ABSTRACT

Municipal wastewater treatment plants are designed to treat domestic wastewater. Industrial wastewaters are accepted to sewer provided they do not adversely affect the performance of the wastewater treatment plant. Although by-laws have been promulgated to control the discharge of industrial wastes, they do not directly address the potential inhibitory nature of the discharge. The recalcitrant nature of most dyes, together with their toxicity to micro organisms, makes biological treatment difficult.

Municipal authorities have promoted the use of low environmental impact chemicals in the textile industry through a co-regulatory approach by scoring the textile chemicals. The objective of this investigation is to model the effects of textile industry wastewater, made up of dyes of different scores, on the performance of a wastewater treatment works (WWTW). The score system (Laursen et al., 2002) was used to choose a high and low scoring dye to be used in laboratory experiments. Batch respirometry was used as the experiment since it is a robust and sensitive method. The optimal experiment design method (Dochain and Vanrolleghem, 2001) was used in to design the batch respirometric experiment, the optimal batch respirometric experiment design provided rapid and reliable experimental data that was used in parameter estimation. Batch respirometric experiments were performed with dyes as the test substance, sodium acetate and ammonium chloride being the reference substrates, and activated sludge from Umbilo wastewater treatment works aeration basin. Performing batch respirometric experiments with a series of different dye concentrations of the dyes allowed the deduction of the dependence of the kinetic parameters on the dye concentrations. The results from the respirometric experiments performed with both dyes indicated that; the dyes have a greater inhibitory effect on the autotrophic biomass growth process as compared heterotrophic biomass growth process.

A Batch Respirometric Experiment (BRE) Model was created and the model calibration involved the assessment of the relevant bio-kinetic parameters. Biomass growth kinetic parameter estimations were performed using the measured data from the batch respirometric experiments, the BRE model and numerical optimisation algorithms provided in WEST software package. The results from the parameter estimation indicated that both dyes used in this investigation have a mixed inhibition effect on both heterotrophic and autotrophic biomass growth process.

Inhibition kinetics for both dyes were determined using the estimated kinetic parameters, thereafter the resultant inhibition kinetics was inputted into the activated sludge process model of the COST simulation benchmark model (Copp, 2002). The COST simulation benchmark protocol (Copp, 2002) was used to assess the impact of both dyes on the performance of the COST simulation benchmark wastewater treatment works model. The benchmark model has a fully defined protocol which provides an unbiased basis without reference to any particular wastewater treatment works. From the results of the COST benchmark simulations it was concluded that the high scoring dye had a great negative impact on the performance of the wastewater treatment works model as compared to the low scoring dye.