Influence of operational variables on nitrogen removal in two full scale MBR systems

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ABSTRACT

The influence of the operational variables (sludge retention time, temperature, recirculation rate, and organic loading) on nitrogen transformations in two full-scale pre-denitrification submerged membrane bioreactor (MBR) was investigated. The study was carried out in two predenitrification MBR full-scale plants, (ultrafiltration and microfiltration) with different recirculation rates. Both installations were fully automated and recorded continuously all flows, temperature, transmembrane pressure (TMP), and dissolved oxygen concentration (DO). Sludge retention time (SRT), activated sludge temperature and organic loading varied between 20–43 days, 13–30˚C, and 0.40–1.1 kg COD/m³ h, respectively. Biochemical oxygen demand (BOD₅) and chemical oxygen demand (COD) removal yield were over 99.5 and 95%, respectively. Both MBR systems demonstrated excellent N–NH₄⁺ removal with yields concerning 99%, and N–NH₄⁺ effluent concentrations lower than 1 mg/L independently of operational conditions. In contrast, the total nitrogen (TN) removal was very influenced by operational variables. The most important influence in nitrate removal for MBR systems was the recirculation ratio between MBR and anoxic bioreactor, which determined the presence of DO in anoxic reactors that affect to the denitrification efficiency. These problems were more significant when activated sludge temperature was low.

Keywords: MBR; Denitrification; Temperature; Recirculation; Total nitrogen

1. Introduction

Nitrogen is one of the major nutrients present in urban wastewater, which can cause problems in ecosystems, such as eutrophication, if it is not controlled dumping in water bodies.

In biological wastewater treatment plants, nitrogen removal is performed by nitrification–denitrification processes. Nitrogen removal is usually achieved in an MBR by integrating an anoxic bioreactor (MBR) was investigated. The study was carried out in two predenitrification MBR full-scale plants, (ultrafiltration and microfiltration) with different recirculation rates. Both installations were fully automated and recorded continuously all flows, temperature, transmembrane pressure (TMP), and dissolved oxygen concentration (DO). Sludge retention time (SRT), activated sludge temperature and organic loading varied between 20–43 days, 13–30˚C, and 0.40–1.1 kg COD/m³ h, respectively. Biochemical oxygen demand (BOD₅) and chemical oxygen demand (COD) removal yield were over 99.5 and 95%, respectively. Both MBR systems demonstrated excellent N–NH₄⁺ removal with yields concerning 99%, and N–NH₄⁺ effluent concentrations lower than 1 mg/L independently of operational conditions. In contrast, the total nitrogen (TN) removal was very influenced by operational variables. The most important influence in nitrate removal for MBR systems was the recirculation ratio between MBR and anoxic bioreactor, which determined the presence of DO in anoxic reactors that affect to the denitrification efficiency. These problems were more significant when activated sludge temperature was low.

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