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Short Communication

Performances study of UV/O_3-aMBR recirculation system in treating polluted surface water

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ABSTRACT

This study used UV/O_3-aMBR system for treating polluted surface water with COD_{Mn} around 10 mg/L, to improve the removal of non-biodegradable components. UV/O_3 was used in the recirculation stream, partially treating the recalcitrant in aMBR permeate to improve its biodegradability, and then send back to aMBR for biodegradation. Removal performance of UV/O_3-aMBR system with recirculation ratio 20, 40, 60 and 80% was tested and compared. The removal of COD_{Mn}, UV_{254} and NH_3-N increased with the increment of recirculation ratio. UV/O_3-aMBR system has higher recalcitrant removal performance and less membrane fouling. The fluorescent dissolved organic matter (FDOM) was largely reduced in UV/O_3-aMBR system, and the system hydrophilicity was higher than aMBR system. The Modified Stover Kincanoon model was able to describe UV/O_3-aMBR system; and has higher Umax than aMBR system. UV/O_3-aMBR can be develop as an effective technology in improving recalcitrant removal in polluted surface water treatment.

1. Introduction

Continuous discharge of domestic wastewater into surface water has led to an increase in organic pollution. This brought immense pressure to the conventional drinking water treatment plants, as surface water is one of the main water source for human beings. Li et al., (2017) reported that attached growth membrane bioreactor (aMBR) was effective in removing the biodegradable organic fractions from polluted surface water with no activated sludge adding and low membrane fouling. While the remaining untreated recalcitrant such as synthetic organic matters (SOMs) and natural organic matters (NOMs) could lead to the generation of disinfection byproducts (DBPs) once chlorination is used, and cause health risk to human beings (Jeong et al., 2015).

Advanced oxidation processes (AOPs) was widely studied as an effective technology in treating recalcitrant organic matters. Oller et al. (2011) has reviewed the combination of AOPs and biological treatments for decontamination of wastewater. AOPs used as chemical pretreatment were effective in partial oxidization of the biologically persistent part to biodegradable intermediates. Mascolo et al. (2010) has used O_3 and UV/H_2O_2 as polishing step in recirculation stream of MBR for treating pharmaceutical wastewater. DOC and nalidixic acid in the effluent of integrated MBR-AOP system was 50 and 70% lower than MBR system alone, respectively. Liao et al. (2013) reported that combined conventional and O_3-BAC process was able to remove organic matters and antibiotics in treating polluted lake water. Li et al. (2005) has compared O_3-BAC, UV/O_3-BAC and TiO_2/UV/O_3-BAC processes in removing organic pollutants in secondary effluents, and found that the presence of UV has improved O_3 utilization and biodegradability of effluent. The combination of AOPs and aMBR in treating polluted surface water with COD_{Mn} around 10 mg/L was rarely reported.

This study integrated UV/O_3 as a polishing step in the recirculation stream of aMBR system (UV/O_3-aMBR). The removal performance of UV/O_3-aMBR system in varies recirculation ratio (volume based) were analyzed and compared. The removal mechanism of selected UV/O_3-aMBR system and aMBR system was compared.

2. Materials and methods

2.1. System set-up and operation conditions

The schematic of UV/O_3-aMBR system was shown in Fig. 1. The flow chart of parallel-operated UV/O_3-aMBR and aMBR system were shown in Fig. 2. Two systems were controlled in 8 min on and 2 min off mode. The transmembrane pressure (TMP) was recorded by digital pressure gauge. Polyvinyl alcohol gel (PVA-gel) was used as bio-carrier with filling ratio 5% in carrier side. The total volume of the aMBR

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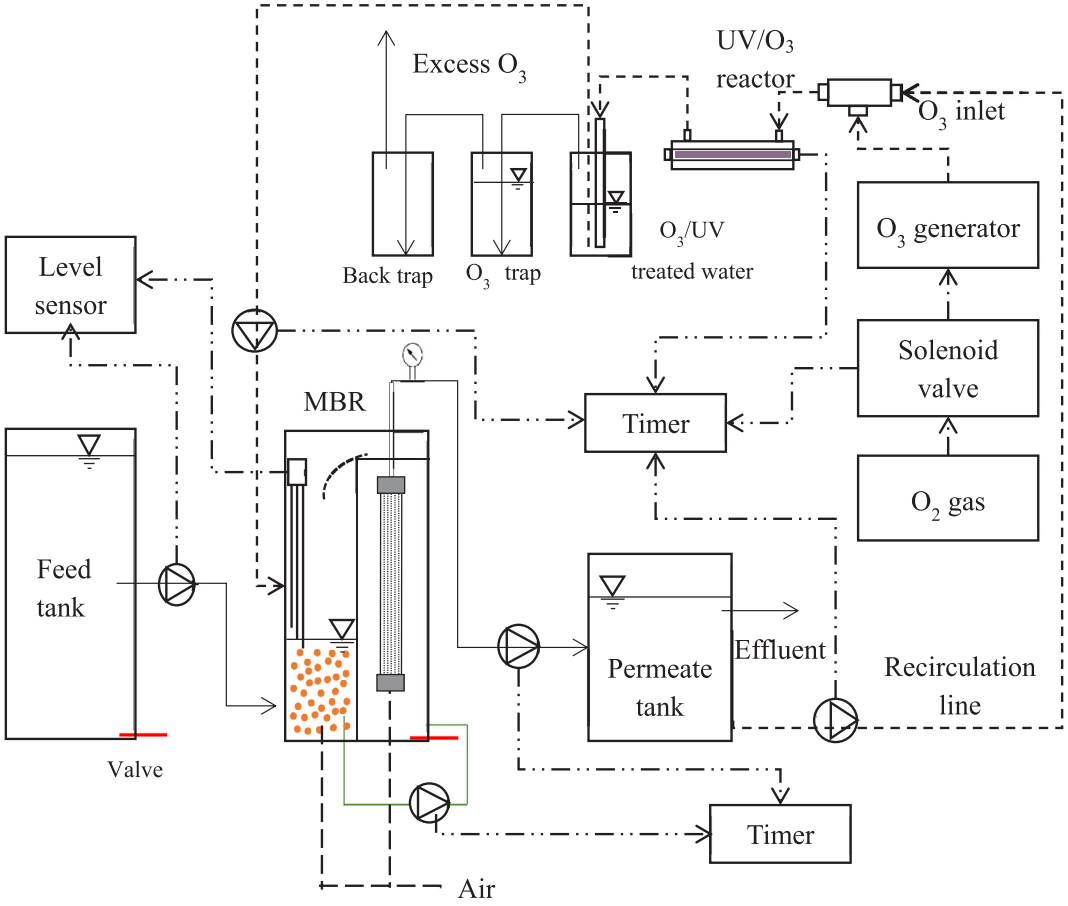

Fig. 1. Schematic of UV/O_3-aMBR system setup.

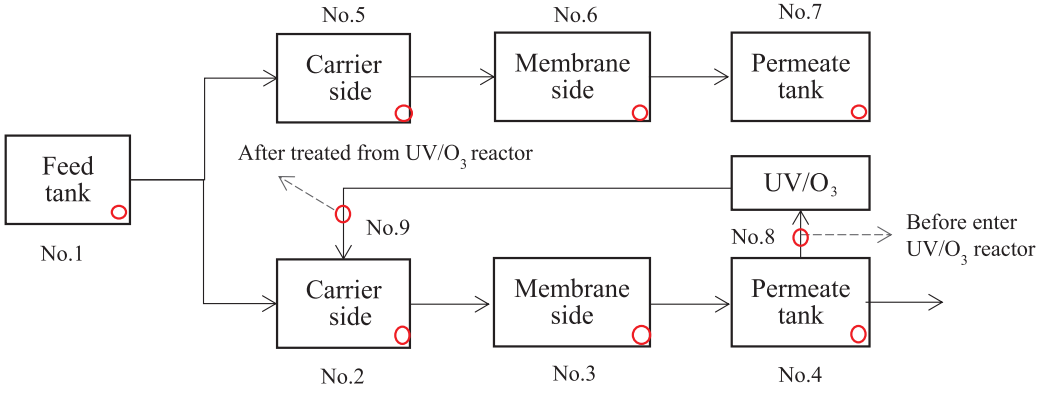

Fig. 2. Flowchart of parallel UV/O_3-aMBR and aMBR system.

system is 20 L. Hollow fiber PTFE UF membrane with pore size 0.1 μm and surface area 0.1 m^2 was submerged in the membrane side. HRT controlled in both systems were 2.5 h. Flow rate of whole system was 2 L/h. The contact time in UV/O_3 reactor was based on Biodegradable dissolved organic carbon (BDOC) results as 7 min. UV light 8 W with wavelength 254 nm and O_3 generator (Nippon Ozone Co., LTD, Japan) with concentration 1.5 mg/L were used. The feed water used was diluted domestic wastewater with COD_{Mn} 8.08 ± 2.52 mg/L.

2.2. Common water quality parameters

The water quality parameters analyzed in this study all follow the standard methods (APHA et al., 2012). COD_{Mn}, Dissolved COD_{Mn} ($DCOD_{Mn}$) and UV_{254} were used as organic matter indexes. NH_3-N was tested by Nessler's method.

2.3. FEEM and FDOM differential

Fluorescence excitation emission matrix (FEEM) was tested by fluorescence spectrometer (Cary Eclipse, USA) equipped with a xenon lamp. The scanning wave was range in 300–600 nm for excitation and 250–445 nm for emission. Excitation interval was 5 nm and emission interval was 4 nm. The scanning speed was 2400 nm/min and with high photomultiplier voltage. The excitation and emission slit were both in 5 nm, and the averaging time was 0.1 s. Pure water (Milli-Q, Millipore Co. Ltd) was used as the blank sample for all fluorescence analysis.

FEEM of the water sample No. 1, No. 4 and No. 7 was shown in Fig. 5, as it was marked in Fig. 2. Fluorescent dissolved organic matters