Desalination and Water Treatment
www.deswater.com
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doi: 10.1080/19443994.2012.672169

43 (2012) 185–192
April

Taylor & Francis
Taylor & Francis Group

External analysis-based fuzzy PLS model for prediction and monitoring in MBR

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Received 25 December 2011; Accepted 10 February 2012

ABSTRACT

In general, the operation conditions of water treatment plants happen to be affected by external environmental variations such as temperature, viscosity, and loading changes. They sometimes result in bad treatment performance due to fouling or sludge decay and some process faults. Therefore, when designing a process model, negative effects of the external variables are needed to be incorporated. The purposes of this study are to propose a new external fuzzy partial least squares method (eFPLS) and apply it to predict the treatment performance of a pilot-scale membrane bioreactor (MBR). The proposed eFPLS model can represent an interpretability of the original FPLS of the inner and outer relationship with the viewpoint of physical meaning as well as keeping the capability of the original FPLS with handling the nonlinear correlation between inputs and outputs, while incorporating operation condition changes by the external analysis. It was used to predict the transmembrane pressure and the removal rates of chemical oxygen demand (COD) and total nitrogen in the MBR as well as to monitor the fouling progress. The prediction performance of the eFPLS model is compared with the other models of linear PLS and original FPLS. The results obtained in this study confirm that the eFPLS model with external analysis could improve not only the prediction efficiency but also the monitoring performance since it can efficiently remove the effects of external variables.

Keywords: Membrane bioreactor; Fuzzy partial least squares; External analysis; External fuzzy partial least squares; Partial least squares

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The 4th International Desalination Workshop (IDW4), 16–18 November 2011, Jeju Island, South Korea