanoparticles and to image chemical compounds within the target. Moreover, a pH-sensitive reporter molecule, pMBA attached to the silver nanoparticles, is used to infer pH values in the extracellular space of an onion layer.

As a second example, we explore how a membrane protein may be used as an efficient sensor in an organic environment via a biomimetic membrane model. The combination of both biomimetic membranes and protein membranes as a signal transduction medium has interesting applications in biology and medicine. It is crucial that the matrix where a protein is embedded is optimal in order to maintain the concentration gradient. Moreover, curvature and mechanical forces in the membrane may also affect the protein function. In this work, by inducing chemical and mechanical changes of the matrix we optimize the system via measuring variations of the gradient through the membrane.

General information

State: Published
Organisations: Department of Physics, Biophysics and Fluids, Department of Environmental Engineering, Water Technologies, Philips Biocell, University of Copenhagen
Authors: Palanco, M. E. (Intern), Mogensen, K. B. (Ekstern), Andersen, N. H. S. (Ekstern), Berg-Sørensen, K. (Intern), Hélix-Nielsen, C. (Intern), Kneipp, K. (Intern)
Pages: 638A-639A
Publication date: 2016
Main Research Area: Technical/natural sciences
Optimal algal cultivation for used water resource recovery

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Department of Chemical and Biochemical Engineering, CAPEC-PROCESS, Technical University of Denmark
Authors: Valverde Pérez, B. (Intern), Wagner, D. S. (Intern), Fuentes-Martinez, J. M. (Ekstern), Steidl, M. (Ekstern), Dechesne, A. (Intern), Flores Alsina, X. (Intern), Gernaey, K. (Intern), Huusom, J. K. (Intern), Plósz, B. G. (Intern)
Number of pages: 1
Publication date: 2016
Event: Poster session presented at 13th IWA Leading Edge Conference on Water and Wastewater Technologies, Jerez da la Frontera, Spain.
Main Research Area: Technical/natural sciences
Electronic versions:
NtoP_poster_final.pdf
Source: PublicationPreSubmission
Source-ID: 125031611
Publication: Research - peer-review › Poster – Annual report year: 2016

Optimization of Synthesis Condition for Nanoscale Zero Valent Iron Immobilization on Granular Activated Carbon

Nanoscale zero valent iron (nZVI) has been intensively studied for the treatment of a plethora of pollutants through reductive reaction, however, the nano size should be of concern when nZVI is considered for water treatment, due to difficulties in recovery. The loss of nZVI causes not only economical loss, but also potential risk to human health and environment. Thus, the immobilization onto coarse or structured support is essential. In this study, two representative processes for nZVI immobilization on granular activated carbon (GAC) were evaluated, and optimized conditions for synthesizing Fe/GAC composite were suggested. Both total iron content and Fe0 content can be significantly affected by preparation processes, therefore, it was important to avoid oxidation during preparation to achieve higher reduction capacity. Synthesis conditions such as reduction time and existence of intermediate drying step were investigated to improve Fe0 content of Fe/GAC composites. The optimal condition was two hours of NaBH4 reduction without intermediate drying process. The prepared Fe/GAC composite showed synergistic effect of the adsorption capability of the GAC and the degradation capability of the nZVI, which make this composite a very effective material for environmental remediation.

General information
State: Published
Organisations: Department of Environmental Engineering, Department of Micro- and Nanotechnology, Surface Engineering, Water Technologies, Kumoh National Institute of Technology
Pages: 521-527
Publication date: 2016
Main Research Area: Technical/natural sciences
Publication information
Journal: Journal of Korean Society of Environmental Engineers
Volume: 38
Issue number: 9
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Original language: Multiple languages
Granular activated carbon, Nanoscale zero valent iron, Oxidation-reduction, Impregnation
Electronic versions:
Hwang_Mines_2016_NZVI_Carbon.pdf
DOIs:
Optimizing nitrification in biological rapid sand filters for drinking water production

Addition of phosphate or trace metals or better management e.g. in terms of ammonium load can improve the nitrification rate and efficiency in biological rapid sand filters.

General information
State: Published
Authors: Albrechtsen, H. (Intern), Smets, B. F. (Intern), Lee, C. O. (Intern), Tatari, K. (Intern), Nielsen, P. B. (Ekstern), Binning, P. J. (Intern), Boe-Hansen, R. (Ekstern), Wagner, F. B. (Intern)
Number of pages: 4
Publication date: 2016
Event: Abstract from IWA World Water Congress & Exhibition 2016, Queensland, Australia.
Main Research Area: Technical/natural sciences
Nitrification, Phosphate, Trace metals
Electronic versions:
IWA_WWCE16_Albrechtsen_Nitrification_373968_20161010_Orbit.pdf

Osmotic stress tolerance in semi-terrestrial tardigrades

Little is known about ionic and osmotic stress tolerance in tardigrades. Here, we examine salt stress tolerance in Ramazzottius oberhaeuseri and Echiniscus testudo from Nivå (Denmark) and address whether limno-terrestrial tardigrades can enter a state of quiescence (osmobiosis) in the face of high external osmolyte concentrations. Direct transfers into NaCl solutions showed an upper tolerance level of around 600 mOsm kg−1 in R. oberhaeuseri and 200 mOsm kg−1 in E. testudo. During salt exposures, R. oberhaeuseri contracted into a ‘tun’, whereas E. testudo remained active leaving it more susceptible to acute effects of the ions. Further experiments focused on the more resilient R. oberhaeuseri, which entered a tun and readily regained activity when directly exposed to polyethylene glycol and sucrose of up to 872 ± 0 and 813 ± 3 mOsm kg−1, respectively, revealing a higher tolerance towards non-ionic osmolytes as compared to NaCl. Ramazzottius oberhaeuseri furthermore readily regained activity following gradual increases in non-ionic osmolytes and NaCl of up to 2434 ± 28 and 1905 ± 3 mOsm kg−1, respectively, showing that short-term acclimation promoted salt stress tolerance. Our results suggest that the limno-terrestrial R. oberhaeuseri enters a state of quiescence in the face of high external osmotic pressure and that it, in this state, is highly tolerant of ionic and osmotic stress.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, University of Copenhagen
Authors: Heidemann, N. W. T. (Ekstern), Smith, D. K. (Ekstern), Hygum, T. L. (Ekstern), Stapane, L. (Ekstern), Clausen, L. K. B. (Ekstern), Jörgensen, A. (Ekstern), Hélix-Nielsen, C. (Intern), Møbjerg, N. (Ekstern)
Number of pages: 7
Pages: 912-918
Publication date: 2016
Main Research Area: Technical/natural sciences
Ozonation for source treatment of pharmaceuticals in hospital wastewater - ozone lifetime and required ozone dose

Ozonation aimed at removing pharmaceuticals was studied in an effluent from an experimental pilot system using staged moving bed biofilm reactor (MBBR) tanks for the optimal biological treatment of wastewater from a medical care unit of Aarhus University Hospital. Dissolved organic carbon (DOC) and pH in samples varied considerably, and the effect of these two parameters on ozone lifetime and the efficiency of ozone in removing pharmaceuticals were determined. The pH in the effluent varied from 5.0 to 9.0 resulting in approximately a doubling of the required ozone dose at the highest pH for each pharmaceutical. DOC varied from 6 to 20 mg-DOC/L. The ozone required for removing each pharmaceutical, varied linearly with DOC and thus, ozone doses normalized to DOC (specific ozone dose) agreed between water samples (typically within 15%). At neutral pH the specific ozone dose required to remove the easiest degradable pharmaceutical, sulfadiazine, was 0.50 ± 0.04 mg-O3/mg-DOC and the most recalcitrant, diatrizoic acid, required 4.7 ± 0.6 mg-O3/mg-DOC. The lifetime of ozone increased drastically in the higher end of the indicated dosage. At the lowest observed pH of 5.0, its lifetime was quadrupled to 20 min which influences the design of the reaction tank. The addition of 0.1 mg-H2O2 per 1 mg-O3 mitigated the prolonged lifetime without a corresponding influence in the pharmaceutical removal efficiency of ozone.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Aarhus University
Authors: Hansen, K. M. S. (Intern), Spiliotopoulou, A. (Intern), Chhetri, R. K. (Intern), Casas, M. E. (Ekstern), Bester, K. (Ekstern), Andersen, H. R. (Intern)
Pages: 507-514
Polishing of pharmaceuticals in conventionally treated wastewater with intermittently fed Moving Bed Biofilm Reactors (MBBR)
Protocol for settling velocity model calibration using an innovative batch settling test—focus on identifiability analysis of the hindered-transient-compression model

Removal of Antibiotics in Biological Wastewater Treatment Systems—A Critical Assessment Using the Activated Sludge Modeling Framework for Xenobiotics (ASM-X)

Many scientific studies present removal efficiencies for pharmaceuticals in laboratory-, pilot-, and full-scale wastewater treatment plants, based on observations that may be impacted by theoretical and methodological approaches used. In this Critical Review, we evaluated factors influencing observed removal efficiencies of three antibiotics (sulfamethoxazole, ciprofloxacin, tetracycline) in pilot- and full-scale biological treatment systems. Factors assessed include (i) retransformation to parent pharmaceuticals from e.g., conjugated metabolites and analogues, (ii) solid retention time (SRT), (iii) fractions sorbed onto solids, and (iv) dynamics in influent and effluent loading. A recently developed methodology was used, relying on the comparison of removal efficiency predictions (obtained with the Activated Sludge Model for Xenobiotics (ASM-X)) with representative measured data from literature. By applying this methodology, we demonstrated that (a) the elimination of sulfamethoxazole may be significantly underestimated when not considering retransformation from conjugated metabolites, depending on the type (urban or hospital) and size of upstream catchments; (b) operation at extended SRT may enhance antibiotic removal, as shown for sulfamethoxazole; (c) not accounting for fractions sorbed in influent and effluent solids may cause slight underestimation of ciprofloxacin removal efficiency. Using tetracycline as example substance, we ultimately evaluated implications of effluent dynamics and retransformation on environmental exposure and risk prediction.
Removal of primary and secondary trace organic substrates in aerobic and anaerobic sewer biofilm

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Environmental Chemistry
Authors: Ramin, P. (Intern), Polesel, F. (Intern), Brock, A. L. (Intern), Torresi, E. (Intern), Plósz, B. G. (Intern)
Number of pages: 2
Publication date: 2016
Event: Abstract from MEWE and biofilms IWA specialist conference, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Sewer biofilm, Drug biomarkers, Wastewater based epidemiology
Electronic versions:
Ramin_et_al._Mewe_2016_FINAL.pdf
Source: PublicationPreSubmission
Source-ID: 125882664
Publication: Research › Conference abstract for conference – Annual report year: 2016

Sammenhæng mellem aktivitet af metanoksiderende bakterier, opformeret fra sandfilter på danske vandværker, og nedbrydningen af pesticidet bentazon

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Systems, Water Technologies
Authors: Hedegaard, M. J. (Intern), Delinere, H. (Ekstern), Prasse, C. (Ekstern), Dechesne, A. (Intern), Smets, B. F. (Intern), Albrechtsen, H. (Intern)
Number of pages: 13
Publication date: 2016
Event: Abstract from Particle Separation - 2016, Oslo, Norway.
Main Research Area: Technical/natural sciences
Hindered, Transient, Compression settling velocity, Settling sensor, Practical identifiability
Electronic versions:
Hedegaard_Mathilde_Dansk_Vand_til_dansk_vand.pdf
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Secondary settling sensor setup development – testing prototypes and compression models via practical model parameter identifiability assessment

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Technical University of Denmark
Authors: Valverde Pérez, B. (Intern), Penkarski-Rodon, E. (Ekstern), Wagner, D. S. (Intern), Plósz, B. G. (Intern)
Number of pages: 1
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Event: Abstract from Particle Separation - 2016, Oslo, Norway.
Main Research Area: Technical/natural sciences
Hindered, Transient, Compression settling velocity, Settling sensor, Practical identifiability
Source: PublicationPreSubmission
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Publication: Research › Conference abstract for conference – Annual report year: 2016

Selective heavy metal capture from contaminated water
Separation of Peptides and Interaction with Forward Osmosis Biomimetic Membranes: A Solution Diffusion Model

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Aalborg University, University of Copenhagen
Authors: Bajraktari, N. (Intern), Madsen, H. T. (Ekstern), Gruber, M. F. (Intern), Jensen, H. (Ekstern), Hélix-Nielsen, C. (Intern)
Number of pages: 1
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Main Research Area: Technical/natural sciences

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Journal: Biophysical Journal
Volume: 110
Issue number: 3, Suppl. 1
ISSN (Print): 0006-3495
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.979 SJR 1.949
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.06 SJR 1.988 SNIP 1.005
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.13 SNIP 1.134 CiteScore 3.3
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.21 SNIP 1.15 CiteScore 3.33
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 2.245 SNIP 1.156 CiteScore 3.64
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 2.361 SNIP 1.143 CiteScore 3.57
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Separation of Peptides with Forward Osmosis Biomimetic Membranes

Forward osmosis (FO) membranes have gained interest in several disciplines for the rejection and concentration of various molecules. One application area for FO membranes that is becoming increasingly popular is the use of the membranes to concentrate or dilute high value compound solutions such as pharmaceuticals. It is crucial in such settings to control the transport over the membrane to avoid losses of valuable compounds, but little is known about the rejection and transport mechanisms of larger biomolecules with often flexible conformations. In this study, transport of two chemically similar peptides with molecular weight (Mw) of 375 and 692 Da across a thin film composite Aquaporin Inside™ Membrane (AIM) FO membrane was investigated. Despite the relative large size, both peptides were able to permeate the dense active layer of the AIM membrane and the transport mechanism was determined to be diffusion-based. Interestingly, the membrane permeability increased 3.65 times for the 692 Da peptide ($1.39 \times 10^{-12} \text{ m}^2 \text{s}^{-1}$) compared to the 375 Da peptide ($0.38 \times 10^{-12} \text{ m}^2 \text{s}^{-1}$). This increase thus occurs for an 85% increase in Mw but only for a 34% increase in peptide radius of gyration ($R_g$) as determined from molecular dynamics (MD) simulations. This suggests that $R_g$ is a strong influencing factor for membrane permeability. Thus, an increased $R_g$ reflects the larger peptide chains ability to sample a larger conformational space when interacting with the nanostructured active layer increasing the likelihood for permeation.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Aalborg University, University of Copenhagen
The new paradigm for used water treatment suggests the use of short solid retention times (SRT) to minimize organic substrate mineralization and to maximize resource recovery. However, little is known about the microbes and the underlying biogeochemical mechanisms driving these short-SRT systems. In this paper, we report the start-up and operation of a short-SRT enhanced biological phosphorus removal (EBPR) system operated as a sequencing batch reactor (SBR) fed with preclarified municipal wastewater, which is supplemented with propionate. The microbial community was analysed via 16S rRNA amplicon sequencing. During start-up (SRT = 8 d), the EBPR was removing up to 99% of the influent phosphate and completely oxidized the incoming ammonia. Furthermore, the sludge showed excellent settling properties. However, once the SRT was shifted to 3.5 days nitrification was inhibited and bacteria of the Thiothrix taxon proliferated in the reactor, thereby leading to filamentous bulking (sludge volume index up to SVI = 1100 mL/g). Phosphorus removal deteriorated during this period, likely due to the out-competition of polyphosphate accumulating organisms (PAO) by sulphate reducing bacteria (SRB). Subsequently, SRB activity was suppressed by reducing the anaerobic SRT from 1.2 day to 0.68 day, with a consequent rapid SVI decrease to ~200 ml/g. The short-SRT EBPR effectively removed phosphate and nitrification was mitigated at SRT = 3 days and oxygen levels ranging from 2 to 3 mg/L.

Short-sludge age EBPR process – Microbial and biochemical process characterisation during reactor start-up and operation

The new paradigm for used water treatment suggests the use of short solid retention times (SRT) to minimize organic substrate mineralization and to maximize resource recovery. However, little is known about the microbes and the underlying biogeochemical mechanisms driving these short-SRT systems. In this paper, we report the start-up and operation of a short-SRT enhanced biological phosphorus removal (EBPR) system operated as a sequencing batch reactor (SBR) fed with preclarified municipal wastewater, which is supplemented with propionate. The microbial community was analysed via 16S rRNA amplicon sequencing. During start-up (SRT = 8 d), the EBPR was removing up to 99% of the influent phosphate and completely oxidized the incoming ammonia. Furthermore, the sludge showed excellent settling properties. However, once the SRT was shifted to 3.5 days nitrification was inhibited and bacteria of the Thiothrix taxon proliferated in the reactor, thereby leading to filamentous bulking (sludge volume index up to SVI = 1100 mL/g). Phosphorus removal deteriorated during this period, likely due to the out-competition of polyphosphate accumulating organisms (PAO) by sulphate reducing bacteria (SRB). Subsequently, SRB activity was suppressed by reducing the anaerobic SRT from 1.2 day to 0.68 day, with a consequent rapid SVI decrease to ~200 ml/g. The short-SRT EBPR effectively removed phosphate and nitrification was mitigated at SRT = 3 days and oxygen levels ranging from 2 to 3 mg/L.
Stable isotope probing and dynamic loading experiments provide insight into the ecophysiology of novel ammonia oxidizers in rapid gravity sand filters

Nitrification is often the dominant microbial process in rapid gravity sand filters (RSF), used to treat aerated groundwater to produce drinking water. RSFs harbor diverse microbial communities including a range of ammonia oxidizing clades; Betaproteobacteria (Nitrosomonas, Nitrosospira), Archaea, diverse potentially ammonia oxidizing heterotrophs and abundant Nitrospira spp., recently shown to comprise both canonical nitrite oxidizing as well as complete ammonium oxidizing (comammox) types. We examined the contributions of the different ammonia oxidizers to in situ ammonia oxidation, and aimed to elucidate the differences in ecophysiology between the ammonia oxidizing clades that enable them to co-exist in this unique environment. Experiments were conducted using sand columns designed and operated to mimic the conditions in the full-scale parent RSF. RNA and DNA stable isotope probing based on 13C-bicarbonate incorporation during continuous feeding with either ammonium or nitrite as sole energy source implicated Nitrospira spp. and certain ‘heterotrophic’ bacteria in addition to Nitrosomonas spp. in autotrophy during ammonium oxidation in RSFs.
Further experimentation aimed to elucidate the ecophysiology of each ammonia oxidizing clade in RSFs, in particular comammox Nitrospira for which little is currently known. Columns were fed with RSF effluent spiked with various concentrations of ammonium ranging from 0.1-5.0 mg/L delivered at different loading rates to examine the effects of both ammonium loading and oxygen limitation on ammonia oxidizers. Our observations indicate that the native conditions in the RSF used in this study foster the enrichment of comammox Nitrospira, which provides a preliminary step in the description of their ecophysiology.

**General information**

State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Urban Water Systems, University of Copenhagen, University of Southern Denmark
Authors: Fowler, J. (Intern), Palomo, A. (Intern), Gülay, A. (Intern), Tatari, K. (Intern), Thamdrup, B. (Ekstern), Albrechtsen, H. (Intern), Sørensen, S. (Ekstern), Smets, B. F. (Intern)
Number of pages: 1
Publication date: 2016
Event: Abstract from 16th International Symposium on Microbial Ecology, Montreal, Canada.
Main Research Area: Technical/natural sciences
Electronic versions:
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Source-ID: 126360804
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

### Structural and functional robustness of an environmental bacterial community degrading diesel fuel

**General information**

State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Poznan University of Technology
Authors: Sydow, M. (Ekstern), Owsianiak, M. (Intern), Smets, B. F. (Intern), Chrzanowski, L. (Ekstern)
Pages: S128-S128
Publication date: 2016
Main Research Area: Technical/natural sciences

**Publication information**

Journal: New Biotechnology
Volume: 33
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BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.14 SJR 0.967
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.67 SJR 1.08 SNIP 1.262
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.073 SNIP 1.055 CiteScore 3.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.994 SNIP 1.237 CiteScore 2.77
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.822 SNIP 0.966 CiteScore 2.5
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.784 SNIP 0.85 CiteScore 2.12
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Suppression of nitrite-oxidizing bacteria in intermittently aerated biofilm reactors: a model-based explanation

**General information**
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Ma, Y. (Intern), Domingo Felez, C. (Intern), Plósz, B. G. (Intern), Smets, B. F. (Intern)
Pages: 158-159
Publication date: 2016

**Host publication information**
Title of host publication: Microbial ecology and water engineering & biofilms specialist groups (MEWE2016)
Place of publication: Copenhagen, Denmark
Publisher: IWA
Main Research Area: Technical/natural sciences
Conference: MEWE and biofilms IWA specialist conference, Copenhagen, Denmark, 04/09/2016 - 04/09/2016
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MEWE2016_AbstractBookyuma.pdf
Publication: Research - peer-review › Conference abstract in journal – Annual report year: 2017

Suppression of nitrite-oxidizing bacteria in intermittently aerated biofilms: a model-based explanation

**General information**
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Ma, Y. (Intern), Domingo Felez, C. (Intern), Plósz, B. G. (Intern), Smets, B. F. (Intern)
Number of pages: 1
Publication date: 2016
Event: Poster session presented at MEWE and biofilms IWA specialist conference, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
MEWE_poster_YUMA.pdf
Source: PublicationPreSubmission
Source-ID: 127665194
Publication: Research - peer-review › Poster – Annual report year: 2016
Systematic design of an optimal control system for the SHARON-Anammox process

A systematic design of an optimal control structure for the SHARON-Anammox nitrogen removal process is studied. The methodology incorporates two novel features to assess the controllability of the design variables candidate for the regulatory control layer: (i) H- control method, which formulates the control problem as a mathematical optimization problem, and (ii) close-loop disturbance gain (CLDG) plots. It is shown that the methodology is especially appropriate for bioreactors. The solution of the mixed sensitivity stacked H control problem ranked the combinations of controlled variables (CVs). The best candidates to CVs were paired with the manipulated variables using the relative gain array. The proposed control structure was further analyzed and verified for disturbance rejection using the CLDG plots. The optimal pairing of CVs with the actuators (kLa and acid/base addition) is found to be dissolved oxygen (DO) and pH in the SHARON reactor. Furthermore, to relate the controller actions to process operation objective, nitrogen removal efficiency, two cascade control systems are designed. The first cascade loop controls TNN/TAN ratio in the influent to the Anammox reactor by adjusting the set point for DO in the regulatory layer, while the second cascade loop controls the nitrogen removal efficiency (i.e. effluent TNN and TAN) by adjusting the TNN/TAN ratio at the effluent of the SHARON reactor. The control system is evaluated and benchmarked using a set of realistic dynamic scenario simulations, demonstrating that the different control strategies successfully maintain stable and high nitrogen removal efficiency. The nested cascade control structure shows the best performance, removing up to 95% of the influent ammonia. Both the control design methodology and the resulting optimal control structures are expected to contribute to stable operation and control of these emerging nitrogen removal technologies.

General information

State: Published
Organisations: Department of Chemical and Biochemical Engineering, Department of Environmental Engineering, Water Technologies, CAPEC-PROCESS
Authors: Valverde Perez, B. (Intern), Mauricio Iglesias, M. (Intern), Sin, G. (Intern)
Number of pages: 10
Pages: 1-10
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information

Journal: Journal of Process Control
Volume: 39
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.971 SJR 1.108
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.41 SJR 1.037 SNIP 2.138
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.346 SNIP 2.028 CiteScore 3.35
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.397 SNIP 2.642 CiteScore 3.92
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.421 SNIP 2.537 CiteScore 3.47
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.435 SNIP 2.883 CiteScore 3.39
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.236 SNIP 2.535 CiteScore 2.9
ISI indexed (2011): ISI indexed yes
Systematic design of optimal control systems for WWTPs: case study of the SHARON-Anammox process

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Department of Chemical and Biochemical Engineering, CAPEC-PROCESS
Authors: Valverde Perez, B. (Intern), Mauricio Iglesias, M. (Intern), Sin, G. (Intern)
Number of pages: 1
Publication date: 2016
Event: Poster session presented at 5th IWA/WEF Wastewater Treatment Modelling Seminar 2016, Annecy, France.
Main Research Area: Technical/natural sciences
Electronic versions:
WWTmod2016_SA_MIM.pdf
Source: PublicationPreSubmission
Source-ID: 123096781
Publication: Research - peer-review › Poster – Annual report year: 2016

The effects of physicochemical wastewater treatment operations on forward osmosis

Raw municipal wastewater from a full-scale wastewater treatment plant was physicochemically pretreated in a large pilot-scale system comprising coagulation, flocculation, microsieve and microfiltration operated in various configurations. The produced microsieve filtrates and microfiltration permeates were then concentrated using forward osmosis (FO). Aquaporin Inside(TM) FO membranes were used for both the microsieve filtrate and microfiltration permeates, and Hydration Technologies Inc.-thin-film composite membranes for the microfiltration permeate using only NaCl as the draw solution. The FO performance was evaluated in terms of the water flux, water flux decline and solute rejections of biochemical oxygen demand, and total and soluble phosphorus. The obtained results were compared with the results of FO after only mechanical pretreatment. The FO permeates satisfied the Swedish discharge demands for small and medium-sized wastewater treatment plants. The study demonstrates that physicochemical pretreatment can improve the FO water flux by up to 20%. In contrast, the solute rejection decreases significantly compared to the FO-treated wastewater with mechanical pretreatment.

General information
State: Published
The formation dynamics of microbial aggregates

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, University of Birmingham
Authors: Cockx, B. (Intern), Clegg, R. J. (Ekstern), Kreft, J. (Ekstern), Smets, B. F. (Intern)
Number of pages: 1
Publication date: 2016
Main Research Area: Technical/natural sciences
Electronic versions:
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Source-ID: 127189159
Publication: Research - peer-review » Poster – Annual report year: 2016

The impact of backwashing on nitrification in biological rapid sand filters under different ammonium loading conditions

General information
State: Published
Authors: Lee, C. O. (Intern), Albrechtsen, H. (Intern), Smets, B. F. (Intern), Boe-Hansen, R. (Ekstern), Lind, S. (Ekstern), Binning, P. J. (Intern)
Pages: 29-29
Publication date: 2016
Host publication information
Title of host publication: 10th annual meeting of DWF16 : Abstracts
Publisher: Danish Water Forum
Main Research Area: Technical/natural sciences
Conference: 10th annual meeting of Danish Water Forum (DWF), Frederiksberg, Denmark, 28/01/2016 - 28/01/2016
Electronic versions:
DWF_The_impact_of_backwashing_on_nitrification_in_biological_rapid_sand_filters_under_different_ammonium_loading_conditions.pdf
Publication: Research - peer-review » Conference abstract in proceedings – Annual report year: 2016

The influence of reactor staging on microbial structure and functions in pre-denitrifying MBBRs

General information
State: Published
Organisations: Department of Environmental Engineering, Environmental Chemistry, Water Technologies, Aarhus University, AnoxKaldnes AB
Authors: Polesel, F. (Intern), Torresi, E. (Intern), Jensen, M. M. (Intern), Escola Casas, M. (Ekstern), Bester, K. (Ekstern), Christensson, M. (Ekstern), Smets, B. F. (Intern)
Pages: 92-93
The perks of agent-based modelling with iDynoMiCS 2

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, University of Birmingham, Friedrich Schiller University
Authors: Cockx, B. (Intern), Clegg, R. J. (Ekstern), Lang, S. (Ekstern), Smets, B. F. (Intern), Kreft, J. (Ekstern)
Number of pages: 1
Publication date: 2016
Event: Poster session presented at MEWE and biofilms IWA specialist conference, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
MEWE_alternative.pdf
Source: PublicationPreSubmission
Source-ID: 127189190
Publication: Research - peer-review › Poster – Annual report year: 2016
Towards a consensus-based biokinetic model for green microalgae – The ASM-A

Cultivation of microalgae in open ponds and closed photobioreactors (PBRs) using wastewater resources offers an opportunity for biochemical nutrient recovery. Effective reactor system design and process control of PBRs requires process models. Several models with different complexities have been developed to predict microalgal growth. However, none of these models can effectively describe all the relevant processes when microalgal growth is coupled with nutrient removal and recovery from wastewaters. Here, we present a mathematical model developed to simulate green microalgal growth (ASM-A) using the systematic approach of the activated sludge modelling (ASM) framework. The process model – identified based on a literature review and using new experimental data – accounts for factors influencing photoautotrophic and heterotrophic microalgal growth, nutrient uptake and storage (i.e. Droop model) and decay of microalgae. Model parameters were estimated using laboratory-scale batch and sequenced batch experiments using the novel Latin Hypercube Sampling based Simplex (LHSS) method. The model was evaluated using independent data obtained in a 24-L PBR operated in sequenced batch mode. Identifiability of the model was assessed. The model can effectively describe microalgal biomass growth, ammonia and phosphate concentrations as well as the phosphorus storage using a set of average parameter values estimated with the experimental data. A statistical analysis of simulation and measured data suggests that culture history and substrate availability can introduce significant variability on parameter values for predicting the reaction rates for bulk nitrate and the intracellularly stored nitrogen state-variables, thereby requiring scenario specific model calibration. ASM-A was identified using standard cultivation medium and it can provide a platform for extensions accounting for factors influencing algal growth and nutrient storage using wastewater resources.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Residual Resource Engineering, Technical University of Denmark
Authors: Wágner, D. S. (Intern), Valverde Pérez, B. (Intern), Sæbø, M. (Ekstern), Bregua de la Sotilla, M. (Ekstern), van Wagenen, J. M. (Intern), Smets, B. F. (Intern), Plös, B. G. (Intern)
Pages: 485-499
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Water Research
Volume: 103
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SJR 2.601 SNIP 2.358
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.49 SJR 2.663 SNIP 2.563
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.665 SNIP 2.482 CiteScore 6.63
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.946 SNIP 2.702 CiteScore 6.13
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.676 CiteScore 6.02
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.914 SNIP 2.442 CiteScore 5.15
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.862 SNIP 2.355 CiteScore 5.43
Towards an optimal experimental design for N₂O model calibration during biological nitrogen removal

Process models describing nitrous oxide (N₂O) production during biological nitrogen removal allow for the development of mitigation strategies of this potent greenhouse gas. N₂O is an intermediate of nitrogen removal, hence its prediction is negatively affected by the uncertainty associated to its substrates. Improving experimental designs for model calibration reduces prediction uncertainties. Moreover, the individual analysis of autotrophic and heterotrophic contribution to the total NO and N₂O pool was assessed for already proposed model structures under different experimental scenarios. The results show the need for information-rich experimental designs to assess the predicting capabilities of N₂O models. This work represents a step further in understanding the N₂O production and emissions associated to conventional wastewater treatment. Moreover, it will facilitate the development of strategies to minimize the carbon footprint of wastewater treatment plants.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Department of Chemical and Biochemical Engineering, CAPEC-PROCESS
Authors: Domingo Felez, C. (Intern), Valverde Pérez, B. (Intern), Plósz, B. G. (Intern), Sin, G. (Intern), Smets, B. F. (Intern)
Number of pages: 3
Publication date: 2016
Event: Abstract from 5th IWA/WEF Wastewater Treatment Modelling Seminar 2016, Annecy, France.
Main Research Area: Technical/natural sciences
Transformation and sorption of illicit drug biomarkers in sewer systems: understanding the role of suspended solids in raw wastewater

Sewer pipelines, although primarily designed for sewage transport, can also be considered as bioreactors. In-sewer processes may lead to significant variations of chemical loadings from source release points to the treatment plant influent. In this study, we assessed in-sewer utilization of growth substrates (primary metabolic processes) and transformation of illicit drug biomarkers (secondary metabolic processes) by suspended biomass. Sixteen drug biomarkers were targeted, including mephedrone, methadone, cocaine, heroin, codeine and tetrahydrocannabinol (THC) and their major human metabolites. Batch experiments were performed under aerobic and anaerobic conditions using raw wastewater, and abiotic biomarker transformation and partitioning to suspended solids and reactor wall were separately investigated under both redox conditions. A process model was identified by combining and extending Wastewater Aerobic/anaerobic Transformations in Sewers model (WATS) and Activated Sludge Model for Xenobiotics (ASM-X). Kinetic and stoichiometric model parameters were estimated using experimental data via the Bayesian optimization method DREAM(ZS). Results suggest that biomarker transformation significantly differs from aerobic to anaerobic conditions, and abiotic conversion is the dominant mechanism for many of the selected substances. Notably, explicit description of biomass growth during batch experiments was crucial to avoid significant overestimation (up to 385%) of aerobic biotransformation rate constants. Predictions of in-sewer transformation provided here can reduce the uncertainty in the estimation of drug consumption as part of wastewater-based epidemiological studies.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Environmental Chemistry, KWR Watercycle Research Institute
Authors: Ramin, P. (Intern), Brock, A. L. (Intern), Polesel, F. (Intern), Causanilles, A. (Ekstern), Emke, E. (Ekstern), de Voogt, P. (Ekstern), Plósz, B. G. (Intern)
Pages: 13397–13408
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Science & Technology
Volume: 50
Issue number: 24
ISSN (Print): 0013-936x
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SJR 2.535 SNIP 1.941
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.559 SNIP 1.902
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.546 SNIP 1.838 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.003 CiteScore 5.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.952 SNIP 2.102 CiteScore 5.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Treatment of Swimming Pool Water with UV Followed by Ozone

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Cheema, W. A. (Intern), Kaarsholm, K. M. S. (Intern), Andersen, H. R. (Intern)
Number of pages: 1
Publication date: 2016
Event: Abstract from International Ozone Association Pan American Group, Las Vegas, United States.
Main Research Area: Technical/natural sciences
Electronic versions:
IOA_proceedings_paper.pdf
Source: PublicationPreSubmission
Source-ID: 1342800979
Publication: Research › peer-review › Conference abstract for conference – Annual report year: 2017
Underestimation of ammonia-oxidizing bacteria abundance by amplification bias in amoA-targeted qPCR

Molecular methods to investigate functional groups in microbial communities rely on the specificity and selectivity of the primer set towards the target. Here, using rapid sand filters for drinking water production as model environment, we investigated the consistency of two commonly used quantitative PCR methods to enumerate ammonia-oxidizing bacteria (AOB): one targeting the phylogenetic gene 16S rRNA and the other, the functional gene amoA. Cloning-sequencing with both primer sets on DNA from two waterworks revealed contrasting images of AOB diversity. The amoA-based approach preferentially recovered sequences belonging to Nitrosomonas Cluster 7 over Cluster 6A ones, while the 16S rRNA one yielded more diverse sequences belonging to three AOB clusters, but also a few non-AOB sequences, suggesting broader, but partly unspecific, primer coverage. This was confirmed by an in silico coverage analysis against sequences of AOB (both isolates and high-quality environmental sequences). The difference in primer coverage significantly impacted the estimation of AOB abundance at the waterworks with high Cluster 6A prevalence, with estimates up to 50-fold smaller for amoA than for 16S rRNA. In contrast, both approaches performed very similarly at waterworks with high Cluster 7 prevalence. Our results highlight that caution is warranted when comparing AOB abundances obtained using different qPCR primer sets.
Used water resource recovery using green microalgae

A paradigm shift is promoted in wastewater treatment whereby wastewater is considered as a source of nutrients, water and energy, rather than waste and it is referred to as used water. Microalgae cultivation on used water resources offers the potential to recover nitrogen, phosphorus, water and energy. When coupling with used water treatment, microalgae is mostly considered to produce energy through biofuel production. A novel used water resource recovery approach was presented earlier, referred to as TRENS – a fully biochemical process for the removal, recovery and reuse of used water resources promoting sustainable urban water management. The system consists of a low solids retention time (SRT) enhanced biological phosphorus removal and recovery (EBP2R) system that can provide optimal cultivation medium – in terms of nutrients and water – for downstream microalgal cultivation. The microalgal suspension cultivated in the photobioreactor (PBR) can be then used for e.g., “fertigation” on agricultural land whereby the water and the nutrients are recovered. Alternatively, the algal biomass can be harvested and can be used for co-digestion in existing anaerobic digesters, whereas the water content can be used for aquifer recharge.

Design and optimization of bacterial-microalgal systems requires process models that can be readily combined with consensus used water treatment models, e.g., the activated sludge models (ASM). Previous microalgal process models cannot be used for such purposes as a result of their deficiencies. Some lack e.g., accounting for the storage of nitrogen and phosphorus and for the potential for microalgae to grow heterotrophic on organic carbon that are relevant processes for used water resource recovery systems.

Therefore, the first objective of this thesis is to develop a consensus-based microalgal process model (ASM-A) accounting for photoautotrophic and heterotrophic microalgal growth, the uptake and storage of nitrogen and phosphorus and decay. The model was developed in the ASM framework as an extension to ASM-2d, thus it can be readily connected to bacterial unit processes. The process rates of the microalgal model were identified based on extensive literature review. Laboratory experiments in differently scaled batch PBRs were conducted in order to provide proper measurement data for model identification, comprising the selection of process rate equations as well as the estimation of the stoichiometric and kinetic model parameter distribution. The model identifiability analysis was conducted using the Latin Hypercube Sampling based Simpex (LHSS) method, adapted from the literature. The process model identified can effectively describe microalgal biomass concentration, soluble ammonium and phosphate concentrations as well as the phosphorus storage. The nitrogen storage is found to be affected by substrate availability, whilst the soluble nitrate concentration depends on the culture history, thereby requiring scenario specific model calibration. Moreover, the effects of light scattering, biomass concentration and pigmentation on light attenuation in PBRs were investigated, using laboratory-scale experimental data. The light attenuation coefficient was estimated using the Lambert-Beer equation. Results suggest that light attenuation depends primarily on the pigmentation of the microalgae and also on the biomass concentration. Moreover, using a discretized layer-model to describe the light distribution in PBRs can result in more accurate prediction of the microalgal growth as well as the reduction of the uncertainty of the model predictions.

Furthermore, the effect of the variation of influent N-to-P ratio on the reactor performance was assessed in a mixed consortium of Chlorella and Scenedesmus sp. as well as in a monoculture of Chlorella sp. (both commonly used in used water treatment systems) in continuous cultivation using the treated used water from the upstream EBPR system. When the N-to-P ratio in the influent was lowered to a sub-optimal level diatoms proliferated in the PBR cultivating the mixed green microalgal consortium. Once the ratio was increased again, the diatoms could be washed out of the system. Model predictive accuracy deteriorated as a result of the changes in culture composition due to the possible change in microalgal kinetics. The variation of the N-to-P ratio did not have an effect on the composition of the monoculture of Chlorella sp., no contamination was encountered during the 85 days of cultivation on used water. The upstream bacterial unit process in the second case was operated at a higher SRT (16 d), suggesting that longer SRT might be able to mitigate the potential of contamination by other microalgal species.

Lastly, an innovative method was developed to harvest microalgal biomass grown in suspended cultures in the TRENS system. A two-step flocculation was applied, whereby in the first step cationic polymer was added to the microalgae to destabilize the cells, then in the second step the aggregation of flocs was enhanced by the addition of bacterial biomass wasted in the upstream short-SRT EBPR process. Effective recovery was obtained (97%), by the significant (40%) reduction in the amount of cationic polymer required compared to the case when only cationic polymer was used for the flocculation without the addition of bacteria, thus further reducing harvesting costs. The biomethane potential of the harvested microalgal-bacterial biomass was estimated at mesophilic conditions, obtaining synergistic effect when co-digesting the two substrates and resulting in a maximum methane yield of 560±24 mlCH4/gVS.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Wágner, D. S. (Intern), Plósz, B. G. (Intern), Smets, B. F. (Intern)
Using mechanisms of hydrolysis and sorption to reduce siloxanes occurrence in biogas of anaerobic sludge digesters

Hydrolysis of hexamethylocyclosiloxane (D3), octamethycycloctasiloxane (D4), decamethylcyclopentasiloxane (D5), dodecamethylcyclohexasiloxane (D6) and dodecamethylcyclohexasilane (D6_silane) and their sorption to digested sludge was studied in batch experiments. Hydrolysis was affected by the type of the compound and the applied temperature, while the relevant half-life values ranged between 0.07 ± 0.01 d (D3, 55 °C) and 48.4 ± 17.1 d (D6_silane, 4 °C). D5 showed the greatest affinity for sorption to digested sludge (logKd: 3.84 ± 3.42), the lowest LogKd value was found for D3 (1.46 ± 0.95). Prediction of investigated compounds' fate in a single-stage anaerobic digestion system indicated that volatilization seems to be the major fate in both mesophilic and thermophilic conditions. The addition of a pre-digester with 3 d retention time would significantly decrease the expected concentrations of all siloxanes in biogas, enhancing their removal through hydrolysis and sorption to sludge.
Wastewater treatment in Kangerlussuaq, Greenland by chemical coagulation and UV disinfection

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Department of Civil Engineering, ARTEK, Section for Arctic Engineering and Sustainable Solutions, Technical University of Denmark
Authors: Chhetri, R. K. (Intern), Klupsch, E. (Ekstern), Andersen, H. R. (Intern), Jensen, P. E. (Intern)
Number of pages: 2
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Publication date: 2016

Host publication information
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Publisher: Arctic Technology Centre, DTU Technical University of Denmark
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Main Research Area: Technical/natural sciences
Electronic versions:
Book_of_Abstracts_Artek_Event_2016.pdf

Bibliographical note
Byg Report R-340
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2016

A comprehensive 454 survey provides insights into microbial diversity and community structure in rapid sand filters

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Urban Water Systems
Authors: Gülay, A. (Intern), Musovic, S. (Intern), Albrechtsen, H. (Intern), Smets, B. F. (Intern)
Pages: 79-83
Publication date: 2015

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Title of host publication: IWA Specialized Conference biofilms in drinking water systems from treatment to tap
Place of publication: Arosa, Switzerland
Publisher: IWA Publishing
Main Research Area: Technical/natural sciences
Rapid sand filters, Pyrosequencing, Core taxa, Drinking water, Groundwater
Source: PublicationPreSubmission
Source-ID: 116644585
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Biodegradation of pharmaceuticals in hospital wastewater by staged Moving Bed Biofilm Reactors (MBBR)
Hospital wastewater contributes a significant input of pharmaceuticals into municipal wastewater. The combination of suspended activated sludge and biofilm processes, as stand-alone or as hybrid process (hybrid biofilm and activated
sludge system (Hybas™)) has been suggested as a possible solution for hospital wastewater treatment. To investigate the potential of such a hybrid system for the removal of pharmaceuticals in hospital wastewater a pilot plant consisting of a series of one activated sludge reactor, two Hybas™ reactors and one moving bed biofilm reactor (MBBR) has been established and adapted during 10 months of continuous operation. After this adaption phase batch and continuous experiments were performed for the determination of degradation of pharmaceuticals. Removal of organic matter and nitrification mainly occurred in the first reactor. Most pharmaceuticals were removed significantly. The removal of pharmaceuticals (including X-ray contrast media, β-blockers, analgesics and antibiotics) was fitted to a single first-order kinetics degradation function, giving degradation rate constants from 0 to 1.49 h⁻¹, from 0 to 7.78 × 10⁻¹ h⁻¹, from 0 to 7.86 × 10⁻¹ h⁻¹ and from 0 to 1.07 × 10⁻¹ h⁻¹ for first, second, third and fourth reactors respectively. Generally, the highest removal rate constants were found in the first and third reactors while the lowest were found in the second one. When the removal rate constants were normalized to biomass amount, the last reactor (biofilm only) appeared to have the most effective biomass in respect to removing pharmaceuticals. In the batch experiment, out of 26 compounds, 16 were assessed to degrade more than 20% of the respective pharmaceutical within the Hybas™ train. In the continuous flow experiments, the measured removals were similar to those estimated from the batch experiments, but the concentrations of a few pharmaceuticals appeared to increase during the first treatment step. Such increase could be attributed to de-conjugation or formation from other metabolites.

General information
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Organisations: Department of Environmental Engineering, Urban Water Engineering, Water Technologies, Aarhus University, Danish Technological Institute
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Main Research Area: Technical/natural sciences

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BFI (2017): BFI-level 2
Scopus rating (2017): SJR 2.601 SNIP 2.358
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.49 SJR 2.663 SNIP 2.563
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.665 SNIP 2.482 CiteScore 6.63
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.946 SNIP 2.702 CiteScore 6.13
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.676 CiteScore 6.02
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.914 SNIP 2.442 CiteScore 5.15
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.862 SNIP 2.355 CiteScore 5.43
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Characterising the Removal of Trace Organic Chemicals in Wastewater - Are we using the Right Tools?

Hypothesis tests posed on trace organics fate and removal in wastewater are often answered using approaches that can introduce significant bias in observations made on the system. Using non-representative sampling approaches in sewer and wastewater treatment plant studies is an example (Ort et al., 2010). This study provides a critical discussion of processes and methodologies used in laboratory- and full-scale wastewater experimental studies, and offers potential solutions to observed pitfalls with the support of a model-based assessment.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies
Authors: Plósz, B. G. (Intern), Polesel, F. (Intern)
Number of pages: 2
Publication date: 2015
Event: Abstract from 9th IWA Specialist Conference on Assessment and Control of Micropollutants and Hazardous Substances in Water, Singapore, Singapore.
Main Research Area: Technical/natural sciences
xenobiotic trace chemical removal, etransformation, environmental representativeness
Electronic versions:
PLOSZ_WWTP_Removal_assessment_FINAL_FINAL.pdf
Source: PublicationPreSubmission
Source-ID: 119957101
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

Computational Design of Biomimetic Phosphate Scavengers
Phosphorus has long been the target of much research, but in recent years the focus has shifted from being limited only to reducing its detrimental environmental impact, to also looking at how it is linked to the global food security. Therefore, the
interest in finding novel techniques for phosphorus recovery, as well as improving existing techniques, has increased. In this study we apply a hybrid simulation approach of molecular dynamics and quantum mechanics to investigate the binding modes of phosphate anions by a small intrinsically disordered peptide. Our results confirm that the conformational ensemble of the peptide is significantly changed, or stabilized, by the binding of phosphate anions and that binding does not take place purely as a result of a stable P-loop binding nest, but rather that multiple binding modes may be involved. Such small synthetic peptides capable of binding phosphate could be the starting point of new novel technological approaches toward phosphorus recovery, and they represent an excellent model system for investigating the nature and dynamics of functional de novo designed intrinsically disordered proteins.

**General information**
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Technical University of Denmark
Authors: Gruber, M. F. (Intern), Wood, E. B. (Intern), Truelsen, S. F. (Intern), Østergaard, T. (Ekstern), Hélix-Nielsen, C. (Intern)
Number of pages: 10
Pages: 9469-9478
Publication date: 2015
Main Research Area: Technical/natural sciences

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- BFI (2018): BFI-level 2
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 2
- Scopus rating (2017): SJR 2.535 SNIP 1.941
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 2
- Scopus rating (2016): CiteScore 6.26 SJR 2.559 SNIP 1.902
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2015): SJR 2.546 SNIP 1.838 CiteScore 5.61
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 2
- Scopus rating (2014): SJR 2.777 SNIP 2.003 CiteScore 5.5
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 2
- Scopus rating (2013): SJR 2.952 SNIP 2.102 CiteScore 5.52
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 2
- Scopus rating (2012): SJR 3.115 SNIP 2.043 CiteScore 5.17
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 2
- Scopus rating (2011): SJR 3.18 SNIP 1.945 CiteScore 5.16
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 2
- Scopus rating (2010): SJR 2.979 SNIP 1.726
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 2
- Scopus rating (2009): SJR 2.86 SNIP 1.809
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 2
Effects of sewage sludge stabilization on fertilizer value and greenhouse gas emissions after soil application

Application of sewage sludge on agricultural land becomes more and more common in many parts of the world in order to recycle the nutrients from the sludge. A range of sewage sludge stabilization techniques are available to make the sludge more stable prior to storage, transportation, and application. These stabilization techniques include dewatering, drying, anaerobic digestion, composting, and reed bed sludge treatment. However, very few studies have investigated the effect of these techniques after the sludge has been applied to agricultural land. The objective of the current study was therefore to investigate the effect of sewage sludge stabilization techniques on the C and N mineralization and gaseous emissions from soil. A soil incubation was conducted to determine the rate of C and N mineralization and N2O and CH4 emissions of sewage sludge stabilized using different techniques. Unstabilized sludge released up to 90% of their C content as CO2, part of which could be caused by release of CO2 from carbonates. Compared with this, sludge stabilization including anaerobic digestion and drying resulted in a reduction of the C mineralization rate of about 40%. Liming reduced C mineralization with around 29%, while treatment in a reed bed system reduced it by 74%. The current study thus clearly demonstrated that stabilization techniques resulted in sludge that was more stable once they were applied to agricultural land. Stabilization also reduced the N immobilization phase, potentially improving the value of the sludge as a fertilizer. Emissions of CH4 were also reduced through sludge stabilization and mainly occurred after application of easily degradable sludge types, which is likely to have enhanced the creation of anaerobic microsites. The stabilization processes also decreased emissions of N2O. The results for both CH4 and N2O indicate that the stabilization tends to reduce the chance of developing conditions where these gases could be produced.

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering, Atmospheric Environment, Water Technologies, University of Copenhagen, Orbicon
Authors: Yoshida, H. (Intern), Nielsen, M. P. (Ekstern), Scheutz, C. (Intern), Jensen, L. S. (Ekstern), Christensen, T. H. (Intern), Nielsen, S. (Ekstern), Bruun, S. (Ekstern)
Number of pages: 11
Pages: 506-516
Publication date: 2015
Publication information
Journal: Acta Agriculturae Scandinavica, Section B - Soil & Plant Science
Volume: 65
Issue number: 6
ISSN (Print): 0906-4710
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- BFI (2018): BFI-level 1
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 1
- Scopus rating (2017): SNIP 0.747 SJR 0.414
- Web of Science (2017): Indexed Yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): SJR 0.367 SNIP 0.639 CiteScore 0.85
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 0.347 SNIP 0.434 CiteScore 0.73
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 0.409 SNIP 0.732 CiteScore 0.8
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 0.338 SNIP 0.646 CiteScore 0.72
- ISI indexed (2013): ISI indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): SJR 0.355 SNIP 0.742 CiteScore 0.74
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 1
- Scopus rating (2011): SJR 0.372 SNIP 0.68 CiteScore 0.78
- ISI indexed (2011): ISI indexed yes
- BFI (2010): BFI-level 1
- Scopus rating (2010): SJR 0.304 SNIP 0.432
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 0.263 SNIP 0.514
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 0.227 SNIP 0.347
- Scopus rating (2007): SJR 0.389 SNIP 0.682
- Scopus rating (2006): SJR 0.255 SNIP 0.481
- Scopus rating (2005): SJR 0.28 SNIP 0.614
- Scopus rating (2004): SJR 0.168 SNIP 0.379
- Web of Science (2004): Indexed yes
- Scopus rating (2003): SJR 0.146 SNIP 0.27
- Web of Science (2003): Indexed yes
- Scopus rating (2002): SJR 0.177 SNIP 0.572
- Scopus rating (2001): SJR 0.24 SNIP 0.31
- Scopus rating (2000): SJR 0.397 SNIP 0.44
- Scopus rating (1999): SJR 0.398 SNIP 0.49
Original language: English
sewage sludge, carbon storage, methane, nitrous oxide, nitrogen mineralization, Soil Science, Agronomy and Crop Science
DOIs:
10.1080/09064710.2015.1027730
Source: FindIt
Source-ID: 2264605552
Publication: Research - peer-review › Journal article – Annual report year: 2015
High yield purification of full-length functional hERG K⁺ channels produced in Saccharomyces cerevisiae

The hERG potassium channel is essential for repolarization of the cardiac action potential. Due to this vital function, absence of unintended and potentially life-threatening interactions with hERG is required for approval of new drugs. The structure of hERG is therefore one of the most sought-after. To provide purified hERG for structural studies and new hERG biomimetic platforms for detection of undesirable interactions, we have developed a hERG expression platform generating unprecedented amounts of purified and functional hERG channels. Full-length hERG, with or without a C-terminally fused green fluorescent protein (GFP) His(8)-tag was produced from a codon-optimized hERG cDNA in Saccharomyces cerevisiae. Both constructs complemented the high potassium requirement of a knock-out Saccharomyces cerevisiae strain, indicating correct tetramer assembly in vivo. Functionality was further demonstrated by Astemizole binding to membrane embedded hERG-GFP-His(8) with a stoichiometry corresponding to tetramer assembly. The 156 kDa hERG-GFP protein accumulated to a membrane density of 1.6%. Fluorescence size exclusion chromatography of hERG-GFP-His(8) solubilized in Fos-Choline-12 supplemented with cholesteryl-hemisuccinate and Astemizole resulted in a monodisperse elution profile demonstrating a high quality of the hERG channels. hERG-GFP-His(8) purified by Ni-affinity chromatography maintained the ability to bind Astemizole with the correct stoichiometry indicating that the native, tetrameric structure was preserved. To our knowledge this is the first reported high-yield production and purification of full length, tetrameric and functional hERG. This significant breakthrough will be paramount in obtaining hERG crystal structures, and in establishment of new high-throughput hERG drug safety screening assays.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, University of Copenhagen
Authors: Molbaek, K. (Ekstern), Scharff-Poulsen, P. (Ekstern), Hélix-Nielsen, C. (Intern), Klaerke, D. A. (Ekstern), Pedersen, P. A. (Ekstern)
Number of pages: 16
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Microbial Cell Factories
Volume: 14
Issue number: 1
Article number: 15
ISSN (Print): 1475-2859
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.227 SJR 1.443
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.92 SJR 1.481 SNIP 1.228
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.563 SNIP 1.265 CiteScore 4.08
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.757 SNIP 1.52 CiteScore 4.25
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.777 SNIP 1.483 CiteScore 4.22
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.43 SNIP 1.363 CiteScore 3.69
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.427 SNIP 1.386 CiteScore 3.91
Modelling the Fate of Ionizable Trace Organic Chemicals from Consumption to Food Crops

In this study, we developed and applied a simulation tool to comprehensively predict the fate of three ionizable trace chemicals (triclosan—TCS, furosemide—FUR, ciprofloxacin—CIP) from human consumption/excretion up to the accumulation in wheat, following application of sewage sludge or irrigation with river water. Highest translocation to wheat (4.3 μg kgDW-1 in grain) was calculated for FUR, being more significant with irrigation (>45% of emission to soil) than with sludge application (<30%). The simulation tool presented here can be used for estimating human exposure to trace chemicals via food crop intake and for priority setting among emerging pollutants.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Technologies, Environmental Chemistry
Authors: Polesel, F. (Intern), Plósz, B. G. (Intern), Trapp, S. (Intern)
Number of pages: 2
Publication date: 2015
Event: Abstract from 9th IWA Specialist Conference on Assessment and Control of Micropollutants and Hazardous Substances in Water, Singapore, Singapore.
Main Research Area: Technical/natural sciences
fate modelling of ionizable trace chemicals, plant uptake

Single-sludge denitrification in recirculating aquaculture systems: effects of pre-fermentation and pH

Single-sludge denitrification (DN) reactors in aquaculture use the carbonous solid fish waste produced in the system to reduce the discharged nitrate load. The solid waste is available for denitrifiers when present in soluble, readily biodegradable form, and the transformation is accomplished by bacterial hydrolysis and fermentation. The objective of this study was to quantify the effect of pre-fermentation of solid fish waste on single-sludge DN reactor efficiency. Pre-fermentation times tested were 0 d (no pre-fermentation), 1 d, 5 d, and 10 d, and the efficiency was quantified as the potential DN rate obtained in laboratory assays. Results showed that the highest DN rate was achieved with 1 d pre-fermentation. The volumetric DN rates measured in decreasing order were 23.4 +/- 0.00 mg NO3-N L-1 h(-1) (1 d), 20.5 +/- 0.35 mg NO3-N L-1 h(-1) (5 d), 17.0 +/- 0.47 mg NO3-N L-1 h(-1) (10 d), and 14.2 +/- 0.24 mg NO3-N L-1 h(-1) (0 d). It
was suspected that the poor utilization of soluble COD (sCOD) in the 5 d and 10 d pre-fermentation treatments was due to the low starting pH (pH <7). Subsequently, the experiments were repeated in 0.1 M HEPES buffer (pH = 7.1) and showed a clear correlation between specific DN rate and sCOD content. Overall, the highest increase in potential specific DN rate was achieved by applying pre-fermentation; e.g., from 0 d to 1 d, the increase was 123% and 106% at unadjusted pH and pH 7.1, respectively. An additional 20% increase was achieved at pH 7.1 by prolonging the pre-fermentation time to 5 d.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquaculture, Department of Environmental Engineering, Water Technologies
Authors: Suhr, K. I. (Intern), Letelier-Gordo, C. O. (Intern), Prat Busquets, P. (Intern)
Pages: 1825-1831
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: American Society of Agricultural and Biological Engineers. Transactions
Volume: 58
Issue number: 6
ISSN (Print): 2151-0032
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.825 SJR 0.481
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.455 SNIP 0.837 CiteScore 1.29
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.765 SNIP 1.012 CiteScore 1.63
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.619 SNIP 0.98 CiteScore 1.23
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.62 SNIP 0.897 CiteScore 1.26
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.657 SNIP 0.959 CiteScore 1.26
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.631 SNIP 0.929 CiteScore 1.3
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.677 SNIP 0.866
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.695 SNIP 0.84
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.713 SNIP 0.928
Scopus rating (2007): SJR 0.575 SNIP 0.953
Scopus rating (2006): SJR 0.778 SNIP 1.015
Scopus rating (2005): SJR 0.723 SNIP 1.182
Scopus rating (2004): SJR 0.791 SNIP 1.136
Scopus rating (2003): SJR 0.706 SNIP 0.97
Scopus rating (2002): SJR 0.625 SNIP 0.935
Scopus rating (2001): SJR 0.548 SNIP 1.091
Scopus rating (2000): SJR 0.918 SNIP 1.062
Scopus rating (1999): SJR 0.826 SNIP 0.99
Original language: English
Aquaculture, Denitrification, Nitrate removal, Single-sludge denitrification, Sludge hydrolysis, Sludge prefermentation
DOIs:
10.13031/trans.58.10952
Novel assay to measure the plasmid mobilizing potential of mixed microbial communities

Mobilizable plasmids lack necessary genes for complete conjugation and are therefore non-self-transmissible. Instead, they rely on the conjugation system of conjugal plasmids to be horizontally transferred to new recipients. While community permissiveness, the fraction of a mixed microbial community that can receive self-transmissible conjugal plasmids, has been studied, the intrinsic ability of a community to mobilize plasmids that lack conjugation systems is unexplored. Here, we present a novel framework and experimental method to estimate the mobilization potential of mixed communities. We compare the transfer frequency of a mobilizable plasmid to that of a mobilizing and conjugal plasmid measured for a model strain and for the assayed community. With Pseudomonas putida carrying the gfp-tagged mobilizable RSF1010 plasmid as donor strain, we conducted solid surface mating experiments with either a P. putida strain carrying the mobilizing plasmid RP4 or a model bacterial community that was extracted from the inner walls of a domestic shower conduit. Additionally, we estimated the permissiveness of the same community for RP4 using P. putida as donor strain. The permissiveness of the model community for RP4 (at 1.16x10^-4 transconjugants per recipient (T/R)) was similar to that previously measured for soil microbial communities. RSF1010 was mobilized by the model community at a frequency of 1.16x10^-5 T/R, only one order of magnitude lower than its permissiveness to RP4. This mobilization frequency is unexpectedly high considering that (i) mobilization requires the presence of mobilizing conjugal plasmids within the permissive fraction of the recipients; (ii) in pure culture experiments with P. putida retromobilization of RSF1010 through RP4 only took place in approximately half of the donors receiving the conjugal plasmid in the first step. Further work is needed to establish how plasmid mobilization potential varies within and across microbial communities.

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Engineering, Water Technologies
Authors: Klümper, U. (Intern), Droumpali, A. (Intern), Dechesne, A. (Intern), Smets, B. F. (Intern)
Number of pages: 9
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Frontiers in Microbiology
Volume: 5
Article number: 730
ISSN (Print): 1664-302X
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SJR 1.699 SNIP 1.174
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.16 SJR 1.759 SNIP 1.161
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.869 SNIP 1.193 CiteScore 4.15
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.879 SNIP 1.148 CiteScore 3.76
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.776 SNIP 0.949 CiteScore 3.56
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.46 SNIP 0.722 CiteScore 2.78
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.642 SNIP 0.192
Web of Science (2011): Indexed yes
Projects:

**Karakterisering og kvantificering af producerede nanobobler i vand**

Department of Environmental Engineering  
Urban Water Systems  
Water Technologies  
CM Aqua Technologies ApS  
Water ApS  
Brancheorganisationen AquaCirkle  
Period: 01/07/2017 → 30/04/2018  
Number of participants: 4  
Acronym: NanoBobler  
Project participant:  
Nielsen, Katrine (Intern)  
Andersen, Henrik Rasmus (Intern)  
Kaarsholm, Kamilla Marie Speht (Intern)  
Droumpali, Ariadni (Intern)

**Fuldautomatisk decentral rensning af partikler i regnbetingede udledninger**

Department of Environmental Engineering  
Urban Water Systems  
Water Technologies  
Teknologisk Institut  
HydroSystems  
Period: 01/11/2016 → 31/10/2018  
Number of participants: 6  
Acronym: FUPARU  
Project participant:  
Nielsen, Katrine (Intern)  
Mikkelsen, Peter Steen (Intern)  
Andersen, Henrik Rasmus (Intern)  
Vezzaro, Luca (Intern)  
Borup, Morten (Intern)  
Chhetri, Ravi Kumar (Intern)

Activities:
**Unge Forskere (External organisation)**
*Period: 19 Mar 2018*
Henrik Rasmus Andersen (Chairman)
Department of Environmental Engineering
Water Technologies

**Description**
Dommer ved semifinale for hovedstadsregionen. Planetariet.
Degree of recognition: National

**Related external organisation**
*Unge Forskere*
astra.dk, Denmark
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

**DTU Sustain 2017**
*Period: 6 Dec 2017*
Marlene Mark Jensen (Organizer)
Department of Environmental Engineering
Water Technologies
Degree of recognition: National

**Related event**
*DTU Sustain 2017*
06/12/2017 → 06/12/2017
Kgs. Lyngby, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**International Symposium on Antimicrobial Resistance in the Environment (ISARE 2017)**
*Period: 30 Nov 2017 → 3 Dec 2017*
Liguan Li (Participant)
Department of Environmental Engineering
Water Technologies
Degree of recognition: International

**Related event**
*International Symposium on Antimicrobial Resistance in the Environment (ISARE 2017)*
30/11/2017 → 03/12/2017
Shenzhen, China
Activity: Attending an event › Participating in or organising a conference

**Tracking and understanding AMR dynamics across European urban water systems**
*Period: 30 Nov 2017 – 3 Dec 2017*
Barth F. Smets (Guest lecturer)
Arnaud Dechesne (Other)
Liguan Li (Other)
Jonas Stenløkke Madsen (Other)
Joseph Nesme (Other)
Søren J. Sørensen (Other)
Marcos Quintela-Baluja (Other)
David Graham (Other)
Department of Environmental Engineering
Water Technologies
Related event

30/11/2017 → 03/12/2017
Shenzen, China
Activity: Talks and presentations › Conference presentations

Controls of N2O production pathways in nitritation-anammox biomass
Period: 13 Nov 2017
Marlene Mark Jensen (Invited speaker)
Department of Environmental Engineering
Water Technologies
Degree of recognition: National

Related event

Danish Microbiological Society 2017 Congress
13/11/2017 → 13/11/2017
Copenhague, Denmark
Activity: Talks and presentations › Conference presentations

DNA and RNA SIP reveal ammonium and nitrite oxidizers in groundwater fed biofilters
Period: 13 Nov 2017 → 15 Nov 2017
Arda Gülay (Speaker)
Barth F. Smets (Other)
Jane Fowler (Other)
Hans-Jørgen Albrechtsen (Other)
Karolina Tatari (Other)
Department of Environmental Engineering
Water Technologies
Degree of recognition: International

Related event

Nordic Environmental Nucleotide Network,: NENUN 2017
13/11/2017 → 15/11/2017
Denmark
Activity: Talks and presentations › Conference presentations

DNA and RNA SIP reveal nitrifiers in groundwater fed biofilters
Period: 13 Nov 2017
Arda Gülay (Other)
Jane Fowler (Other)
Barth F. Smets (Other)
Hans-Jørgen Albrechtsen (Other)
Department of Environmental Engineering
Water Technologies

Description
Poster presentation
Degree of recognition: National

Related event

Danish Microbiological Society: DMS Congress 2017
Permissiveness of Microbial Community from Wastewater Treatment Plant towards incP-1 Plasmid

Period: 13 Nov 2017

Liguan Li (Other)
Arnaud Dechesne (Other)
Barth F. Smets (Other)
Jonas Stenløkke Madsen (Other)
Søren J. Sørensen (Other)

Department of Environmental Engineering
Water Technologies
Degree of recognition: Local

Documents:
Abstract_LiguanLi

Related external organisation

Danish Microbiology Society
Activity: Talks and presentations › Conference presentations

The microbiome of potable water producing biofilters: taxonomic insights and anomalies, metabolic potentials, biotechnological opportunities?

Period: 7 Sep 2017 → 8 Sep 2017
Barth F. Smets (Keynote speaker)

Department of Environmental Engineering
Water Technologies
Degree of recognition: International

Related event

2nd International Symposium on microbial resource management : MRM2
07/09/2017 → 08/09/2017
Gent, Belgium
Activity: Talks and presentations › Conference presentations

International workshop on marine geomicrobiology - A matter of energy

Period: 28 Aug 2017 → 1 Sep 2017
Marlene Mark Jensen (Participant)

Department of Environmental Engineering
Water Technologies
Degree of recognition: International

Related event

International workshop on marine geomicrobiology - A matter of energy
28/08/2017 → 01/09/2017
Sønderborg, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Plasmid Host Range (Permissiveness) in Microbial Communities across Urban Water Systems

Period: 13 Aug 2017 → 17 Aug 2017
Barth F. Smets (Invited speaker)
Arnaud Dechesne (Other)
Liguan Li (Other)
Søren Johannes Sørensen (Other)
Jonas S. Madsen (Other)
Department of Environmental Engineering
Water Technologies
Degree of recognition: International
Documents:
EDAR2017_BFSM

Related event

4th International Symposium on the Environmental Dimension of Antibiotic Resistance
13/08/2017 → 17/08/2017
Lansing, MI, United States
Activity: Talks and presentations › Conference presentations

ICoN5: 5th International Conference on Nitrification
Period: 23 Jul 2017 → 27 Jul 2017
Carlos Domingo-Felez (Participant)
Department of Environmental Engineering
Water Technologies

Related event

ICoN5: 5th International Conference on Nitrification
23/07/2017 → 27/07/2017
Vienna, Austria
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

N2O dynamics of N-transforming microbial communities: from mechanistic insights to full-scale process control
Period: 23 Jul 2017 → 27 Jul 2017
Barth F. Smets (Invited speaker)
Department of Environmental Engineering
Water Technologies
Degree of recognition: International
Links:
https://icon5.univie.ac.at/welcome/

Related event

ICoN5: 5th International Conference on Nitrification
23/07/2017 → 27/07/2017
Vienna, Austria
Activity: Talks and presentations › Conference presentations

Diversity, structure, and novel physiologies in microbial communities in rapid sand filters
Period: 9 Jul 2017 → 13 Jul 2017
Barth F. Smets (Invited speaker)
Arda Gülay (Other)
Alejandro Palomo (Other)
Jane Fowler (Other)
Thomas Sicheritz-Pontén (Other)
Department of Environmental Engineering
Water Technologies
Department of Bio and Health Informatics
Metagenomics
Degree of recognition: International
Documents:
  fems 2

Related event
The Federation of European Microbiological Societies
09/07/2017 → 13/07/2017
Valencia, Spain
Activity: Talks and presentations » Conference presentations

The industrial dynamics of water innovation: A comparison of China and Europe
Period: 26 Jun 2017
Mariú Abritta Moro (Speaker)
Department of Environmental Engineering
Water Technologies
Department of Management Engineering
Technology and Innovation Management
Degree of recognition: International

Related event
International Conference on Innovation Studies
26/06/2017 → 27/06/2017
Beijing, China
Activity: Talks and presentations » Conference presentations

Frontiers International Conference on Wastewater Treatment (FICWTM2017)
Period: 21 May 2017 → 24 May 2017
Carlos Domingo-Felez (Participant)
Department of Environmental Engineering
Water Technologies

Related event
Frontiers International Conference on Wastewater Treatment (FICWTM2017): FICWTM 2017
21/05/2017 → 24/05/2017
Palermo, Italy
Activity: Attending an event » Participating in or organising a conference

Low nitrous oxide production in intermittent-feed high performance nitrifying reactors
Period: 21 May 2017 → 24 May 2017
Qingxian Su (Keynote speaker)
Department of Environmental Engineering
Water Technologies

Description
Flash presentation
Degree of recognition: International

Related event
Frontiers International Conference on Wastewater Treatment (FICWTM2017): FICWTM 2017
21/05/2017 → 24/05/2017
Palermo, Italy
Activity: Talks and presentations » Conference presentations
Intermittent aeration regimes are effective tools to manage size of bio-granules and microbial communities in PN/A SBRs.

Period: 10 May 2017
Jan-Michael Blum (Speaker)
Department of Environmental Engineering
Water Technologies

**Description**
The presentation was given at the 10th International Conference on Biofilm Reactors at University College Dublin, Ireland.
Degree of recognition: International

**Related event**
10th International Conference on Biofilm Reactors
09/05/2017 → 12/05/2017
Dublin, Ireland
Activity: Talks and presentations › Conference presentations

Differential adhesion and the spatial positioning effect on early stage microbial aggregation

Period: 9 May 2017 → 12 May 2017
Bastiaan Cockx (Other)
Jan-Ulrich Kreft (Other)
Barth F. Smets (Other)
Department of Environmental Engineering
Water Technologies
Degree of recognition: International

**Related event**
10th International Conference on Biofilm Reactors
09/05/2017 → 12/05/2017
Dublin, Ireland
Activity: Talks and presentations › Conference presentations

**7th International Conference**
Period: 2 May 2017 → 5 May 2017
Kamilla Marie Speht Kaarsholm (Participant)
Henrik Rasmus Andersen (Chairman)
Traek Manasfi (Participant)
Jean-Luc Boudenne (Participant)
Department of Environmental Engineering
Water Technologies

**Description**
Effect of UV treatment on DBPs formation in chlorinated seawater swimming pools- a laboratory study

The study aim was to investigate the effect of UV treatment followed by chlorination on DBP formation was studied using laboratory experiments. Three groups of DBPs were investigated including THMs, HANs and HAAs. DBP level measured after post-UV chlorination was compared to dark control sample which was not subjected to UV exposure. Bromine substitution was investigated to analyse its effects on the formation of DBPs. Finally, overall cytotoxicity and genotoxicity were estimated for the toxic potency of compounds before and after treatment.
Degree of recognition: International

**Related event**
7th International Conference: Swimming Pool and Spa
Destruction of DBPs and their precursors in swimming pool water by combined UV-treatment and ozonation

The study aim was to investigate the effect of a combined treatment system on DBP formation. As both ozone and chlorine preferably react with electrophilic groups in compounds, we hypothesise that reactivity to chlorine, created by the UV treatment of dissolved organic matter in pool water, might also mean that there is increased reactivity to ozone and that ozonation might remove the chlorine reactivity created by UV treatment. Therefore, we first performed an experiment to range-find the effect of swimming pool water UV activation on chlorine reactivity. Secondly, an experiment was carried out to characterise the effect of adding various doses of ozone to pool water, with or without UV pre-treatment, before chlorination to study the effect on chlorine reactivity and the formation of chlorination by-products. Finally, the possible effect on chlorination by-product formation was investigated by a repeated, combined UV-ozone treatment interchanged with chlorination (repeated cycles of UV followed by ozone with subsequent chlorination). Toxicity estimation was used to evaluate water quality.

Degree of recognition: International
Documents:
combined UV and ozone treatment for swimming pool water

Related event
7th International Conference: Swimming Pool and Spa
02/05/2017 → 05/05/2017
Kos, Greece
Activity: Attending an event › Participating in or organising a conference

Destruction of DBPs and their precursors in swimming pool water by combined UV-treatment and ozonation
Period: 2 May 2017 → 5 May 2017
Waqas Akram Cheema (Speaker)
Department of Environmental Engineering
Water Technologies
Description
The study aim was to investigate the effect of a combined treatment system on DBP formation. As both ozone and chlorine preferably react with electrophilic groups in compounds, we hypothesise that reactivity to chlorine, created by the UV treatment of dissolved organic matter in pool water, might also mean that there is increased reactivity to ozone and that ozonation might remove the chlorine reactivity created by UV treatment. Therefore, we first performed an experiment to range-find the effect of swimming pool water UV activation on chlorine reactivity. Secondly, an experiment was carried out to characterise the effect of adding various doses of ozone to pool water, with or without UV pre-treatment, before chlorination to study the effect on chlorine reactivity and the formation of chlorination by-products. Finally, the possible effect on chlorination by-product formation was investigated by a repeated, combined UV-ozone treatment interchanged with chlorination (repeated cycles of UV followed by ozone with subsequent chlorination). Toxicity estimation was used to evaluate water quality.

Degree of recognition: International
Documents:
combined UV and ozone treatment for swimming pool water

Related event
7th International Conference: Swimming Pool and Spa
02/05/2017 → 05/05/2017
Kos, Greece
**Effect of UV treatment on DBPs formation in chlorinated seawater swimming pools- a laboratory study**  
Period: 2 May 2017 → 5 May 2017  
Waqas Akram Cheema (Speaker)  
Department of Environmental Engineering  
Water Technologies  

**Description**  
The study aim was to investigate the effect of UV treatment followed by chlorination on DBP formation was studied using laboratory experiments. Three groups of DBPs were investigated including THMs, HANs and HAAs. DBP level measured after post-UV chlorination was compared to dark control sample which was not subjected to UV exposure. Bromine substitution was investigated to analyse its effects on the formation of DBPs. Finally, overall cytotoxicity and genotoxicity were estimated for the toxic potency of compounds before and after treatment.

**Degree of recognition:** International  
**Documents:**  
UV for seawater pools

**Related event**  
7th International Conference: Swimming Pool and Spa  
02/05/2017 → 05/05/2017  
Kos, Greece

**2017 IUVA Americas Conference**  
Period: 5 Feb 2017 → 8 Feb 2017  
Waqas Akram Cheema (Speaker)  
Department of Environmental Engineering  
Water Technologies  

**Description**  
presented topic "Effect of UV treatment on formation of disinfection by-products in chlorinated seawater swimming pools"  
**Degree of recognition:** International

**Related event**  
2017 IUVA Americas Conference  
05/02/2017 → 08/02/2017  
Austin, United States

**9th International membrane science and technology conference (IMSTEC)**  
Period: 5 Dec 2016 → 8 Dec 2016  
Agata Zarebska (Speaker)  
Department of Environmental Engineering  
Water Technologies  

**Description**  
Influence of mechanical wastewater pretreatment on membrane fouling during municipal wastewater treatment by forward osmosis

**Oral presentation**

**Related event**  
9th International Membrane Science & Technology Conference  
05/12/2016 → 08/12/2016  
Adelaide, Australia
Kortlægning af den bakterielle lattergasproduktion i aktivt slam ved hjælp af stabile isotoper
Period: 9 Nov 2016
Marlene Mark Jensen (Speaker)
Department of Environmental Engineering
Water Technologies

Related event
Dansk Vand Konference
08/11/2016 → 09/11/2016
Århus, Denmark

C-accounting and the role of LCA in waste management
Thomas Højlund Christensen (Keynote speaker)
Department of Environmental Engineering
Atmospheric Environment
Water Technologies
Documents:
16 ICWMT Beijing T H Christensen

Related event
The 11th International Conference on Waste Management and Technology
21/10/2016 → 24/10/2016
Beijing, China

LCA – Life-Cycle-Assessment - modeling with an industrial waste example
Period: 27 Sep 2016 → 30 Sep 2016
Thomas Højlund Christensen (Invited speaker)
Department of Environmental Engineering
Atmospheric Environment
Water Technologies
Documents:
16 Crete Thomas Christensen Invited lecture

Related event
5th International Conference on Industrial and Hazardous waste management
27/09/2016 → 30/09/2016
Crete, Greece

When is it produced, why is it produced and how to prevent nitrous oxide emissions? Main findings from a large nitrous oxide project in Denmark
Period: 27 Sep 2016
Marlene Mark Jensen (Invited speaker)
Department of Environmental Engineering
Water Technologies

Related event
Swedish Water & Waterwater Fair 2016: Leading Edge Wastewater Treatment
27/09/2016 → 27/10/2016
Jönköping, Sweden
Activity: Talks and presentations › Conference presentations

N2O Expert Meeting and Workshop
Period: 21 Sep 2016 → 22 Sep 2016
Carlos Domingo-Felez (Participant)
Department of Environmental Engineering
Water Technologies
Description
10 minutes presentation about current research on DTU-Miljø

N2O expert meeting and workshop held at the Ruhr-Universität Bochum on September 2016. Two days of presentations and discussions about analytical methods, full-scale measurement campaigns and modelling of biological N2O turnover

Related event

N2O Expert Meeting and Workshop
21/09/2016 → 22/09/2016
Bochum, Germany
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

MEWE and biofilms IWA specialist conference
Period: 4 Sep 2016 → 7 Sep 2016
Jane Fowler (Organizer)
Department of Environmental Engineering
Water Technologies
Description
Vice chairperson

Related event

MEWE and biofilms IWA specialist conference
04/09/2016 → 07/09/2016
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising a conference

EuroTech Postdoc seminar
Period: 31 Aug 2016 → 2 Sep 2016
Agata Zarebska (Participant)
Department of Environmental Engineering
Water Technologies
Description
Intensive, highly interactive, and fun crash course in the soft skills underlying professional success for postdoctoral researchers from EuroTech Universities: - Selling your science and yourself by Jen Rolfe (UK) - Global mindset and intercultural competence! by Christine McCarthy (DE) - Networking and career planning - how to use your network for your next career step! by Barbara Wagner (DE)

Participant

Related event

EuroTech Postdoc seminar
31/08/2016 → 02/09/2016
Munich, Germany
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.
IOA-PAG International Conference
Waqas Akram Cheema (Speaker)
Department of Environmental Engineering
Water Technologies

Description
presented topic “Treatment of Swimming Pool Water with UV Followed by Ozone”
Degree of recognition: International

Related event
International Ozone Association Pan American Group: 2016 Annual Conference
28/08/2016 → 31/08/2016
Las Vegas, United States
Activity: Talks and presentations › Conference presentations

16th Nordic Filtration Symposium - Filtration for Circular Economy
Agata Zarebska (Speaker)
Department of Environmental Engineering
Water Technologies

Description
Oral presentation

Related event
16th Nordic Filtration Symposium - Filtration for Circular Economy
24/08/2016 → 26/08/2016
Lappeenranta, Finland
Activity: Talks and presentations › Conference presentations

Who are the water innovators?
Period: 7 Jul 2016
Mariú Abritta Moro (Speaker)
Department of Environmental Engineering
Water Technologies
Department of Management Engineering
Technology and Innovation Management
Degree of recognition: International

Related event
16th International Schumpeter Society Conference
06/07/2016 → 08/07/2016
Montreal, Canada
Activity: Talks and presentations › Conference presentations

8th INTERNATIONAL WATER & HEALTH SEMINAR
Kai Tang (Participant)
Department of Environmental Engineering
Water Technologies
Polishing of pharmaceuticals in conventionally treated wastewater with intermittently fed Moving Bed Biofilm Reactors (MBBR)

Related event

8th INTERNATIONAL WATER & HEALTH SEMINAR
27/06/2016 → 29/06/2016
Cannes, France
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Advanced Applications of Spectrophotometry and Surface Analysis
Period: 16 Jun 2016
Agata Zarebska (Participant)
Department of Environmental Engineering
Water Technologies

Related event

Advanced Applications of Spectrophotometry and Surface Analysis
16/06/2016 → 16/06/2016
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Where to direct modelling efforts for a faster road towards resource recovery?
Period: 31 Mar 2016
Borja Valverde Pérez (Invited speaker)
Department of Environmental Engineering
Water Technologies

Related event

5th IWA/WEF Wastewater Treatment Modelling Seminar 2016: Where to direct modelling efforts for a faster road towards resource recovery?
02/04/2016 → 06/04/2016
Annecy, France
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

Advanced Materials Characterization
Period: 30 Mar 2016
Agata Zarebska (Participant)
Department of Environmental Engineering
Water Technologies

Related event

Advanced Materials Characterization
30/03/2016 → 30/03/2016
Brøndby, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

2nd Young Water Professionals Denmark Conference and Workshop
Period: 10 Mar 2016
Kai Tang (Participant)
Department of Environmental Engineering
Water Technologies

Description
Influence of dissolved organic carbon on biodegradation of pharmaceuticals by suspended biofilms in wastewater

Documents:
YWPDK_2nd_conf_abstract (kaitang DTU)

Links:
http://ywp.dk/?page_id=784

Related event

2nd Young Water Professionals Denmark Conference and Workshop
10/03/2016 → 11/03/2016
Aarhus, Denmark
Activity: Attending an event › Participating in or organising a conference

2016 IUVA World Congress
Period: 31 Jan 2016 → 3 Feb 2016
Waqas Akram Cheema (Speaker)
Department of Environmental Engineering
Water Technologies

Description
presented topic "Destruction of disinfection by products and their precursors in swimming pool water by combined UV treatment and ozonation"

Degree of recognition: International

Related event

2016 IUVA World Congress
31/01/2016 → 03/02/2016
Vancouver, Canada
Activity: Talks and presentations › Conference presentations

Prizes:

Best Presentation Award at 7th International Conference Swimming Pool & Spa
Waqas Akram Cheema (Recipient)
Department of Environmental Engineering, Water Technologies

Description
At the 7th International Swimming Pool & Spa Conference (Kos Island, Greece), Waqas A. Cheema (WCHE) received the award for the best presentation out of 48 presentations. The title of the presentation was "Destruction of DBPs and their precursors in swimming pool water by combined UV treatment and ozonation".

Details
Awarded date: 5 May 2017
Degree of recognition: International
Granting Organisations: National University of Sciences & Technology (NUST)
event: 7th International Conference
Prize: Prizes, scholarships, distinctions

EliteForsk-rejsestipendierne 2017
Aikaterini Spiliotopoulou (Recipient)
Department of Environmental Engineering, Water Technologies

Description
The Elite Research Prize is awarded to outstanding researchers under 45 years of international excellence. The Ministry for Higher Education and Science annually distributes five prizes. Each prize is 1.2 million. 200,000 is a personal award and 1,000,000 goes to research.
The Elite Research travel grant is DKK 200,000 and helps very talented PhD students to perform longer-term studies in some of the best research environments in the world. The Ministry of Higher Education and Science annually distributes
up to 20 Elite Research travel grants. Recipients of Elite Research prices are presented and honoured at the annual Elite Research Conference.

**Details**
Awarded date: 23 Feb 2017  
Degree of recognition: National  
Granting Organisations: The Ministry for Higher Education and Science (Danish)  
event: EliteForsk-konferencen  
Prize: Prizes, scholarships, distinctions

**Nanoscale zero-valent iron impregnation of covalent organic polymer grafted activated carbon for water treatment: 11th International Conference on the Environmental Effects of Nanoparticles and Nanomaterials (ICEENN 2016)**
Paul D. Mines (Recipient)  
Department of Environmental Engineering, Water Technologies, Department of Micro- and Nanotechnology, Surface Engineering

**Description**  
Best Poster Prize

**Details**
Awarded date: 18 Aug 2016  
Granting Organisations: Royal Society of Chemistry  
Prize: Prizes, scholarships, distinctions

**Trophees Performance Veolia Environment**  
Aikaterini Spiliotopoulou (Recipient)  
Department of Environmental Engineering, Water Technologies

**Details**
Awarded date: 2013  
Granting Organisations: VEOLIA  
Prize: Prizes, scholarships, distinctions

**Press clippings:**

**Sourcetreatment of pharmaceuticals in hospital wastewater**  
Henrik Rasmus Andersen  
15/05/2018 → 16/05/2018  
Department of Environmental Engineering, Water Technologies

**Media contributions (3)**

**Radioavisen**  
16/05/2018  
DR P1 (National), Denmark, Radio  
https://www.dr.dk/radio/p1/p1-radioavisen/radioavisen-2018-05-16-08-00#t00:00:00  
Interview. DTU budskab er at det er billigst at rense for lægemidler på de eksisterende rensenanlæg. Henrik Rasmus Andersen  
Department of Environmental Engineering, Water Technologies

**Eksperter er enige: Fejlinvestering at bygge rensningsanlæg på sygehuse**  
15/05/2018  
JP (National), Denmark, Print  
Nordjyderne vil snart kunne blive behandlet på et splinternyt og flot supersygehus i Aalborg. 4,7 mia. kr. vil det have kostet at opføre, når det står klart i 2021. Men nogle af pengene kunne måske være anvendt lidt klogere.

I hvert fald sætter en række eksperter spørgsmålstegn ved, om millioninvesteringer i små, decentrale rensningsanlæg på sygehuse som det nye i Aalborg er den miljømæssigt bedste måde at rense vandet for medicinrester. Blot 4 pct. af medicinforureningen kommer fra sygehusene, mens resten kommer fra private husstande, plejehjem og lignende. Derfor vil det ifølge kritikere være langt bedre at investere i ny teknologi på de store, centrale rensningsanlæg, der vil kunne fjerne langt flere medicinrester – og gøre det for færre penge.
Henrik Rasmus Andersen
Department of Environmental Engineering, Water Technologies

**Professorer: Sygehuse er i gang med gigantisk fejlinvestering for milliarder**
15/05/2018
JP (National), Denmark, Print
https://jyllands-posten.dk/indland/ECE10604933/professorer-sygehuse-er-i-gang-med-gigantisk-fejlinvestering-for-milliarder/
Ifølge vandselskaber og eksperter er regionerne i gang med en milliardinvestering, der kan være unødvidig spild af penge.
Henrik Rasmus Andersen
Press / Media

**Forurening af flod ved Carlsbergs bryggeri i Nepal**
Henrik Rasmus Andersen
08/03/2018 – 08/03/2018
Department of Environmental Engineering, Water Technologies

**Media contributions (3)**

**Massiv forurening ved Carlsberg-bryggeri i Nepal**
08/03/2018
Danwatch (National), Denmark, Web
Emilie Ekeberg
https://danwatch.dk/undersoegelse/carlsberg-bryggeri-forurener-i-nepal/
Vandprøver viser udledning af giftigt spildevand ved Carlsbergs bryggeri i Nepal.
Henrik Rasmus Andersen
Department of Environmental Engineering, Water Technologies

**Carlsberg anklages for at forurene en af Nepals største floder**
08/03/2018
Danwatch (National), Denmark, Web
Vandprøver indikerer, at der udledes giftigt spildevand fra Carlsbergs bryggeri i Nepal. Lokale indbyggere har i årevis klaged over forureningen, imens Carlsberg hævder, at de har løst problemerne.
Henrik Rasmus Andersen
Department of Environmental Engineering, Water Technologies

**Knuste flasker og forurening belaster Carlsbergs bryggeri i Nepal**
08/03/2018
Danmark, Web
https://www.dr.dk/nyheder/penge/knuste-flasker-og-forurening-belaster-carlsbergs-bryggeri-i-nepal
Flere vandprøver viser kraftig forurening, der belaster både fisk og truede dyrearter, lige uden for Carlsbergs bryggeri.
Henrik Rasmus Andersen
Press / Media

**Bornholm: Flere bassiner har problemer med vandkvalitet**
Henrik Rasmus Andersen
24/07/2017
Department of Environmental Engineering, Water Technologies

**Media contribution (1)**

**Bornholm: Flere bassiner har problemer med vandkvalitet**
24/07/2017
Danmarks Radio (National), Denmark, Television
http://www.dr.dk/nyheder/regionale/bornholm/bornholm-flere-bassiner-har-problemer-med-vandkvalitet
Henrik Rasmus Andersen
Press / Media

**Fire sandheder om vandet i poolen: Nej, det er hverken kløren der lugter eller svier i øjnene**
Henrik Rasmus Andersen
19/07/2017
Fire sandheder om vandet i poolen: Nej, det er hverken kloren der lugter eller svier i øjnene
19/07/2017
TV2 (National), Denmark, Web
Marie Kjempff
2p
Det er højsæson for plasken og sjasken i swimmingpools og badebassiner. Men hvad er det egentlig, der foregår under vandoverfladen? Er det for eksempel farligt at sluge poolvandet? Og hvad er det egentlig, der svier sådan i øjnene?
Henrik Rasmus Andersen