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Performance and model of a novel membrane bioreactor to treat the low-strengthen complex wastewater

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ABSTRACT

A MLMBR and a conventional IMBR with DO control system were investigated for simultaneously removing organic carbon and nitrogen in the low-strengthen complex wastewater. Four stages of the laboratory scale system with SRT of 30 day and HRTs of 20, 16, 12, and 8 h, respectively, were conducted. During the 4 months experimental period, COD removal efficiencies averaged at 92.2% and 85.3%, SS removal efficiencies averaged at 93.8% and 85.2%, and NH_4^+–N removal efficiencies averaged at 84.1% and 65.3%, respectively, for MLMBR and IMBR. What's more, the sludge characteristics were explored explicitly, results demonstrate that MLMBR not only perform better in substrates removal, also can alleviate the membrane fouling due to better sludge characteristics. In addition, mathematical statistical models, built on the linear regression techniques were developed for explore the inner relationship between HRTs and the performance of the MLMBR.

1. Introduction

Membrane bioreactor (MBR) is commonly known as the combination of membrane filtration and biological treatment using an activated sludge, where the membrane primarily serves to replace the clarifier in the wastewater treatment system (Meng et al., 2009). Compared with the conventional wastewater treatment processes, MBR has smaller footprint and reactor requirements, higher effluent quality, better disinfection capability, higher volumetric loading and less sludge production. Consequently, the MBR process is employed as an attractive option to treat and reuse the industrial and municipal wastewaters (Chiemchaisri and Yamamoto, 1994).

However, membrane fouling and low ammonia nitrogen (NH_4^+–N) removal efficiency hamper the widespread application of MBRs (Le-Clech et al., 2006; Yang et al., 2009b). In order to alleviate membrane fouling and enhance ammonium removal efficiency, many studies have been devoted to improve the MBR system by different methods. Yang et al. filled with carriers instead of activated sludge in MBR to simultaneously removing organic carbon and nitrogen in wastewater (Yang et al., 2009b). Ren et al. used a nonwoven fabric filter bag (NFFB) as the membrane bioreactor, the NFFB reactor was operated without forming excess sludge and denitrification occurred in the biofilm layer. The results indicate that the improved system provides a high potential of alleviating membrane fouling and enhancing ammonium removal efficiency (Ren et al., 2010). Bani-Melhem and Elektorowicz reported a novel technology called submerged membrane electro-bioreactor (SMEBR) which applying an intermittent direct current field between immersed circular perforated electrodes around an immersed membrane filtration module to treat the wastewater by combining membrane filtration, electro kinetic phenomena, and biological processes in one reactor, and improves treatment performance while helping to control membrane fouling (Bani-Melhem and Elektorowicz, 2011). Lots of improvements of MBR, such as replaced the membrane module by a new material or combined a physical or chemical process, were conducted to offset these shortages. While the greatly increased of operational costs of these measurements leads the novel MBR system still limited widespread application in wastewater treatment. In this study, a novel MBR system, which with a new internal structure to create a better gas–liquid–solid exchange and mass transfer, is investigated to treat the low strength complex wastewater.

The low strength complex wastewater which generated by various industrial activities, such as pharmaceutical industrial, printing and dyeing industrial, coal chemical industrial, has a COD below 1000 mg L^{-1}, low biodegradation, also may contains heavy metals and other inorganic compounds which are often hazardous or toxic (Kumar et al., 2008; Reyes et al., 1999). In recent years,

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