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# Effects of chemical additives on filtration and rheological characteristics of MBR sludge

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## HIGHLIGHTS

- Poly-1 and -2 additives recommended due to their good filtration characteristics.
- PACl and chitosan showed average performances compared to the other additives.
- Starch exhibited the worst filtration results.
- Rheology and particle size data showed correlations with other fouling parameters.
- Results at low shear rates were important due to possible effects on cake transport.

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## ABSTRACT

The main goal of this study was to control the fouling phenomena in MBR using chemical additives. In the first phase of the study, SMP removal and bound EPS formation capacity of chemical additives were determined. Highest SMP removal (72%) was achieved by the Poly-2 additive. In the second phase of the study, short term filtration tests were conducted. Poly-1 exhibited highest performance based on membrane resistance, permeability and average TMP. According to the results obtained from constant shear rate tests in fourth phase, no significant change in viscosity with time was observed. Studies for the adaptation of rheograms to common flow models showed that chitosan and starch was not able to fit to Ostwald de Waele and Bingham models. At a shear rate of 73.4 $s^{-1}$ viscosities of all samples were close to each other. Chitosan and starch achieved highest viscosity values at the shear rate of 0.6 $s^{-1}$.



## 1. Introduction

Limited natural resources of 21st century enforce the recycle, recovery and reuse applications for maximum efficiency in all processes. It is well known that the membrane bioreactors (MBR) are able to meet stringent water reuse criteria with reasonable operational costs. With an average growth rate of 10.9% per annum, the MBR market has been growing significantly faster than other advanced wastewater treatment processes and membrane technologies (Drews, 2010). Fouling, the major obstacle for the MBR process, is not only a barrier for the feasibility but also a hindrance for the process flexibility and simplicity. There is huge extent of studies about MBR fouling which can be classified in two major section: detection/identification and control of fouling. Extracellular polymeric substances (EPS) and soluble microbial products (SMP) are accepted as the major foulants in many studies. Removal of SMP is of great importance by means of internal fouling, cake porosity, initial cake formation, and local flux increments (Hwang et al., 2007). Control methods of MBR fouling covers a large field including; surface modification and preparation of novel membranes (Maximous et al., 2009), relaxation and backwashing conditions (Wu et al., 2008), and novel module configurations (Grelot et al., 2009; Nguyen et al., 2011). Biomass modification by chemical additives is another way of fouling control. Easy implementation of this concept on existing plants is another attractive dimension of the technique. Several studies on the topic covers a wide range of additives e.g. polymers (Yoon et al., 2005); zeolite (Lee et al., 2001); metal salts (Wu and Huang, 2008); bentonite, vermiculite (Malamis et al., 2009); diatomite (Yang et al., 2010), starch and chitosan (Ji et al., 2008; Koseoglu et al., 2008). However, side-by-side comparison of the wide range of additives at regular intervals under the same operational conditions is a significant gap in literature. Side-by-side comparisons provide sound data for decision-makers.

Another neglected area of fouling control by additives is their impact on the rheological characteristics of sludge. The sludge viscosity influences the MBR performance at the longitudinal head

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