



## Characteristics of wastewater and mixed liquor and their role in membrane fouling

W.J. Gao<sup>a,1</sup>, M.N. Han<sup>a,1</sup>, X. Qu<sup>a</sup>, C. Xu<sup>b</sup>, B.Q. Liao<sup>a,\*</sup>

<sup>a</sup> Department of Chemical Engineering, Lakehead University, 955 Oliver Road, Thunder Bay, ON, Canada P7B 5E1

<sup>b</sup> Department of Chemical and Biochemical Engineering, University of Western Ontario, London, ON, Canada N6A 3K6

### HIGHLIGHTS

- ▶ Effect of wastewater characteristics on membrane fouling was studied.
- ▶ Colloidal content in feed and mixed liquor plays dominant role in controlling fouling.
- ▶ The ratio of proteins to polysaccharides in SMPs is important in controlling fouling.
- ▶ Characterization of feed and mixed liquor may be used as a tool for fouling prediction.

### ARTICLE INFO

#### Article history:

Received 22 August 2012

Received in revised form 14 October 2012

Accepted 16 October 2012

Available online 26 October 2012

#### Keywords:

Submerged anaerobic membrane bioreactor

Thermophilic submerged aerobic membrane bioreactor

Membrane fouling

Wastewater characteristics

Sludge properties

### ABSTRACT

Effects of wastewater and mixed liquor characteristics on membrane fouling in both a submerged anaerobic membrane bioreactor and a thermophilic submerged aerobic membrane bioreactor were studied with four types of industrial wastewaters. Significant differences in particle size distribution, colloidal content, the protein to polysaccharide ratio, and soluble compounds molecular weight distribution were observed among the four types of wastewaters and mixed liquors. Differences in wastewater and mixed liquor characteristics were correlated to the changes in membrane filtration behavior in both systems. The colloidal content in feed and mixed liquor plays a dominant role and is more important than the quantity of total suspended solids in controlling membrane fouling. The ratio of proteins to polysaccharides is more important than the total quantity of soluble organic substances in controlling membrane fouling. A full characterization of feed and mixed liquor may be used as a tool to predict membrane performance.

© 2012 Elsevier Ltd. All rights reserved.

### 1. Introduction

Membrane bioreactor (MBR) has received considerable attention in recent years. It has been well implemented in treating both municipal and industrial wastewater (Le-Clech, 2010; Smith et al., 2012). The MBR system has many advantages over the conventional activated sludge process in terms of its excellent effluent quality, high removal efficiency of chemical oxygen demand (COD), small footprint, and integration of biological treatment and filtration (Abeynayaka and Visvanathan, 2011; Akram and Stuke, 2008; Jeison et al., 2009). However, the loss of the membrane performances due to membrane fouling remains a major obstacle in the extensive application of MBRs. Membrane fouling results in a rapid reduction of permeation flux or an increase in trans-membrane pressure, energy consumption, frequent membrane cleaning, and replacement, thus increasing the operation cost of the process.

Membrane fouling is directly or indirectly affected by a number of factors, such as wastewater characteristics, sludge properties, operating and environmental conditions as well as hydrodynamic conditions (Drews, 2010; Meng et al., 2009). Although extensive studies have been conducted on the effects of sludge properties (Tian et al., 2011; Wu and Lee, 2011) and operating and environmental conditions (Dvorák et al., 2011; Miyoshi et al., 2009) on membrane fouling, the importance of wastewater characteristics in MBRs has not been well studied. There are only a few studies that addressed the effect of wastewater characteristics (Arabi and Nakhla, 2008; Park et al., 2006) on membrane fouling in MBRs. Therefore, it is highly desirable to understand the role of wastewater characteristics on membrane fouling in both submerged anaerobic membrane bioreactor (SAnMBR) and submerged aerobic membrane bioreactor (SAMBR) systems.

To gain more insight into the optimization of MBRs design, this study focused on the three fractions, i.e., total solids, colloids, and soluble organic materials, of the wastewater and mixed liquor and their effects on the membrane fouling. Moreover, no comparative studies have been reported to date on the effects of different industrial wastewaters on membrane fouling despite the evidence to the

\* Corresponding author. Tel.: +1 807 343 8437(O).

E-mail address: [bliao@lakeheadu.ca](mailto:bliao@lakeheadu.ca) (B.Q. Liao).

<sup>1</sup> These authors contributed equally to this work.