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Fouling in membrane bioreactors: the influence of some parameters and the effectiveness of some control strategies

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ABSTRACT

Despite the outstanding performance of membrane bioreactors (MBRs) in producing excellent quality effluent, they can't evade fouling. Fouling control in MBRs is continuously requiring scientific and practical investigations. In this research, an MBR system was run in a currently operating, activated sludge, wastewater treatment plant (WWTP). The influence of hydraulic retention time (HRT), sludge retention time (SRT), and the mixed liquor suspended solids (MLSS) on MBR fouling was studied. The study outlined that increasing MLSS from 5,630 to 8,020 mg/L resulted in flux decline from 12.77 to 10.27 L/m^2·h, while at MLSS between 8,790 and 10,930 mg/L there was no clear relationship between MLSS and flux, furthermore, at MLSS > 10,900 mg/L slow flux decline was noticed. Moreover, the study showed that higher HRTs improved sludge settling and reduced the sludge carryover onto the membrane thus decreasing fouling, while short HRTs increase the likelihood of MBR fouling. Additionally, increasing SRT resulted in flux decline due to the increase of MLSS concentration and viscosity, and reduced hydraulic capacity inside the bioreactor. Backwashing resulted in flux increase from 3.93 to 7.6 L/m^2·h indicating its effectiveness in fouling control, thus it should be kept on when running the MBR system. Aeration intensities of 480, 720, 960, and 1,200 L/h enhanced flux when compared to 240 L/h (biological requirement), their corresponding cumulative flux increase percentages were 9.5%, 22.35%, 40.69%, and 41.35%, respectively. The optimum aeration intensity for this setup was 960 L/h. The effect of membrane-aerator distance was investigated through using four values (5, 10, 17.5 and 25 cm); the results indicated that the distance of 10 cm produced the highest flux. Granular activate carbon (GAC) was added at doses of 1, 1.5, 2, 2.5, 3, 3.5, and 4 g/L. The study concluded that the optimum GAC dose was 2.5 g/L. Running the system at the optimum values of the previously mentioned parameters and at variable aeration intensities revealed that it was possible to reduce the aeration intensity from 1,200 L/h to 720 to get the same flux, thus indicating 40% aeration reduction.

Keywords: Membrane bioreactor; Fouling; Backwashing; Aeration; Granular activated carbon

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