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Influence of mechanical mixing intensity on a biofilm structure and permeability in a membrane bioreactor

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Abstract

Membrane fouling mitigation in a membrane bioreactor (MBR) performance has been the main focus of research in recent times and researchers have proposed many mechanisms based on biological, hydrodynamic and physico-chemical approaches. From this perspective, this paper has been divided into two main parts — the first part gives a review of the recent research and development in fouling mitigation approaches in a membrane bioreactor and the second part emphasizes a hydrodynamic approach in the form of mechanical mixing as a membrane performance enhancement technique in submerged-MBRs operation using hollow-fiber membrane modules. Four laboratory scale MBRs were operated at different mechanical mixing conditions. The control reactor (MBR_0) was operated with aeration only supplemented by mechanical stirring at 150, 300 and 450 rpm in MBR_{150}, MBR_{300} and MBR_{450}, respectively. An optimum mixing speed of 300 rpm was determined based on the membrane filtration performance. The optimized mechanical mixing induced hydrodynamic shear stress on membrane fibers to limit rapid clogging of the hollow-fiber bundle as well as modified the sludge characteristics to improve the biofilm permeability. It was found that the bio-flocs were broken into smaller particles under a high shear stress and their activity in terms of specific oxygen uptake rate (SOUR) was reduced. The low SOUR of microbes demonstrated low biopolymer release during the biofilm simulation test due to a slow cell death rate. The optimized mixing condition led to the slow deposition of bio-particles as well as demonstrated a high biofilm permeability due to a low biopolymer concentration in the biofilm contributing to fouling mitigation in the MBR.

Keywords: Membrane bioreactor; Membrane fouling; Mixing intensity; Particle size distribution; Extracellular polymeric substances (EPS); Biofilm structure

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