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# Correlations between trans-membrane pressure (TMP) and sludge properties in submerged membrane electro-bioreactor (SMEBR) and conventional membrane bioreactor (MBR)

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## HIGHLIGHTS

- SMEBR is a novel, compact and complex treatment unit.
- SMEBR combines biological, electrokinetics and membrane filtration processes.
- Statistical analyses showed differences in sludge properties in SMEBR and MBR.

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## ABSTRACT

The influence of sludge properties in SMEBR and conventional MBR pilot systems on membrane fouling was investigated. Generated data were analyzed using statistical analysis Pearson's product momentum correlation coefficient ($r_p$). Analysis showed that TMP had strong direct ($r_p = 0.9182$) and inverse ($r_p = -0.9205$) correlations to mean particle size diameter in MBR and SMEBR, respectively. TMP in SMEBR had a strong direct correlation to the sludge mixed liquor suspended solids concentration (MLSS) ($r_p = 0.7757$) while a weak direct correlation ($r_p = 0.1940$) was observed in MBR. SMEBR showed a moderate inverse correlation ($r_p = -0.6118$) between TMP and soluble carbohydrates ($EPS_c$) and a very weak direct correlation ($r_p = 0.3448$) to soluble proteins ($EPS_p$). Conversely, $EPS_p$ in MBR had more significant impact ($r_p = 0.4856$) on membrane fouling than $EPS_c$ ($r_p = 0.3051$). The results provide insight into optimization of operational conditions in SMEBR system to overcome membrane fouling.



## 1. Introduction

Membrane bioreactors (MBRs) combine biological treatment with a direct solid/liquid separation by membrane filtration (Bai and Leow, 2002). Membrane fouling is still considered as the major problem hindering the wide applications of MBRs. Membrane fouling refers to the deposition of feed water components and other impurities produced in the bioreactor onto the internal and external features of membrane surface. The accumulation of those materials causes an increase in the overall resistance to the filtration process, thus increasing the energy demand (Chang et al., 2002). Several factors contribute to membrane fouling such as membrane characteristics, operating conditions, and sludge properties (Chang et al., 2002). The influence of the sludge mixed liquor suspended solids (MLSS) on the apparent viscosity, and hence membrane fouling, has been reported by some researchers (Huang et al., 2000). The impact of other parameters such as extracellular polymeric substances (EPS), i.e. soluble EPS and floc particle size (Bai and Leow, 2002) on fouling were also investigated (Chang et al., 2002). Membrane fouling leads to a decline in the permeate flux, an increase in the trans-membrane pressure (TMP), and finally, a reduction in the treatment process performance (Nagaoka et al., 1998). In this study, TMP was selected as the key indicator of membrane fouling.

Submerged membrane electro-bioreactor (SMEBR) is a recently developed wastewater treatment solo unit that operates based on the interaction between biological processes, membrane filtration, and electrokinetic processes (Bani-Melhem and Elektorowicz, 2010). Previous bench-scale research investigated the processes of biological transformation of organics and ammonia (Bani-Melhem and Elektorowicz, 2011; Elektorowicz et al., 2009), electrocoagulation phenomena (Hirzallah et al., 2010), phosphorous removal (Wei et al., 2009, 2011, 2012), changing morphology of flocs (Ibeid

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