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Commentary

Monitoring of Membrane Bioreactors by 2D Fluorescence Spectroscopy

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DESCRIPTION

Membrane bioreactors couple with a membrane by allowing the retention of solids and macromolecules during the biological reaction occur while the fluid is permeated through the membrane allowing for continuous use of biological catalyst and retention of the compounds according by their size. Due to the direct contact with the membrane and highly complex biological media monitoring of membrane bioreactors are particularly vulnerable for the development of fouling caused by adsorption of colloidal and soluble material on the membrane surface and pores as well as to the adhesion and deposition of biomass. The large applicability of monitoring of membrane bioreactors in different processes are mostly known and studied for wastewater treatment and offering several advantages such as high effluent quality and stability with retention of microbial species independent of hydraulic retention time and reduced footprint. However, the application of monitoring of membrane bioreactors is still conditioned by the inevitable membrane fouling which high costs associated with aeration and complex control systems required.

In monitoring of membrane bioreactors for wastewater treatment monitoring is essential to ensure the quality and stability of the permeated effluent and meet legal requirements for discharge. Monitoring the biological reaction is essential to characterize the influent and also effluent streams the biological media inside the reactor by biological activity. The organic compounds present in the biological media deriving both from the incoming wastewater and from the microbial activity are grouped under the term of Extracellular Polymeric Substances (EPS) and can be classified into bound EPS. They are attached to cells to form biomass aggregates and soluble EPS when they are freely suspended in media. Microbiologic assessments are also relevant especially when applying mixed microbial cultures. In the biological treatment of wastewaters, it is essential to monitor the presence of both beneficial and hazardous microorganisms. In addition to the presence of virus and other pathogens in the effluent water, the analysis of specific groups of microorganisms is often performed to assess the ability of the biomass to remove such compounds.

However the methods used for these assessments rely on sample collection and they often require microbial cultivation of DNA/RNA analysis which are time consuming and require specialized analysts. Membrane performance is assessed through flux and transmembrane pressure. To achieve a continuous flow in MBRs, they are usually operated with imposed permeate flux while the transmembrane pressure is monitored online. This behavior is related to the concept of critical flux but it is hard to predict due to the several factors affecting fouling evolution and the filtration forces, which depends greatly on media characteristics and filtration setup and operation. These systems are usually operated at a sustainable flux and defined as a flux bellow the critical flux to avoid the deposition of solids at the surface due to pressure. This type of strategy increases the time of operation by a stable TMP.

Two-dimensional fluorescence spectroscopy

Use of 2D fluorescence spectroscopy to characterize MBR systems: In monitoring of membrane bioreactors systems particularly for wastewater treatment the culture media have a complex composition requiring the assessment of compounds simultaneously. Non-invasive and non-destructive measuring systems are preferable to avoid disturbing the system and allow frequent assessment. Development of new sensors is able to monitor several compounds which increase in the number of monitoring parameters raises the costs of monitoring. So, multivariate methods able to simultaneously detect various compounds or parameters become cost effective. If these methods are applied online they may also allow for real time monitoring and control including the ability to detect the appearance of undesirable by-products or the presence of toxic compounds.

CONCLUSION

By using 2D fluorescence spectroscopy, the samples are assessed

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by scanning a range of selected emission wavelengths and covering a wide spectral region. These fluorescence scans result in large matrices (excitation/emission matrices, EEMs), where the intensity of 2D fluorescence emission is recorded for each pair of excitation and emission wavelengths. Such matrices can be plotted as contour plots. Fluorescence spectroscopy is sensitive to fluorophores present in monitoring of membrane bioreactors systems and to mutual interferences of these compounds with their surrounding media. Therefore, the fluorescence spectra obtained from these complex systems capture extensive information from media, not only regarding to natural fluorophores present, but also related to the optical characteristics of the media.