Respirometry for kinetic and stoichiometric characterization of biofilm reactors

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Introduction. Submerged fixed-bed reactors, also called biofilm reactors, are of interest for biological processes with low microbial growth rates (i.e. nitrification). Biofilm reactors consist of microbial cells and their extra cellular material accumulated on a support. This support can be either organic or inorganic but it has to be inert. The use of support media allows (i) long microbial residence times,(ii) short hydraulic residence time with low wash-out risk, (iii) high removal or production rates and (iv)high resistance to toxic loads. Compared to suspended biomass reactors, biofilm are also significantly more complex to operate and to characterize due to the high heterogeneity inside of the bioreactor.

Traditional biofilm reactors characterization is achieved during batch experiments with samples of the filter media however it is also difficult to obtain representative samples from the support media. The use of non invasive methods such as influent and effluent mass balance is preferable as it reflects the real performance of the biofilm reactor. Nevertheless mass balance methods require the analysis of several pseudo steady-states similarly to the classical chemostat method, which is time-consuming and does not take into account potential biofilm accumulation and therefore process modifications between two measurements. An alternative non invasive method is pulse respirometry, which consists in measuring the dissolved oxygen (DO) concentration after the injection of a defined concentration of substrate into the system. The exogenous oxygen uptake rate (OURex) curves reflect the kinetics and stoichiometry of the aerobic biodegradation process. Compared to techniques based on substrate concentration measurement, respirometry allows the retrieval of numerous parameters with relatively small experimental effort, during real time, and using a low cost probe. So far respirometry has been successfully applied in stirred tank reactor, airlift reactor, bubble column reactor among other design of bioreactors as well as in different bioprocess such as removal of contaminants or production of interest metabolites. There are just a few works dealing with the use of respirometry in biofilm reactors, some of them have only studied theoretical aspects such as mathematical modeling and others have already applied in situ pulse respirometry taking into account the hydrodynamic of the bioreactor for anaccurate interpretation of the respirometric data.

Conclusions. Undoubtedly Biofilm reactor is a promising technology that together with the use of respirometry for reactor control and characterization, will allow having a more robust bioprocess for the removal of pollutants or production of bioproducts of interest.

References.

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