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MATHEMATICAL MODELLING OF PRIMARY SLUDGE ANAEROBIC HYDROLYSIS

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EXTENDED ABSTRACT

Biological nitrogen and phosphorus removal requires readily biodegradable organic carbon. Introduction of a primary treatment stage such as sedimentation or chemically enhanced sedimentation reduces the organic load entering the biological stage. In order to counteract this loss, an anaerobic primary sludge biological hydrolysis process may be introduced to produce readily biodegradable carbon. The quantities of soluble carbon produced according to this process, may be added in the biological stage, in order to enhance biological nutrient removal processes (BNR). The resulting increased rates of denitrification or enhanced biological phosphorous removal can lead to reduced reactor volume requirements and lower effluent nutrient concentrations.

The aim of this work was the application and evaluation of a mathematical model for the simulation of anaerobic hydrolysis and acid production processes. For the description of the processes involved the Anaerobic Digestion Model ADM1 (IWA, 2002) was employed. The ADM1 is a generic model for anaerobic digestion and it is a very useful tool for full-scale anaerobic digestors design, operation and optimization. Its implementation in prefermenters is relatively easy, but the estimation of its components concentrations, kinetic parameters and stoichiometric coefficients, remains a problem to be solved. This study provides useful results for the ADM1 implementation in acid digesters design and operation.

Model calibration and verification was performed using experimental data from two bench scale acid digesters operating at different temperatures (12, 20, 27 and 34 °C) and retention times (1,2, 4 and 6 days). Model sensitivity analysis illustrated that the values of pH, disintegration kinetic parameter and aceticlastic methanogenesis specific rate, as well as biomass and inert soluble COD concentrations in the primary sludge exert a significant influence on soluble COD production. Model parameters (disintegration and hydrolysis kinetic parameters and specific rate of methane production) as well as the temperature dependency of these parameters are given in this paper. Model prediction was quite satisfactory and the values of kinetic rates and temperature coefficients were comparable with similar values reported in the literature.

Key words: mathematical modelling, anaerobic sludge hydrolysis, prefermenter, biological nutrient removal.