MONITORING OF MEMBRANE BIOREACTOR PERFORMANCE USING 2D FLUORESCENCE SPECTROSCOPY AND MULTIVARIATE STATISTICALLY BASED MODELLING

Keywords: Membrane Bioreactor; 2D Fluorescence Spectroscopy; Wastewater quality monitoring

Membrane bioreactors (MBR) are increasingly applied in wastewater treatment plants, mainly due to their small footprint and high effluent quality. The increasing demand for MBR technology requires the development of adequate monitoring and control techniques, particularly in view of the high operational costs associated to membrane fouling resulting from the adhesion of cells to the membrane.

Monitoring of MBR performance involves a large number of off-line and time consuming analytical techniques, regarding the complexity of the media. Therefore, MBR technology would greatly benefit from real-time monitoring techniques that could be used to support immediate control actions.

2D-fluorescence spectroscopy is an on-line and non-destructive technique that can quickly provide information about the composition of complex biological media and consequently be used as a real-time monitoring tool. Wastewater media contain high quantities of natural fluorophores, such as aminoacids (e.g. tyrosine, tryptophan and phenylalanine), vitamins, coenzymes and aromatic organic matter in general. Furthermore, extracellular polymeric substances (EPS) containing large amounts of proteins are the major fouling agent of MBRs. Thus, fluorescence is a good candidate technique for MBR monitoring, able to capture fingerprinting information on the state of the biological media.

In this work, it has been shown that 2D-fluorescence spectroscopy is a promising on-line tool to monitor wastewater treatment efficiency and the formation of potential biological fouling agents. The main objective of this project is to develop a methodology to predict the dependent parameters (e.g, Chemical Oxygen Demand) for MBR performance monitoring. The methodology developed enabled the deconvolution of 2D fluorescence spectroscopy data (Excitation Emission matrices – EEMs) using Multi-way Projection to latent structure (nPLS) modelling to predict the COD of sample wastewater.

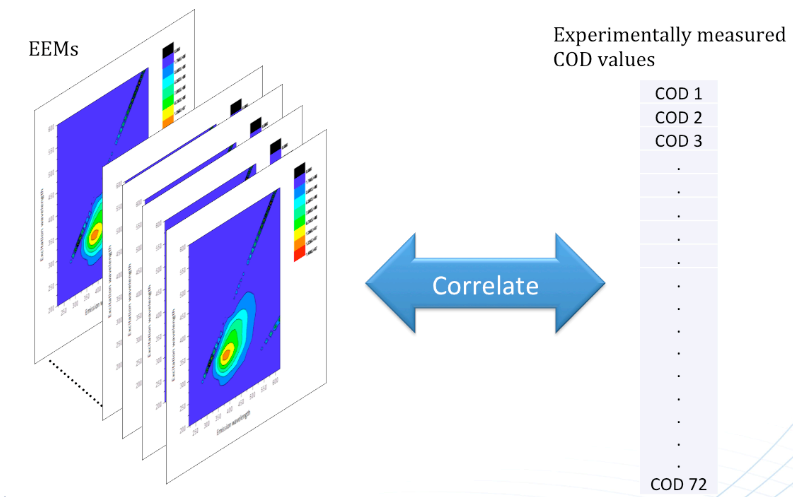

Figure 1.1 Use of PLS regression to correlate fluorescence data matrices with experimentally measured COD values for model training

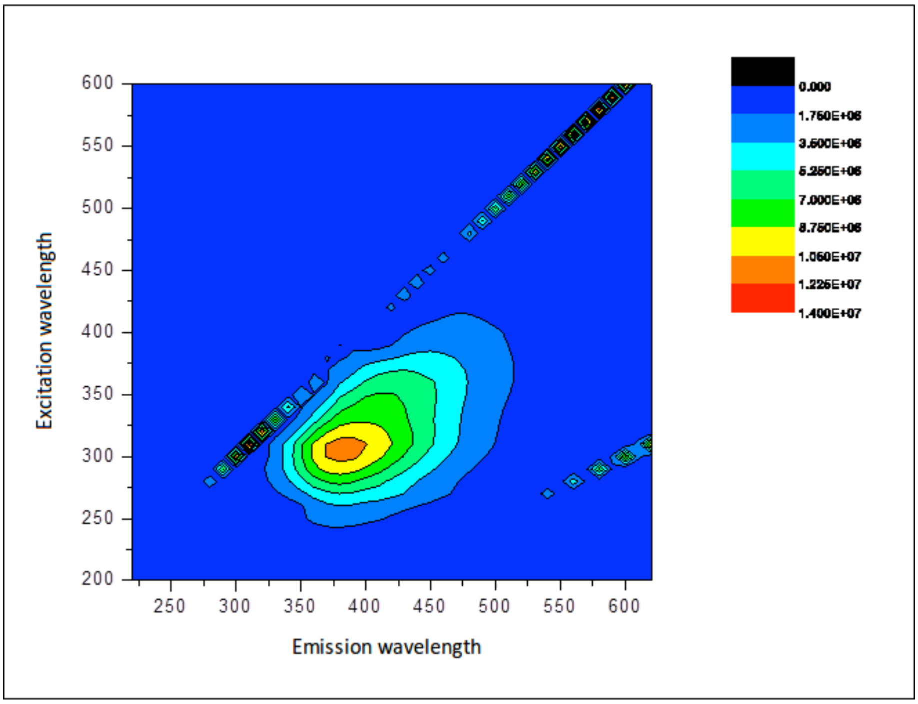

Figure 1.2 Contour plot of an Excitation Emission Matrix. Intensity values are represented by the colours as shown in the legend

A total of 82 different measurements of 2D fluorescence spectroscopy and COD were obtained a wastewater sample with COD range between 100-1000 mg/L. The raw data was used to develop a model for predicting the COD. Following figure shows the relation between predicted and experimentally measured COD values:

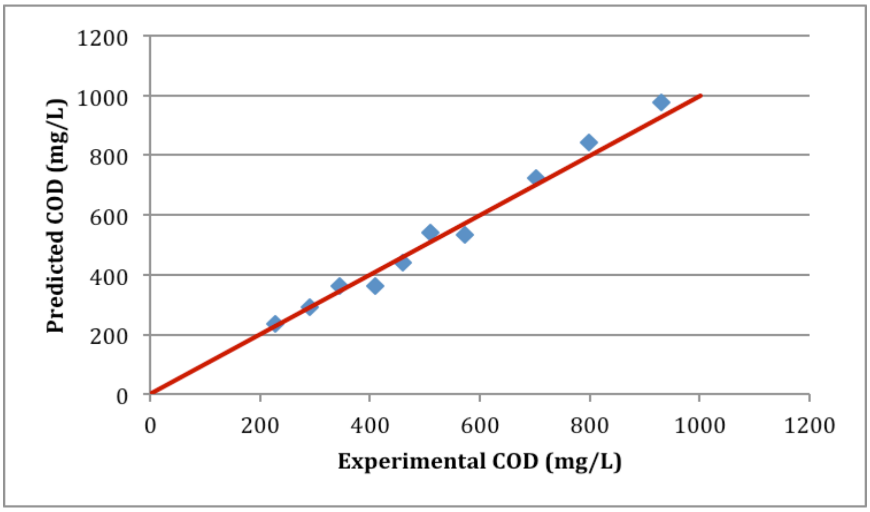

Figure 1.3 Comparison between the COD experimental and COD predicted

References

Li JK and Humphrey AE (1991) Use of fluorometry for monitoring and control of a bioreactor. Biotechnol Bioeng 37:1043-1049

Marose S, Lindemann Cand Scheper T. (1998) Two-dimensional fluorescence spectroscopy: a new tool for on-line bioprocess monitoring. Biotechnol Prog 14:63–74

Claudia F. Galinha, Gilda Carvalho, Carla A.M. Portugal. Two dimensional fluorescence as a fingerprinting tool for monitoring wastewater treatment systems. Wiley online library

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