ABSTRACT

Researchers at Rhodes University conducted investigations into the anaerobic co-disposal of primary sewage sludge (PSS) and high sulphate acid mine drainage (AMD) resulting in the development of the Rhodes BioSURE Process® which forms the basis for the operation of a pilot recycling sludge bed reactor (RSBR). Further research has been conducted by researchers at the University of Cape Town (UCT), with the principle aim of determining the rate of hydrolysis of PSS under methanogenic, acidogenic and sulphate reducing conditions in laboratory-scale anaerobic digesters.

The University of Cape Town's Anaerobic Digestion Model No.1 (UCTADM1) which integrates various biological anaerobic processes for the production of methane was extended with the development of a mathematical model incorporating the processes of biosulphidogenic reduction and the biology of sulphate reducing bacteria (SRB). Kinetic parameters used in the model were obtained from Sötemann et al. (2005b) and Kalyuzhnyi et al. (1998).

The WEST® software was used as a platform in translation of the basic UCTADM1 from AQUASIM, and subsequently applied to data sets from UCT laboratory experiments. Incomplete closure of mass balances was attributed to incorrect reaction stoichiometry inherited through translation of the AQUASIM model into WEST®. The WEST® implementation of the model to the experimental methanogenic systems gave fairly close correlations between predicted and measured data for a single set of stoichiometric and kinetic constants, with regressed hydrolysis rate constants. Application of the extended UCTADM1 to experimental sulphidogenic systems demonstrated simulation results reasonably close to measured data, with the exception of effluent soluble COD and sulphate concentrations. Except for a single system with a high COD:SO_4 ratio, sulphidogens are out competed for substrate by methanogens within the model. Therefore the model does not properly represent the competition between methanogenic and sulphidogenic organism groups.

Trends observed in application of the model to available pilot plant RSBR data were similar to those observed in sulphidogenic systems, resulting in methanogens out-competing sulphidogens. The model was used as a tool to explore various scenarios regarding operation of the pilot plant. Based on the work conducted in this study, various areas for further information and research were highlighted and recommended.