Long-Term Operational Performance of PAN and PVDF Membranes in MBR: Fouling, Recovery, and Energy-Saving Potential

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Abstract

Long-term operational performance for industrial membrane bioreactor (MBR) is significant. To investigate the fouling behavior, the flux recovery rate (FRR), water production and energy consumption of 0.1 μm polyacrylonitrile (PAN) and polyvinylidene fluoride (PVDF) membranes (commonly used materials in MBR) fouled by activated sludge suspension, the multiple filtration-rinsing experiments were conducted (6 cycles). Meanwhile, the filtration flux was predicted by a model, and the corresponding effective membrane area ratio (A(t)/A0) was obtained. Results indicated that the model showed a good agreement (R^2 ≥0.9555). Meanwhile, A(t)/A0 and FRR decreased with the cycle number (N), and FRR of PAN membrane was consistently nearly twice that of PVDF membrane while the ratio decreased with N (it respectively was 2.5 (1st) and 1.9 (6th)), and the decline in A(t)/A0 of PVDF membrane in the first cycle (0.72) was much greater than that of PAN membrane (0.42), showing the anti-fouling advantage of PAN membrane in the early stage. However, PVDF had higher virgin pure water flux and its fouling mitigation improved with N, eventually surpassing PAN in water production with lower energy consumption. This study guides MBR membrane selection: 0.1 μm PAN membrane for short-term use and 0.1 μm PVDF membrane for long-term use.

Keywords

Membrane fouling, water production, energy consumption, membrane bioreactor.