MODELING THE PERFORMANCE OF A MEMBRANE BIOREACTOR CONTROLLED BY AIR SPARGING

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keywords: Modeling, MBR, air-sparging, fouling

INTRODUCTION

A membrane bioreactor (MBR) combines biological treatment with the membrane separation technology. To improve the understanding of the MBR processes and know how, many researches were carried out suing the trial and error method and build the knowledge based on experiments. The problem with such an empirical research is that the results are difficult to generalize due to the complexity of the system. In the past, mechanistic mathematical models have proven their usefulness to understand processes of complex systems. A crucial step in calibrating these models is the collection of experimental data.

OBJECTIVES

The objective of long term study is to build a mechanistic model that is able to describe both the biological and filtration performance, with special attention to their mutual dependencies. The integral model will contain a submodel describing the biological processes and a submodel describing the filtration processes. The link between both submodels will be described by a third submodel, which describes hydrodynamics and the particle size distribution of the activated sludge. This work will mainly focus on the hydrodynamics and the filtration submodels, while the biological model is developed by Jiang (Jiang et al., 2005).

MATERIAL & METHODS

A lab scale MBR (figure 1) has been set up in 2005. The MBR of 29 L is a side stream type: the membrane unit is seperated from the bioreactor and the driving force to filter the sludge is a pressure difference over the membrane. The reactor removes COD, phosphorus and nitrogen from a synthetic sewage, which aims at mimicing a real pre-settled domestic wastewater (Boeije et al., 1998). The MBR consists of an anaerobic compartiment, an aerobic/anoxic compartment and a membrane loop. To control the membrane fouling the membrane is periodically backwashed and air is introcuced in the membrane to scour the membrane surface by means of a slug flow. All devices controlling the MBR set-up and performing the online measurements are connected to a Labview data acquisition and control (DAC) system. The online data (pH, DO, ORP, TMP, Temp) are stored in a PC, and offline measurements are performed on the sludge (MLSS, OUR, EPS, SMP) and the effluent (N, P, COD, ...). For the modelling work the simulation software WEST (Hemmis, Belgium) is used.

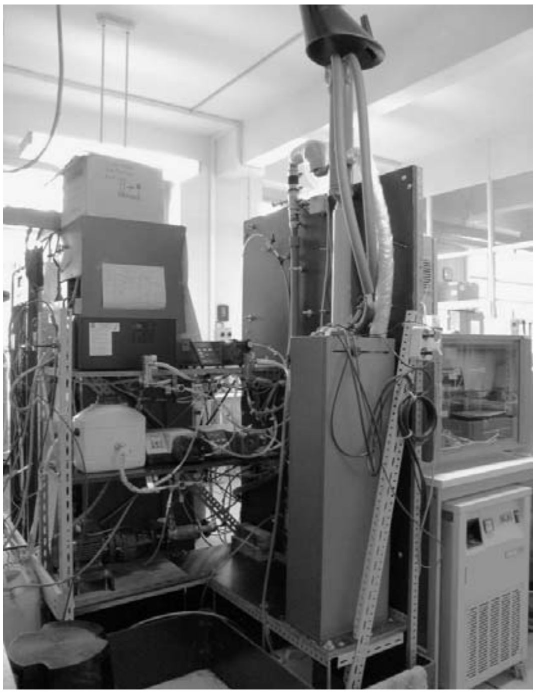

Figure 1. Lab scale MBR

RESULTS AND DISCUSSION

Effluent measurements shows that the COD is always lower than 20 mg/L. The influent COD is 495 mg/l; hence a removal efficiency of 96% is always reached in the MBR, which confirms the good performance of the labscale MBR.

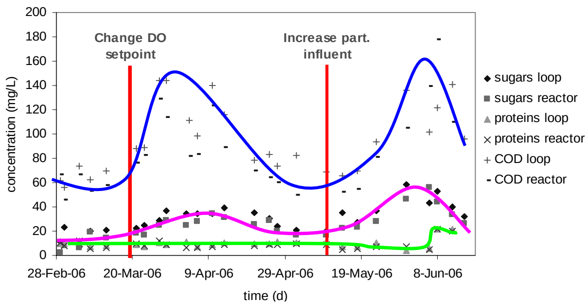

Figure 2. SMP (COD, proteins and polysaccharides) concentration in the reactor of the lab scale MBR during 5 moths

Soluble microbial products (SMP) are considered as substances with a high fouling potential for membranes, as such are they very important to describe the fouling process. A change in DO setpoint (from 1mg/L to 2 mg/L) caused a large increase in SMP content (figure 2), which was coupled with an increase of the membrane fouling (figure 3). A subsequent increase in particulate influent COD also resulted in an increase of SMP, however the membrane fouling remained the same. Hence the relationship between fouling and SMP changes is not straightforward and should be clarified before a mechanistic model can describe the fouling process. From figure 3 it is clear that a membrane cleaning during the intensive fouling period was not effective (first green line). When the fouling was decreasing, the membrane cleaning appeared again very effective (second green line).

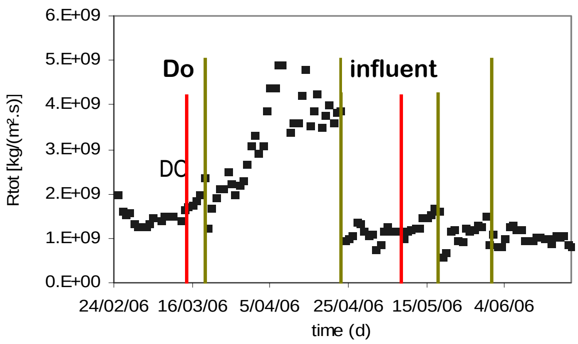

Figure 3. Fouling degree (Rtot) of the lab scale MBR during 5 moths. Red lines are process changes, green lines are membrane cleanings or membrane replacements

CONCLUSIONS

The processes responsible for the membrane fouling are influenced be changes in the SMP concentrations, but the influence of those SMP changes is not always straightforward. Hence, the fouling process is not only linked to SMP but also to other factors. These factors should be detected and investigated in order to build a model that can describe the fouling behaviour properly.

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