On-site treatment and landfilling of MSWI air pollution control residues

Air pollution control (APC) residues from municipal solid waste incineration (MSWI) are difficult to landfill due to substantial leaching of trace metals. An on-site pretreatment prior to landfilling of APC-residues was investigated in terms of bench-scale experiments with a semidry APC-residue and a fly ash. The treatment involved mixing of the residues with a ferrous sulphate solution and subsequent oxidation of the suspension. Afterwards, the suspension was spread on a dedicated landfill section and allowed to drain by gravity through the drainage system of the landfill. The wastewater from the process, collected through the drainage system, contained large concentrations of salts (Cl: 14–30 g/l, Na: 4–9 g/l, K: 5–11 g/l, Ca: 2–12 g/l) but low concentrations of trace metals (e.g. Pb: 14–100 μg/l, Cd: <2–7 μg/l). The treated residues left in the landfills were later subject to leaching by simulated rainfall. The leachate contained low concentrations of trace metals (Pb: <120 μg/l, Cd: <2 μg/l, Cr: <485 μg/l). The leachate concentrations from the treated APC-residues were substantially reduced compared to concentrations in leachate from untreated APC-residues. Particularly in the early stages of the leaching, concentrations of trace metals were reduced by up to four orders of magnitude.
Incineration residues, Fly ash, Semidry air pollution control residue, Ferrous sulphate, Treatment, Stabilization, Trace metals, Leaching

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Re-use of stabilised flue gas ashes from solid waste incineration in cement-treated base layers for pavements

Fly ash from coal-burning power plants has been used extensively as a pozzolan and fine filter in concrete for many years. Laboratory experiments were performed investigating the effect of substituting the coal-based fly ash with chemically stabilised flue gas ashes (FGA) from waste incineration. Two types of FGA were treated by the Ferrox-process, which removes the majority of the easily soluble salts in the FGA and provides binding sites for heavy metals in terms of ferrihydrite. Cubes of cement treated base layer materials containing 5% stabilised FGA were cast, sealed and cured for two weeks. Cylinders (diameter 100 mm, length 150 mm) were drilled from these cubes for tank leaching experiments. Duplicate specimens were subject to compression strength testing and to tank leaching experiments. The compressive strength of the CTB fulfilled the Danish requirements for CTB, i.e. strength more than 5 MPa after 7 days. The tank leaching tests revealed that leaching of heavy metals was not significantly affected by the use of chemically stabilised flue gas ashes from waste incineration. Assuming that diffusion controls the leaching process it was calculated that less than 1% of the metals would leach during a 100-year period from a 0.5 m thick concrete stab exposed to water on one side. Leaching of the common ions Ca, Cl, Na and SO4 was increased 3-20 times from the specimens with chemically stabilised flue gas ashes from waste incineration. However, the quantities leached were still modest. These experiments suggest that FGA from waste incineration after Ferrox-treatment could be re-used in CTB without compromising the
strength and teaching from the base layer.

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Scopus rating (2014): SJR 0.741 SNIP 1.085 CiteScore 1.28
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BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.588 SNIP 0.951 CiteScore 1.17
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Web of Science (2007): Indexed yes
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Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.449 SNIP 0.729
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.48 SNIP 0.787
Stabilization of APC residues from waste incineration with ferrous sulfate on a semi-industrial scale

A stabilization method for air pollution control (APC) residues from municipal solid waste incineration (MSWI) involving mixing of the residue with water and FeSO₄ has been demonstrated on a semi-industrial scale on three types of APC residues: a semidy (SD) APC residue, a fly ash (FA), and an FA mixed with sludge (FAS) from a wet flue gas cleaning system. The process was performed in batches of 165-175 kg residue. It generates a wastewater that is highly saline but has a low content of heavy metals such as Cd, Cr, and Pb. The stabilized and raw residues have been subject to a range of leaching tests: the batch leaching test, the pH-static leaching test, the availability test, and the column test. These tests showed that the stabilized residues have remarkably improved leaching properties, especially with respect to Pb but also with respect to Cd, Cu, and Zn. The release of Pb was reduced by a factor of 250-36,000.

The solubility of rhodochrosite (MnCO₃) and siderite (FeCO₃) in anaerobic aquatic environments

Natural groundwaters are often reported to be highly supersaturated with the carbonate minerals siderite (FeCO₃) and rhodochrosite (MnCO₃). The kinetics of precipitation and dissolution were determined in the light of new determinations of the solubility products of siderite and rhodochrosite. Laboratory experiments showed that the precipitation kinetics of siderite and rhodochrosite were much slower than that of calcite, and also much slower than their dissolution kinetics. Experiments with supersaturated solutions failed to reach steady state within 474 days in the case of siderite, whereas steady state for rhodochrosite was reached after 140 days. Suspensions of siderite and rhodochrosite crystals reached steady state after 10 and 80 days, respectively. The solubility product of siderite (log KS0(FeCO₃)) was 11.03 ± 0.10 for dried crystals and 10.43 ± 0.15 for wet crystals. For rhodochrosite the solubility product (log KS0(MnCO₃)) was 11.39 ± 0.14 for dried crystals and 12.51 ± 0.07 for wet crystals. The solubility product determined from supersaturated solutions was log KS0(MnCO₃)=11.65 ± 0.14. The observed slow precipitation kinetics of siderite and rhodochrosite might explain the apparent supersaturation that is often reported for anaerobic aquatic environments. # 2002 Elsevier Science Ltd. All rights reserved.
This paper describes a new concept for treatment of air-pollution-control (APC) residues from waste incineration and characterises the wastewater and stabilised residues generated by the process. The process involves mixing of APC-residues with a ferrous sulphate solution and subsequent oxidation of the suspension (Ferroxprocess 1996). The process results in a significant reduction in the leaching of salts and heavy metals from the residue, by washing out most of the salts and by binding the heavy metals in the iron oxides formed. In the laboratory, a semidry gas-cleaning residue and a fly ash were treated by the process. The generated wastewater contained low concentrations of heavy metals (e.g. Pb: 27–39 μg l–1 and Cd: 2.6–4.6 μg l–1), but high concentrations of salts (e.g. Cl, Na, K, and Ca). The treatment process reduced the leaching of Pb from the residues by more than two orders of magnitude at fixed pH as determined by pHstatic leaching tests. Likewise, the leaching of Cd, Zn and Cu was significantly reduced. The effect on elements that form oxyanions (e.g. Cr) is marginal and in the current process there is no reduction in the release of Hg.
Treatment of waste incinerator air-pollution-control residues with FeSO₄: Laboratory investigation of design parameters

The key design parameters of a new process for treatment of air-pollution-control (APC) residues (the Ferrox-process) were investigated in the laboratory. The optimisation involved two different APC-residues from actual incinerator plants. The design parameters considered were: amount of iron oxide supplied, the liquid-to-solid ratio of the process, the separation of solids and wastewater, the sequence of material mixing, the possibilities of reuse of water, the feasibility of using secondary (brackish) water, and simple means to improve the wastewater quality. The investigation showed that an optimum process configuration could be obtained yielding a stabilised solid product with low leaching of heavy metals and a dischargable wastewater with high contents of salts (in order to remove salts from the solid product) and low concentrations of heavy metals. The amount of iron added to the APC-residues must be optimised for each residue. The overall water use can be limited to a L/S-ratio of 3 l kg⁻¹ including water used for washing of the treated products.
Biogeochemistry of landfill leachate plumes

The literature has been critically reviewed in order to assess the attenuation processes governing contaminants in leachate affected aquifers. Attenuation here refers to dilution, sorption, ion exchange, precipitation, redox reactions and degradation processes. With respect to contaminants, focus is on dissolved organic matter, xenobiotic organic compounds, inorganic macrocomponents as anions and cations, and heavy metals. Laboratory as well as field investigations are included. This review is an up-date of an earlier comprehensive review. The review shows that most leachate contamination plumes are relatively narrow and do not in terms of width exceed the width of the landfill. The concept of redox zones being present in the plume has been confirmed by the reported composition of the leachate contaminated groundwater at several landfills and constitutes an important framework for understanding the behavior of the contaminants in the plume as the leachate migrates away from the landfill. Diverse microbial communities have been identified in leachate plumes and are believed to be responsible for the redox processes. Dissolved organic C in the leachate, although it appears to be only slowly degradable when the volatile organic acids are gone, apparently acts as substrate for the microbial redox processes. Several xenobiotic organic compounds have been found to be degradable in leachate contaminated groundwater, but degradation rates under anaerobic redox conditions have only been determined in a few cases. Apparently, observations in actual plumes indicate more extensive degradation than has been documented in the laboratory. The behavior of cations in leachate plumes is strongly influenced by exchange with the sediment, although the sediment often is very coarse and sandy. Ammonium seems to be subject to anaerobic oxidation, but the mechanisms are not yet understood. Heavy metals do not seem to constitute a significant pollution problem at landfills, partly because the heavy metal concentrations in the leachate often are low, and partly because of strong attenuation by sorption and precipitation. Although complexation of heavy metals with dissolved organic matter is significant, the heavy metals are in most cases still strongly attenuated in leachate-polluted aquifers. The information available on attenuation processes has increased dramatically during the last 15 a, but the number of well-documented full scale leachate plumes are still few and primarily from sandy aquifers. Thus, the diversity of attenuation processes in leachate plumes is probably not yet fully understood. Apparently, the attenuation processes in leachate plumes may for many contaminants provide significant natural remediation, limiting the effects of the leachate on the groundwater to an area usually not exceeding 1000 m from the landfill.

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Co-sintering of treated APC-residues with bottom ash

Air pollution control residues stabilised by means of the Ferrox process can be safer disposed of due to lower contents of soluble salts and less soluble heavy metals stabilised in iron oxides. Co-combustion tests in the Karlsruhe test incinerator TAMARA were carried out in order to investigate the influence of co-sintering of Ferrox products with bottom ashes on the quality of the residues and the effects on the combustion process. Only few elements showed higher concentrations in the bottom ashes of these co-combustion tests compared to reference tests. No significant effect on the leaching behaviour of the bottom ashes could be found. During the co-combustion process an increase in SO2 concentrations in the raw gas and slightly lower temperatures in the fuel bed could be observed.

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Organisations: Department of Environmental Engineering
Authors: Bergfeldt, B. (Ekstern), Jensen, D. L. (Intern), Vehlow, J. (Ekstern), Mogensen, E. (Ekstern), Christensen, T. H. (Intern)
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Co-sintering of treated APC-residues with bottom ash

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Ferroxprocessen - en miljøforbedrende stabiliseringsmetode for roggasrensningsprodukter fra affaldsforbrænding

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High temperature co-treatment of bottom ash and stabilized fly ashes from waste incineration

Bottom ashes from two Danish municipal solid waste incineration plants were heated at 900 degreesC with iron oxide stabilized air pollution control residues at actual mass flow ratios (9:1), simulating a treating method for the residues. The two residues were cotreated, producing one combined stream that may be utilized as a secondary road construction material. Scanning electron microscope analysis and grain size distribution analysis indicated that sintering of the particles did not occur. Batch leaching tests at liquid/solid 10 l/kg at a range of pH-values (6-10) quantified with respect to Cd, Cr and Pb revealed significant positive effects of co-heating the ashes, although Pb showed slightly increased leaching. At a liquid/solid ratio of 10 l/kg the leachate concentrations were still low at pH 7-10 and the release of Pb was, thus, not expected to limit the utilization of the mixed ashes. The process, thus, fixes the metals in the solid residues without altering the leaching properties of the bottom ash too significantly. (C) 2001 Elsevier Science Ltd. All rights reserved.

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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
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Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.822 SNIP 2.435 CiteScore 3.39
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BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.698 SNIP 2.085 CiteScore 2.99
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Scopus rating (2010): SJR 1.555 SNIP 1.78
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Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.035 SNIP 1.767
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.046 SNIP 1.749
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.059 SNIP 1.65
Scopus rating (2004): SJR 1.289 SNIP 1.939
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.847 SNIP 1.269
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.561 SNIP 0.874
Scopus rating (2001): SJR 0.456 SNIP 0.696
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Performance of the ferrox-process on a semi-industrial scale

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The ferrox-process in an industrial scale - Developing a stabilisation process for air pollution control residues from municipal solid waste incineration

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Behandling af røggasrensningsprodukter fra affaldsforbrænding

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Leachability of heavy metals from scrap dirt sampled at two scrap iron and metal recycling facilities

Column and batch leaching experiments were performed to quantify leaching of heavy metals (Pb, Cu, Cd and Zn) from scrap dirt representing different activities at two iron scrap and metal recycling facilities. The scrap dirt is often found directly upon the bare unprotected soil at recycling facilities. In most cases the leaching of heavy metals was modest, within five times the leaching from reference soils, and the concentrations were usually within a factor of 2 of drinking water criteria. The high pH of the scrap dirt samples seemed to control the leaching. However, scrap dirt from car battery salvage locations was different, showing lower pH and significant leaching of lead (up to 8000 mg Pb l⁻¹), cadmium (up to 40 mg Cd l⁻¹), and zinc (up to 2000 mg Zn l⁻¹). The column and batch leaching experiments gave comparable results at the order of magnitude level, and both approaches are, at that level, useful for evaluation of leaching potentials from scrap dirt. The experiments showed that scrap dirt at recycling facilities constitutes only a modest leaching problem, but a long-term soil pollution problem from a land-use perspective. Leaching experiments with compost solution indicated that covering of the scrap dirt with an organic rich dressing for vegetation support would dramatically increase the leaching of heavy metals.
On-site treatment and landfilling of MSWI air pollution control residues

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Organic halogens in landfill leachates

Using a group parameter, total organic halogens (TOX), high TOX concentrations were found in leachates and leachate contaminated groundwaters at two Danish mixed sanitary and hazardous waste sites. With commonly used screening procedures for organic contaminants, the individual halogenated organic compounds behind the high TOX could not be found. Conversely, part of the TOX could be attributed to halogenated humic substances that cannot be analysed with conventional organic contaminant analyses. Even though TOX can still be considered an indicator of leachate contamination in the aquifers, attempts to identify the halogenated contaminants behind the TOX using screening methods such as GC-MS will be unsuccessful in most cases.

General information

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BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.8
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Scopus rating (2012): CiteScore 1.81
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Scopus rating (2011): CiteScore 1.72
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Soil and groundwater contamination with heavy metals at two scrap iron and metal recycling facilities

Field studies were performed at two actual scrap iron and metal recycling facilities in order to evaluate the extent of heavy metal migration into subsoil and groundwater caused by more than 25 years of handling scrap directly on the ground without any measures to prevent leaching. Surface soil samples, called 'scrap dirt', representing the different activities on the two recycling facilities, all showed very high concentrations of lead (Pb), copper (Cu) and zinc (Zn), high concentrations of cadmium (Cd), chromium (Cr) and nickel (Ni) and somewhat elevated concentrations of many other metals. In particular high concentrations were found for Pb at the car-battery salvage locations (13 to 26 g Pb kg⁻¹) and Cu at the cable burning location (22 g Cu kg⁻¹) at one site. The migration of metals below the surface in general (except at the car-battery salvage locations) was very limited even after approximately 25 years of activity. Soil and soil water profiles all showed elevated concentrations in the upper 40 cm but below this depth the soil concentrations as well as the soil water concentrations of metals were comparable with the concentrations found in uncontaminated reference profiles. The retention of the metals in the upper part of the profile was supposedly due to sorption as well as precipitation processes. At one site the metals had migrated to 80 cm depth at the car battery salvage location and at the other site with coarse sandy subsoils, elevated concentrations of Pb, Zn, and Cd were found in the groundwater 3 m below the ground surface. In the unsaturated soil, pH had decreased to about 3.5, facilitating the migration of the metals. This low pH value was presumably caused by the acids from the car batteries. The investigation concluded that the risk of metal migration to the groundwater is limited as long as pH stays high (above pH 6.5) in the top soils containing very high metal concentrations. The now abandoned car battery salvage operated directly on the ground surface has led to very high concentrations of metals in the soil and migration of metals that may affect the groundwater. However, the extent of the metal plume in the groundwater was not investigated.

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Scopus rating (2015): SJR 0.617 SNIP 0.899 CiteScore 1.53
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.741 SNIP 1.085 CiteScore 1.28
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Stabilization of waste incinerator APC-residues with FeSO4

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**Binding of trace metals to iron oxides-stabilization of incineration residues. Abstract**

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**Colloidal and dissolved metals in leachates from four Danish landfills**

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Main Research Area: Technical/natural sciences

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Web of Science (2016): Indexed yes
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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.957 SNIP 2.727 CiteScore 6.13
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
On-site treatment and landfilling of MSWI air pollution control residues

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Lundtorp, K. (Ekstern), Jensen, D. (Intern), Sørensen, M. (Intern), Christensen, T. (Intern)
Publication date: 1999

Host publication information
Title of host publication: Sardinia 99 (eds.: Christensen, T.H., Cossu, R., Stegmann, R.)
Place of publication: Cagliari, Italy
Publisher: CISA, Environmental Sanitary Engineering Centre
Main Research Area: Technical/natural sciences
Speciation of heavy metals in landfill-leachate plume

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Jensen, D. (Intern), Ledin, A. (Intern), Christensen, T. (Intern)
Publication date: 1999

Host publication information
Title of host publication: Sardinia 99 (eds.: Christensen, T.H., Cossu, R., Stegmann, R.)
Place of publication: Cagliari, Italy
Publisher: CISA, Environmental Sanitary Engineering Centre
Main Research Area: Technical/natural sciences
Conference: Seventh International Waste Management and Landfill Symposium, 4-8 October, Proceedings, Vol. IV, S. Margherita di Pula, Cagliari, Sardinia, 01/01/1999

Speciation of heavy metals in landfill-leachate polluted groundwater

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Jensen, D. (Intern), Ledin, A. (Intern), Christensen, T. (Intern)
Pages: 2642 - 2650
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: Water Research
Volume: 33
Issue number: 11
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Web of Science (2016): Indexed yes
Scopus rating (2016): CiteScore 7.49 SJR 2.629 SNIP 2.558
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.689 SNIP 2.507 CiteScore 6.63
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.957 SNIP 2.727 CiteScore 6.13
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.693 CiteScore 6.02
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.966 SNIP 2.456 CiteScore 5.15
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Speciation of heavy metals in landfill-leachate polluted groundwater. Abstract

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Jensen, D. (Intern), Ledin, A. (Intern), Christensen, T. (Intern), Wenzel, W. A. (Ekstern)
Publication date: 1999

Host publication information
Title of host publication: Speciation of heavy metals in landfill-leachate polluted groundwater. Abstract
Place of publication: Wien
Publisher: Universität für Bodenkultur
Main Research Area: Technical/natural sciences
Conference: 5th International Conference on the Biogeochemistry of Trace Elements, July 11-15, Proceedings of Extended Abstracts, Volume II, Vienna, 01/01/1999
Source: orbit
Source-ID: 172996
Publication: Research › Article in proceedings – Annual report year: 1999

Stabilization of APC-residues with FeSO4

General information
Stabilization of APC-residues with FeSO4

Abstract

State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Lundtorp, K. (Intern), Jensen, D. L. (Intern), Sørensen, M. A. (Intern), Mogensen, E. (Ekstern), Christensen, T. H. (Intern)
Publication date: 1999

Host publication information
Title of host publication: Sardinia 99
Publisher: CISA, Environmental Sanitary Engineering Centre
Place of publication: Cagliari, Italy
Editors: Christensen, T. H., Cossu, R., Stegmann, R.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 172944
Publication: Research - peer-review › Article in proceedings – Annual report year: 1999

Stabilization of APC-residues with FeSO4

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Lundtorp, K. (Intern), Jensen, D. L. (Intern), Sørensen, M. A. (Intern), Mogensen, E. (Ekstern), Christensen, T. H. (Intern), Wenzel, W. A. (Ekstern)
Publication date: 1999

Host publication information
Title of host publication: 5th International Conference on the Biogeochemistry of Trace Elements, July 11-15, Proceedings of Extended. Abstracts
Volume: II
Publisher: Universität für Bodenkultur
Place of publication: Wien
Main Research Area: Technical/natural sciences
Conference: 5th International Conference on the Biogeochemistry of Trace Elements : July 11-15, Vienna, 01/01/1999
Source: orbit
Source-ID: 172999
Publication: Research › Article in proceedings – Annual report year: 1999

Stabilization of APC-residues with FeSO4

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Lundtorp, K. (Intern), Jensen, D. L. (Intern), Sørensen, M. A. (Intern), Mogensen, E. P. B. (Ekstern), Christensen, T. H. (Intern)
Publication date: 1999

Host publication information
Title of host publication: Proceedings of the 2nd International Symposium on Incineration and Flue Gas Treatment Technologies. 4-6 July, Flue Gas Treatment
Place of publication: Sheffield
Publisher: IchemE, University of Sheffield
Main Research Area: Technical/natural sciences
Conference: 2nd International Symposium on Incineration and Flue Gas Treatment Technologies. 4-6 July, Flue Gas Treatment, Sheffield, 01/01/1999
Source: orbit
Source-ID: 172945
Publication: Research - peer-review › Article in proceedings – Annual report year: 1999

Stabilization of APC-residues with FeSO4

General information
Characterization of the dissolved organic carbon in landfill leachate-polluted groundwater

Samples of dissolved organic carbon (DOC) were obtained from landfill leachate-polluted groundwater at Vejen Landfill, Denmark. The humic acids, fulvic acids and the hydrophilic fraction were isolated and purified. Based on DOC measurements, the fulvic acid fraction predominated, accounting for about 60% of the total amount of DOC with an apparent molecular weight of about 1800 Da. The hydrophilic fraction constituted about 30% of the total amount of DOC with an apparent molecular weight of about 2100 Da, and the humic acid fraction made up about 10% of the total amount of DOC with an apparent molecular weight of about 2600 Da. The elemental compositions of the humic acids, fulvic acids and the hydrophilic fraction were in the ranges typical for humic substances from other origins. The O/C ratios for humic acids, fulvic acids and the hydrophilic fraction were in the ranges typical for humic substances from other origins. The O/C ratios were slightly higher than reported in the literature, indicating a high content of carboxylic groups, phenolic groups or carbohydrates. Acid-base titration indicated that, in the fulvic acids and the hydrophilic fraction, carboxylic acids were the dominating functional group, representing about 6 meq g(-1). The weakly acidic groups in fulvic acids and the hydrophilic fraction represented about 1 and 3 meq g(-1), respectively. The total acidity in fulvic acids and the hydrophilic fraction accounted for 48-57% of the O/C ratio. In the humic acids, carboxylic groups made up about 3 meq g(-1) and the weakly acidic groups made up about 1.5 meq g(-1). The total acidity accounted for 29-32% of the O/C ratio. The characterization of DOC in leachate-polluted groundwater in terms of humic acids, fulvic acids and hydrophilic fraction showed that the hydrophilic fraction resembles, in many ways, humic and fulvic acids; thus, a distinction between the fractions may be related to the methods only and be of little practical value. The three fractions constituting the DOC content in a sample should all be considered when evaluating processes such as metal complexation and transport of metals and hydrophobic, organic contaminants. (C) 1998 Elsevier Science Ltd. All rights reserved.
Volume: 32
Issue number: 1
ISSN (Print): 0043-1354
Ratings:
  BFI (2018): BFI-level 2
  Web of Science (2018): Indexed yes
  BFI (2017): BFI-level 2
  Web of Science (2017): Indexed yes
  BFI (2016): BFI-level 2
  Scopus rating (2016): CiteScore 7.49 SJR 2.629 SNIP 2.558
  Web of Science (2016): Indexed yes
  BFI (2015): BFI-level 2
  Scopus rating (2015): SJR 2.689 SNIP 2.507 CiteScore 6.63
  Web of Science (2015): Indexed yes
  BFI (2014): BFI-level 2
  Scopus rating (2014): SJR 2.957 SNIP 2.727 CiteScore 6.13
  Web of Science (2014): Indexed yes
  BFI (2013): BFI-level 2
  Scopus rating (2013): SJR 2.956 SNIP 2.693 CiteScore 6.02
  ISI indexed (2013): ISI indexed yes
  Web of Science (2013): Indexed yes
  BFI (2012): BFI-level 2
  Scopus rating (2012): SJR 2.966 SNIP 2.456 CiteScore 5.15
  ISI indexed (2012): ISI indexed yes
  Web of Science (2012): Indexed yes
  BFI (2011): BFI-level 2
  Scopus rating (2011): SJR 2.867 SNIP 2.374 CiteScore 5.43
  ISI indexed (2011): ISI indexed yes
  Web of Science (2011): Indexed yes
  BFI (2010): BFI-level 2
  Scopus rating (2010): SJR 2.582 SNIP 2.196
  Web of Science (2010): Indexed yes
  BFI (2009): BFI-level 2
  Scopus rating (2009): SJR 2.319 SNIP 2.225
  Web of Science (2009): Indexed yes
  BFI (2008): BFI-level 2
  Scopus rating (2008): SJR 2.065 SNIP 2.19
  Web of Science (2008): Indexed yes
  Scopus rating (2007): SJR 1.994 SNIP 2.208
  Web of Science (2007): Indexed yes
  Scopus rating (2006): SJR 1.695 SNIP 2.214
  Web of Science (2006): Indexed yes
  Scopus rating (2005): SJR 2.114 SNIP 2.337
  Web of Science (2005): Indexed yes
  Scopus rating (2004): SJR 2.227 SNIP 2.106
  Web of Science (2004): Indexed yes
  Scopus rating (2003): SJR 1.696 SNIP 1.917
  Web of Science (2003): Indexed yes
  Scopus rating (2002): SJR 1.54 SNIP 1.775
  Web of Science (2002): Indexed yes
  Scopus rating (2001): SJR 1.321 SNIP 1.711
  Web of Science (2001): Indexed yes
  Scopus rating (2000): SJR 1.305 SNIP 1.688
  Web of Science (2000): Indexed yes
Speciation of dissolved iron(II) and manganese(II) in a groundwater pollution plume

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Jensen, D. L. (Intern), Boddum, J. K. (Intern), Redemann, S. (Ekstern), Christensen, T. H. (Intern)
Pages: 2657-2664
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Science and Technology
Volume: 32
Issue number: 18
ISSN (Print): 1382-3124
Ratings:
Web of Science (2018): Indexed yes
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Web of Science (2005): Indexed yes
Web of Science (2004): Indexed yes
Web of Science (2001): Indexed yes
Web of Science (2000): Indexed yes
Original language: English
Source: orbit
Source-ID: 171462
Publication: Research - peer-review › Journal article – Annual report year: 1998

Characterization of Colloids and Trace Elements Associated with Colloids in Landfill Leachates at Four Danish Landfills

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Jensen, D. (Intern), Christensen, T. (Intern)
Publication date: 1997

Host publication information
Title of host publication: Characterization of colloids and trace elements associated with colloids in landfill leachates at four Danish landfills
Place of publication: Hanover, NH
Publisher: U.S. Army Cold Regions Research and Engineering Laboratory,
Main Research Area: Technical/natural sciences
Conference: 4th International Conference on the Biogeochemistry of Trace Elements, Berkeley, CA, United States, 23/06/1997 - 23/06/1997
Source: orbit
Source-ID: 169692
Publication: Research - peer-review › Article in proceedings – Annual report year: 1997

In-situ fixation as remediation of lead pollution in groundwater: A model aquifer study

General information
State: Published
Host publication information
Title of host publication: In-situ fixation as remediation of lead pollution in groundwaters: A model aquifer study
Place of publication: Hanover, NH
Publisher: U.S. Army Cold Regions Research and Engineering Laboratory
Main Research Area: Technical/natural sciences
Conference: 4th International Conference on the Biogeochemistry of Trace Elements, Berkeley, CA, United States, 23/06/1997 - 23/06/1997
Source: orbit
Source-ID: 169685
Publication: Research - peer-review › Article in proceedings – Annual report year: 1997

Kolloidt og opløst metal i lossepladsperkolat. Undersøgelse af 4 danske lossepladser

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Jensen, D. (Intern), Christensen, T. (Intern)
Pages: 24 - 28
Publication date: 1997
Main Research Area: Technical/natural sciences

Publication information
Journal: INFO-NYT
Issue number: 16
Original language: Danish
Source: orbit
Source-ID: 169752
Publication: Research › Journal article – Annual report year: 1997

Speciation of heavy metals in landfill leachate

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Jensen, D. (Intern), Christensen, T. (Intern)
Publication date: 1997

Host publication information
Title of host publication: Speciation of heavy metals in landfill leachate
Place of publication: Cagliari, Italy
Publisher: CISA, Environmental Sanitary Engineering Centre
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 169693
Publication: Research - peer-review › Article in proceedings – Annual report year: 1997

Effect of dissolved organic carbon on the mobility of cadmium, nickel and zinc in leachate polluted groundwater

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Christensen, J. (Intern), Jensen, D. (Intern), Christensen, T. (Intern)
Pages: 3037 - 3049
Publication date: 1996
Main Research Area: Technical/natural sciences

Publication information
Kompleksering og mobilitet af tungmetaller

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Technical University of Denmark
Authors: Christensen, J. B. (Ekstern), Jensen, D. L. (Intern), Christensen, T. H. (Intern), Holm, P. E. (Intern)
Pages: 179-190
Publication date: 1994

Host publication information
Title of host publication: ATV Møde: Vintermøde om grundvandsforurening
Place of publication: Bredsten
Publisher: Akademiet for de Tekniske Videnskaber, ATV
Main Research Area: Technical/natural sciences
Conference: ATV Møde: Vintermøde om grundvandsforurening, Bredsten, Denmark, 08/03/1994 - 08/03/1994
Source: orbit
Source-ID: 317589
Publication: Research › Article in proceedings – Annual report year: 1994

Opløste humuslignende stoffer betydning for tungmetallers opløselighed og mobilitet

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Residual Resource Engineering, Technical University of Denmark
Authors: Christensen, J. B. (Ekstern), Jensen, D. L. (Intern), Holm, P. E. (Intern), Christensen, T. H. (Intern)
Pages: 61-74
Publication date: 1994

Host publication information
Title of host publication: ATV Møde: Forskningsprojekter vedrørende grundvandsforurening
Place of publication: Danmark
Publisher: Akademiet for de Tekniske Videnskaber, ATV
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 317247
Publication: Research › Article in proceedings – Annual report year: 1994

Udvaskning af metaller fra metalgevindingspladser

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Residual Resource Engineering, Technical University of Denmark
Authors: Jensen, D. L. (Intern), Holm, P. E. (Intern), Futtrup, J. (Ekstern), Christensen, T. H. (Intern)
Pages: 49-59
Publication date: 1994

Host publication information
Title of host publication: ATV Møde: Forskningsprojekter vedrørende grundvandsforurening
Place of publication: Danmark
Publisher: Akademiet for de Tekniske Videnskaber, ATV
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 317241
The Influence of Dissolved Humic Like Materials on the Solubility and Mobility of Heavy Metals

General information
State: Published
Organisations: Department of Environmental Engineering, Department of Environmental Science and Engineering, Technical University of Denmark
Authors: Christensen, J. B. (Ekstern), Jensen, D. L. (Intern), Christensen, T. H. (Intern), Holm, P. E. (Intern)
Pages: 34-40
Publication date: 1993

Host publication information
Title of host publication: Proceedings of Meeting on Danish Soil Organic Matter Research at Research Centre Foulum
Place of publication: Tjele
Publisher: Danish Society of Soil Sceince & Research Centre Foulum
Main Research Area: Technical/natural sciences
Conference: Meeting on Danish Soil Organic Matter Research at Research Centre Foulum, Tjele, Denmark, 01/01/1993
Source: orbit
Source-ID: 315619
Publication: Research - peer-review › Article in proceedings – Annual report year: 1993

Projects:

Prediction of Leaching from Waste Incineration Residues
Department of Environmental Engineering
Period: 01/10/2004 → 01/09/2008
Number of participants: 6
Phd Student:
Hyks, Jiri (Intern)
Supervisor:
Astrup, Thomas Fruergaard (Intern)
Main Supervisor:
Christensen, Thomas Højlund (Intern)
Examiner:
Jakobsen, Rasmus (Intern)
Jensen, Dorthe Lærke (Intern)
Johnson, Carola Annette (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Eksternt finansieret virksomhed
Project: PhD

Treatment of residues from solid waste incineration
Incineration is the most common waste treatment and disposal method for municipal and industrial solid waste in Denmark. Solid residues are generated in terms of bottom ash and APC (air pollution control) solids (fly ashes and acid flue gas cleaning products). The bottom ashes are primarily used for construction purposes while the APC solids are landfilled or temporarily stored until permanent landfills are approved. All the residues from incineration should be utilized or landfilled by sustainable methods without adverse impacts on the environment. One of the main environmental concerns is the short term (few years) as well as long term (centuries) leaching of salts and heavy metals from construction material containing residues or from waste residue landfills. The aim of this project is to develop technologies for bottom ashes as well as for APC products based on combinations of washing and chemical stabilization. Currently focus is on APC solids and washing followed by stabilization by ironoxides. This leads to a reduction in the leaching of salts by partial removal and a permanent binding of heavy metals in the treated solids. Utilization by incorporation into ceramics is currently being considered.

Department of Environmental Engineering
Period: 01/12/1997 → 30/08/2000
Number of participants: 6
Acronym: 90
Project ID: 30020
Project participant:
- Skov, Bent Henning (Intern)
- Jensen, Dorthe Lærke (Intern)
- Lundtorp, Kasper (Intern)
- Sørensen, Mette Abildgaard (Intern)
- Duhring, Pernille Bayard (Intern)

Project Manager, organisational:
- Christensen, Thomas Højlund (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 1,512,000.00 Danish Kroner

Project: Stabilisation of residues from solid waste incineration
Department of Environmental Engineering
Period: 01/10/1997 → 30/10/2001
Number of participants: 7
Phd Student:
- Lundtorp, Kasper (Intern)
Supervisor:
- Jensen, Dorthe Lærke (Intern)
Mogensen, Erhardt (Ekstern)
Main Supervisor:
- Christensen, Thomas Højlund (Intern)
Examiner:
- Kjeldsen, Peter (Intern)
Hjelmar, Ole (Ekstern)
Johnson, Carola Annette (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Erhvervsforskerordningen
Project: PhD

Treatment of residues from solid waste incineration
Incineration is the most common waste treatment and disposal method for municipal and industrial solid waste in Denmark. Solid residues are generated in terms of bottom ash and APC (air pollution control) solids (fly ashes and acid flue gas cleaning products). The bottom ashes are primarily used for construction purposes while the APC solids are landfilled or temporarily stored until permanent landfills are approved. All the residues from incineration should be utilized or landfilled by sustainable methods without adverse impacts on the environment. One of the main environmental concerns is the short term (few years) as well as long term (centuries) leaching of salts and heavy metals from construction material containing residues or from waste residue landfills. The aim of this project is to develop technologies for bottom ashes as well as for APC products based on combinations of washing and chemical stabilization. Currently focus is on APC solids and washing followed by stabilization by iron oxides. This leads to a reduction in the leaching of salts by partial removal and a permanent binding of heavy metals in the treated solids. Extensive laboratory studies are being carried out and currently a pilot-plant is being constructed.

Department of Environmental Science and Engineering
Department of Environmental Engineering
Ansaldo Vølund A/S
University of Copenhagen
Royal Veterinary and Agricultural University
University of Washington
Period: 01/09/1997 → 30/08/2000
Number of participants: 11
Iron and manganese in an anaerobic leachate plume
In the strongly anaerobic part of the leachate plume at the Grindsted Landfill very high concentrations of dissolved iron and manganese have been observed consistently; for example iron was found in concentrations exceeding 200 mg/l. Samples carefully obtained from the plume have been characterized in terms of colloidal content (cross flow filtration) and free ferro-ion activity (ion exchange resin technique). The results surprisingly suggest that more than 70% of the measured iron concentrations are due to free ferro-ions. This suggests strongly supersaturated conditions in the plume and currently the thermodynamic data for siderite (FeCO3 is being revisited and supplementary measurements made.

Leaching of heavy metals from soils
Quality criteria for soils with respect to heavy metals have traditionally focused on the environmental issues related to the land use (ingestion of soil, skin contact, etc.) and very little attention has been given to protection of the groundwater. The complex form of heavy metals in polluted soils makes prediction of leachability difficult and leaching experiments or leaching test are usually the only way to assess the amount of metal to leach from the soil. Model scenarios are being developed to evaluate heavy metal leaching in the context of groundwater protection and allow for simplified methods to account for groundwater quality criteria, depth and location of polluted soil, reduction in infiltration and leachable amounts determined in leaching test. Experimental studies have been performed at actual sites and leaching experiments are conducted in the laboratory.
**Leaching of heavy metals from soils.**

Quality criteria for soils with respect to heavy metals have traditionally focused on the environmental issues related to the land use (ingestion of soil, skin contact, etc.) and very little attention has been given to protection of the groundwater. The complex form of heavy metals in polluted soils makes prediction of leachability difficult and leaching experiments or leaching test are usually the only way to assess the amount of metal to leach from the soil. Model scenarios are being developed to evaluate heavy metal leaching in the context of groundwater protection and allow for simplified methods to account for groundwater quality criteria, depth and location of polluted soil, reduction in infiltration and leachable amounts determined in leaching test. Experimental studies have been performed at actual sites and leaching experiments are conducted in the laboratory.

**Department of Environmental Engineering**
Period: 01/01/1996 → 31/12/1998
Number of participants: 5
Acronym: 10
Project participant:
Foverskov, Anja (Intern)
Jensen, Dorthe Lærke (Intern)
Kjeldsen, Peter (Intern)
Astrup, Thomas Fruegaard (Intern)
Project Manager, organisational:
Christensen, Thomas Højlund (Intern)

**Colloids in landfill leachate**

Heavy metal contents of landfill leachate sometimes are unexpectedly high. This may be related to the presence of colloidal matter with high metal contents that, due to lack of strict protocols on sampling and solid separation, some times are found in the sampled leachate. Leachate has been sampled by special techniques at four Danish full scale landfills and the colloidal content (down to about 1 nm) has been characterized. The four leachates had low contents of heavy metals except high concentrations of zinc in one leachate sample. A substantial part of the heavy metals were associated with the colloidal matter suggesting that the presence of colloidal matter in leachate samples may cause high metal concentrations. Sampling protocols should precisely specify the filtration procedures for leachate sampling.

**Department of Environmental Science and Engineering**
Period: 01/10/1995 → 30/05/1998
Number of participants: 4
Project participant:
Jensen, Dorthe Lærke (Intern)
Ledin, Anna (Intern)
Hauritz, Anita (Intern)
Project Manager, organisational:
Christensen, Thomas Højlund (Intern)
Colloids in landfill leachate
Heavy metal contents of landfill leachate sometimes are unexpectedly high. This may be related to the presence of colloidal matter with high metal contents that, due to lack of strict protocols on sampling and solid separation, some times are found in the sampled leachate.

Department of Environmental Engineering
Period: 01/08/1994 → 30/04/1998
Number of participants: 3
Acronym: 4
Project participant:
Hauritz, Anita (Intern)
Jensen, Dorthe Lærke (Intern)
Project Manager, organisational:
Christensen, Thomas Højlund (Intern)

Tungmetallers binding i affaldsdeponier
Department of Environmental Engineering
Number of participants: 4
Phd Student:
Jensen, Dorthe Lærke (Intern)
Main Supervisor:
Christensen, Thomas Højlund (Intern)
Examiner:
Bjerg, Poul Løgstrup (Intern)
Hansen, Hans Chr. B. (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-Su Stipendium, Eksperiment
Project: PhD