Characterisation of wastewater for modelling of wastewater treatment plants receiving industrial effluent

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ABSTRACT

Bio-process modelling is increasingly used in design, modification and troubleshooting of wastewater treatment plants (WWTPs). Characterisation of the influent wastewater to a WWTP is an important part of developing such a model. The characterisation required for modelling is more detailed than that routinely employed for monitoring WWTP operation. Wastewater characteristics depend on the sources within the catchment served by a particular WWTP, and the presence of industrial effluents can cause the wastewater to be significantly different from purely domestic effluent. eThekwini's wastewater treatment system is one of those most affected by industrial effluents in South Africa. Where industrial pollutants cause particular problems, additional measurements, beyond those standardly applied in sewage treatment, are required. Since influent characteristics vary from one catchment to another, this paper presents and compares results of influent wastewater characterisation from three municipal WWTPs, two of which are operated by eThekwini Water Services, which receive a combination of industrial and domestic wastewater. The paper also presents efforts to fractionate the influent COD of another WWTP run by eThekwini municipality and receiving a complex mixture of industrial and domestic effluent. The influent characterisation involves the determination of the volumes and concentrations of the carbonaceous, nitrogenous and phosphorus fractions in the wastewater, as well as other constituents present in the wastewater. This paper focuses on the carbonaceous fraction in the wastewater.

Keywords: influent characterisation, industrial effluent, process modelling

LIST OF ACRONYMS

ASM1	Activated sludge model number 1
ASM2	Activated sludge model number 2
ASM2d	Activated sludge model number 2d
ASM3	Activated sludge model number 3
BOD	Biological oxygen demand
COD	Chemical oxygen demand
DO	Dissolved oxygen
F/M	Food to mass ratio
IAWPRC	International Association on Water Pollution Research and Control
IAWQ	International Association on Water Quality
IWA	International Water Association
MLVSS	Mixed liquor volatile suspended solids
OUR	Oxygen uptake rate
RBCOD	Readily biodegradable COD
TSS	Total suspended solids
VSS	Volatile suspended solids
WWTP	Wastewater treatment plant
WWTW	Wastewater treatment works
WRC	Water Research Commission

LIST OF SYMBOLS AND UNITS

C_{TCOD}	Total chemical oxygen demand ($mgO_2 \cdot \ell^{-1}$)
S_I	Inert soluble substrate ($mgO_2 \cdot \ell^{-1}$)
S_S	Readily biodegradable substrate ($mgO_2 \cdot \ell^{-1}$)
X_{AUT}	Autotrophic biomass ($mgO_2 \cdot \ell^{-1}$)
X_H	Heterotrophic biomass ($mgO_2 \cdot \ell^{-1}$)
X_S	Slowly biodegradable biomass ($mgO_2 \cdot \ell^{-1}$)
X_I	Particulate inert organics ($mgO_2 \cdot \ell^{-1}$)
Y_H	Yield of heterotrophic biomass ($mgCOD \cdot mgCOD^{-1}$)

INTRODUCTION

Bio-process modelling is fundamental in designing and managing wastewater treatment plants (WWTPs). Process models for WWTPs find application in forecasting, fault detection, monitoring plant operations and research (Lindberg, 1997). At a fundamental level a model may be a conceptual image of how a system functions, which alone cannot provide sufficient information about the behaviour of the actual system. To learn more about the system a pilot plant can be constructed. However, the pilot plants may have limitations of time and resources which prevent exploration of all potentially feasible solutions of the system, hence the turn to mathematical models which allow relatively more exploration of the feasibility space (Henze et al., 1987).

The modelling of biological wastewater treatment systems has developed from fundamental concepts to mathematical models. The IAWPRC, later IAWQ and now IWA (International Water Association) Task Group (Henze et al., 1987, Henze et al., 2000) has introduced an activated sludge model suite (ASM1, ASM2, ASM2d, ASM3 and other models), which provides researchers and practitioners with a standard set of basic models for biological wastewater treatment processes. These standard models may be used as building blocks for more complex biological processes. Wastewater characterisation generates input data for the bioprocess models.

Wastewater characterisation is crucial in process modelling because the quality of the model's predictions depends on the

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