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A simplified model of a submerged membrane bioreactor

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1 Introduction

Nowadays, there is a rich literature about mathematical modeling of membrane bioreactors (MBR), mostly based on a detailed physical description, including aeration, cake formation, filtration, fouling [1] and biological activity [2]. These models however contain a large number of parameters to estimate and are too complex for process control. In this connection, there are only a few proposals based on empirical approaches or artificial neural network models. The motivation of this study is to derive a simplified model of a submerged MBR based on first principles and to analyze its dynamical behavior.

2 Simplified Model

A simple bioreactor model (equation 1), assuming a single biomass at this preliminary stage, is coupled with a dynamic model representing the cake formation. Most authors agree on the fact that the most important factor is the cake resistance [3].

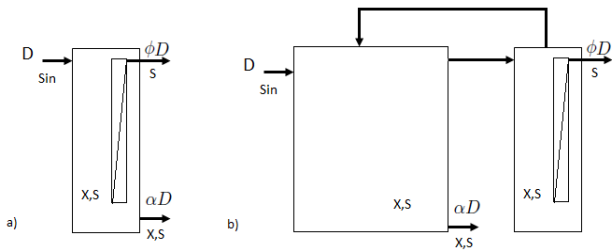


Figure 1: a) Simplified membrane bioreactor, $\phi = \frac{J(m(t))A}{V}$ is the permeate flux factor and α is the waste factor. b) Different representation for the same model.

$$\begin{cases} \frac{dS}{dt} = -\frac{1}{V}\mu(S)X + \frac{Q_{in}}{V}S_{in} - \frac{Q_{in}}{V}\alpha S - \frac{J(m(t))A}{V}S \\ \frac{dX}{dt} = (\mu(S) - \alpha \frac{Q_{in}}{V})X - \frac{J(m(t))A}{V}X + \beta \frac{J_{air}}{V} \frac{m^2}{K_{air} + m} \\ \frac{dm}{dt} = J(m(t))AX - \beta J_{air} \frac{m^2}{K_{air} + m} \end{cases} \quad (1)$$

3 Validation

Figure 2 shows the cake dynamics with and without air cross flow. As a first validation the proposed model has been compared to results of the GPS-X software [4] and to Li and Wang's model [1], implemented in *Matlab/Simulink*.

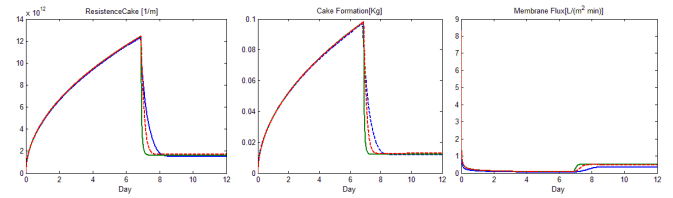


Figure 2: Comparison between the models. Red: Li Model, Blue: GPS-X model and Green: Proposed Model.

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