

A review of modeling bioprocesses in membrane bioreactors (MBR) with emphasis on membrane fouling predictions

S.I. Patsios, A.J. Karabelas*

*Department of Chemical Engineering, Aristotle University of Thessaloniki and Chemical Process Engineering Research Institute, Centre for Research and Technology – Hellas 6th km Charilaou-Thermi Road, PO Box 60361, Thermi, Thessaloniki GR 570 01, Greece
Tel. +30 23 10498181; Fax +30 23 10498189; email: karabaj@cperi.certh.gr*

Received 1 July 2009; Accepted 20 March 2010

ABSTRACT

Membrane bioreactor technology is an attractive approach for combined wastewater treatment and water reclamation. Although considerable practical experience and experimental data are available, regarding the operation of MBR, mathematical models that would be valuable for improved design and optimization of MBR systems are still at an unsatisfactory state. This paper presents a critical review of existing activated sludge mathematical models and variations thereof, with emphasis on the special requirements which arise from the strong interaction of the concurrently occurring biological process and membrane filtration in MBR systems. The desirable attributes of an activated sludge model, focused on MBR technology, emerge by assessing the influence of this interrelation on both processes. Special attention is paid to identifying key variables that can help establish a direct link between bioprocess modeling and membrane fouling models. Various activated sludge models, originally developed for, and commonly used in the conventional activated sludge systems, as well as some modified versions employed in MBR systems, are reviewed. It is pointed out that these models, by design, have inherent deficiencies for MBR simulation mainly because they do not provide sufficient data to comprehensively simulate the fate of different microbial products (like EPS and SMP) that play an important role in membrane fouling. The necessity of an alternative bioprocess modeling framework, de novo focused on the specific needs of the MBR technology, as well as guidelines concerning the development of such a model are suggested in the paper.

Keywords: Membrane bioreactor (MBR); Membrane fouling models; Wastewater treatment; Activated sludge modeling; EPS; SMP

* Corresponding author.