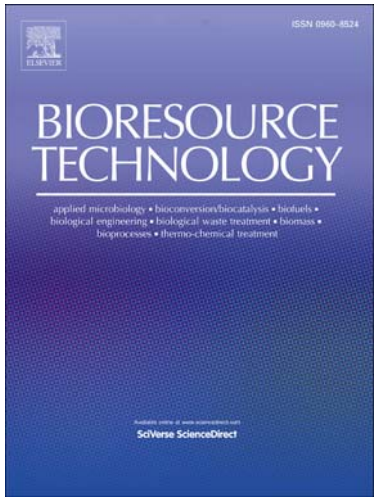


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# Optimization of Membrane Bioreactors by the Addition of Powdered Activated Carbon

Choon Aun Ng[2], Darren Sun[3], Mohammed J. K. Bashir, Soon Han Wai[2], Ling Yong Wong[2], Humaira Nisar2, Bing Wu and Anthony G. Fane[1,3]

1. Singapore Membrane Technology Centre, Nanyang Technological University, Singapore 637723
2. Faculty of Engineering and Green Technology, University of Tunku Abdul Rahman, 31900 Kampar Perak Malaysia
3. School of Civil & Environmental Engineering, Nanyang Technological University, Singapore 637723

Corresponding author: Choon Aun Ng; Email: ngca@utar.edu.my; Tel: (60) 468 8888; Fax: (60) 466 7449

## Abstract:

It was found that with replenishment, powdered activated carbon (PAC) in the membrane bioreactor (MBR) would develop biologically activated carbon (BAC) which could enhance filtration performance of a conventional MBR. This paper addresses two issues (i) effect of PAC size on MBR (BAC) performance; and (ii) effect of sludge retention time (SRT) on the MBR performance with and without PAC. To interpret the trends, particle/floc size, concentration of mixed liquor suspended solid (MLSS), total organic carbon (TOC), short-term filtration properties and transmembrane pressure (TMP) versus time are measured. The results showed improved fouling control with fine, rather than coarse, PAC provided the flux did not exceed the deposition flux for the fine PAC. Without PAC, the longer SRT operation gave lower fouling at modest fluxes. With PAC addition, the shorter SRT gave better fouling control, possibly due to greater replenishment of the fresh PAC.

*Keywords*: Membrane bioreactor; powdered activated carbon (PAC); size of the PAC; PAC replacement rate; sludge retention time (SRT)

## 1. Introduction

Membrane bioreactors (MBRs) are known for their capability to (i) produce particle free high quality effluent, (ii) have less excess sludge and (iii) have a relatively smaller footprint (Le-Clech et al., 2006). With these beneficial characteristics, MBRs have been recognized as a good alternative to the conventional activated sludge treatment system. However, the main problem in MBRs is still membrane fouling, especially irreversible fouling caused by cake formation (Ognier et al., 2002) on the membrane surface and pore clogging (Choi et al., 2005; Liu et al., 2005). Many methods have been utilized for fouling control improvement. The reported methods include the followings (i) intermittent filtration (Chua et al., 2002); (ii) backwashing (Bouhabila et al., 2001); (iii) fixing the flux below the 'sustainable' flux (Cho and Fane, 2002); (iv) good hydrodynamic design to prevent cake accumulation on the membrane surface (Innocenti et al., 2002); (v) cleaning using physical and chemical methods (Lim and Bai, 2003); (vi) sidestream operation with two-phase flow applied to the lumen of the hollow fiber module (Laborie et al., 1998) and (vii) hybrid MBRs with porous and flexible suspended carriers (Yang et al., 2006). In addition, modification of the characteristics of the mixed liquor suspension by adsorbents, such as powdered activated carbon (PAC), can improve fouling control (Li et al., 2005; Seo et al., 2004; Ng et al., 2006; Khan et al., 2012; Ma et al., 2012; Ng et al., 2010). However, in our previous work [Ng et al., 2006; Ng et al., 2010], it was observed that fouling in a PAC-MBR