Calibration of the comprehensive NDHA-N₂O dynamics model for nitrifier-enriched biomass using targeted respirometric assays - DTU Orbit (02/05/2019)

Calibration of the comprehensive NDHA-N₂O dynamics model for nitrifier-enriched biomass using targeted respirometric assays

The NDHA model comprehensively describes nitrous oxide (N₂O) 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 N₂O additions under aerobic and anaerobic conditions were tracked with continuous measurement of dissolved oxygen (DO) and N₂O. 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 N₂O 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 N₂O 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 N₂O 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 N₂O production, which is expected to benefit N₂O model discrimination studies and reliable full scale applications.

General information
Publication status: Published
Organisations: Department of Environmental Engineering, Water Technologies, Department of Chemical and Biochemical Engineering, PROSYS - Process and Systems Engineering Centre, Technical University of Denmark
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Pages: 29-39
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Water Research
Volume: 126
ISSN (Print): 0043-1354
Ratings:
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.55 SJR 2.601 SNIP 2.358
Web of Science (2017): Impact factor 7.051
Web of Science (2017): Indexed yes
Original language: English
Keywords: Nitrous oxide, Respirometry, Uncertainty, Modelling, Parameter estimation
DOIs: 10.1016/j.watres.2017.09.013
Source: FindIt
Source-ID: 2374285368
Research output: Contribution to journal » Journal article – Annual report year: 2017 » Research » peer-review