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EFFECT OF POWDERED ACTIVATED CARBON (PAC) CONCENTRATION ON LOCALLY DEVELOPED HYBRID MEMBRANE BIOREACTORS (HMBRS)

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Abstract
Membrane bioreactor (MBR) system is recently a well-known process in purifying waste water into clean water. It is also a much safer disinfection treatment compared to the conventional water treatment plant. However, the fouling problems still a great challenge to be overcome for this system. This project aims to investigate the better condition for MBR in order to prolong the filtration progress. MBR was hybrid with powdered activated carbon (PAC) in different concentration, 0.1 g/L and 1 g/L. The investigation will include the relative performances of the hybrid MBRs during start up and approaching steady state as well as operation at a sludge retention time (SRT) of 30 days and infinity. Parameters used for comparison of the MBRs included mixed liquor suspended solids (MLSS), Chemical Oxygen Demand (COD) loads, EPS (extracellular polymeric substances), floc size, transmembrane pressure (TMP) (the key indicator of fouling) and filtration characteristics of the mixed liquor measured ex-situ. By identifying the optimum condition, the membrane can perform longer and better, which directly lower the operation cost in any of the application.

Keywords: Membrane Bioreactor, Fouling, Hybrid, Powdered Activated Carbon, Trans MembranePressure.

1. Introduction

Since the benefit and output quality being discovered, membrane bioreactors (MBRs) are recognized as an effective alternative to the conventional activated sludge treatment process, especially for wastewater treatment field. However, the operation cost of the MBRs is much depended on the membrane fouling rate. In this study, the lab-scale MBR system will be setting up in order to find out the effect of PAC concentration to the MBRs performance.

2. Literature Review

The fouling consists of reversible and irreversible components which are caused by cake formation [Ognier, et. Al., 2002] and pore blocking or restriction [Choo et. Al., 1998] respectively. A lot of research has been done in order to improve this problem. Reported methods used to improve fouling control, include (i) intermittent filtration [Gui et. al., 2002] and backwashing.[Bouhabila et al., 2001], (ii) fixing the flux below the 'sustainable' flux [Cho et al., 2002], (iii) good hydrodynamic design to prevent cake accumulation on the membrane surface [Rosenberger et al., 2002], (iv) physical and chemical cleaning [Lim and Bai, 2003], (v) sidestream operation with two-phase flow applied to the lumen of the hollow fiber module [Mahmud et. al., 2004], and (vi) hybrid MBRs with porous and flexible suspended carriers [Yang et. al., 2006]. In addition, the modification of the characteristics of the mixed liquor suspension by additives, such as powdered activated carbon (PAC) in the MBR to improve removal efficiency and fouling control has attracted attention [Leesage et. al., 2008; Ravindran et al., 2009; Remy et al., 2009; Akram et al., 2008].

3. Methodology

This experiment involved 3 set of 2L MBRs with activated sludge obtained from a local municipal wastewater treatment plant. The sludge is keep for 3 months within the MBRs in order the system to be stabilized. PAC with different concentration (0g/L, 0.1g/L, and 1g/L) is added into the MBRs accordingly. For filtration process, hollow fiber membrane with inner diameter 1mm is submerged from top into the MBRs.

4. Result and Analysis

In this study, effect of PAC concentration on membrane fouling was observed. 3 set of MBRs with different concentration of PAC were examined on same flow rate until the fouling occur in the system. Fig. 1 showing a comparison among MBR without and with very low concentration (0.1g/L) of PAC.

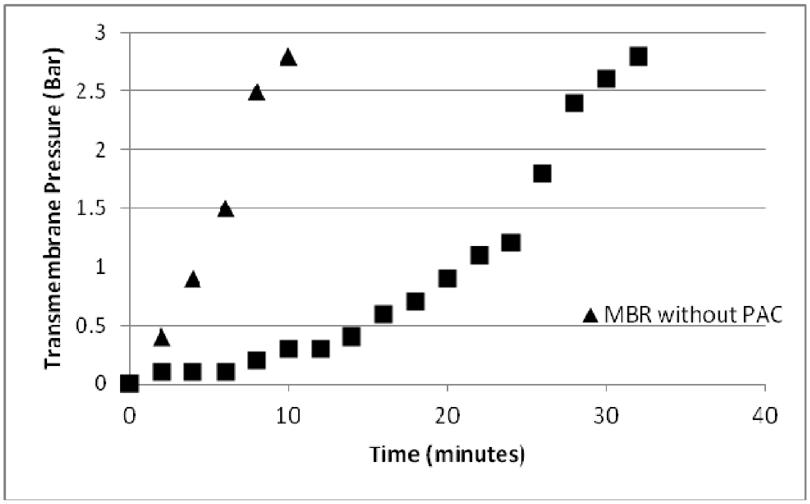

Figure 1: Transmembrane pressure against time for MBR without and with PAC concentration of 0.1 g/L

According to Fig. 1, by adding only low concentration of PAC into the system, the membrane can sustain a longer time before the fouling happen. Clearly notice that for MBR without PAC, transmembrane pressure has significantly increased within 10 minutes from 0 to 2.8 bar, which shows that membrane fouling phenomena occurs rapidly in the system. By having PAC in the system, even in a low concentration, a slight improvement can be observed which membrane life span can be prolonged from 10 min to 30 minutes. However, great improvement on membrane life span was observed when higher concentration of PAC used in the system. Fig. 2 shows the membrane performance in a MBR system with 1 g/L of PAC.

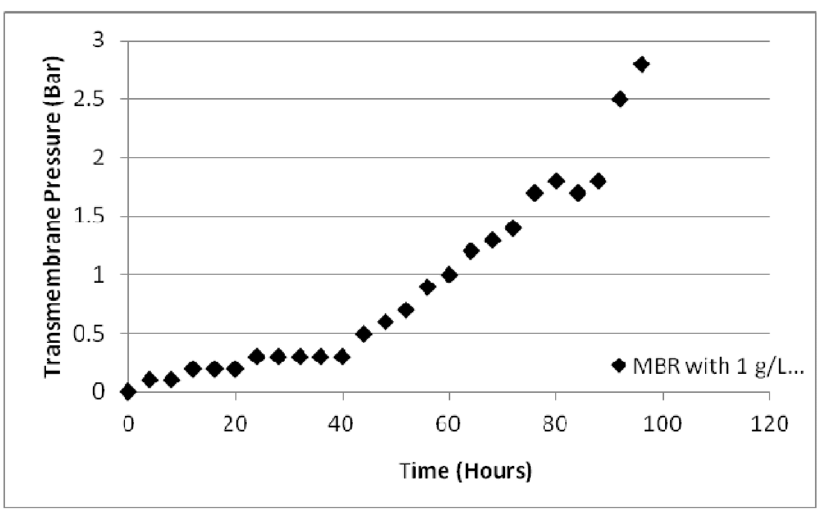

Figure 2: Transmembrane pressure against time for MBR with PAC concentration of 1 g/L

As PAC concentration increased from 0.1 g/L to 1 g/L, it shows a large improvement to the membrane performance. The life span for membrane was prolonged until to almost 4 days before fouling occurs. It shows that PAC can act better as additives in solution with higher concentration. According to literature review, increasing of PAC in solution will directly influence the membrane performance because PAC not only acts as adsorbent, but also creating the scouring effect which become the major reason for prolongs the membrane life span.

5. Conclusion

This study has discovered the significant of PAC concentration in prolong the membrane life span. By adding 0.1 g/L of PAC into the system, it can prolong the membrane up to 3 times compare to the system without PAC. By increasing the concentration 10 times higher (from 0.1 to 1 g/L), it can prolong the membrane life span until 192 times longer.

Acknowlegement

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