



Aalborg Universitet

AALBORG UNIVERSITY
DENMARK

The contribution of various sludge fractions to fouling in membrane bioreactors

Jørgensen, Mads Koustrup; Justesen, Rikke; Niessen, Wolfgang; Hansen, Susan Hove; Nielsen, Per Halkjær; Christensen, Morten Lykkegaard

Publication date:
2014

Document Version
Early version, also known as pre-print

[Link to publication from Aalborg University](#)

Citation for published version (APA):

Jørgensen, M. K., Justesen, R., Niessen, W., Hove Hansen, S., Nielsen, P. H., & Christensen, M. L. (2014). The contribution of various sludge fractions to fouling in membrane bioreactors. Poster session presented at Nordic Filtration Symposium, Lund, Sweden.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- ? Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- ? You may not further distribute the material or use it for any profit-making activity or commercial gain
- ? You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us at vbn@aub.aau.dk providing details, and we will remove access to the work immediately and investigate your claim.

Contribution of various sludge fractions to fouling in membrane bioreactors

Mads K. Jørgensen*, Rikke Justesen, Wolfgang Niessen, Susan H. Hansen, Per H. Nielsen & Morten L. Christensen

¹Department of Biotechnology, Chemistry and Environmental Engineering, Aalborg University, Frederik Bajers Vej 7H, 9220 Aalborg Øst, Denmark (*mkj@bio.aau.dk)

Introduction

Membrane bioreactors (MBR) for wastewater treatment provide high effluent quality, low footprint and efficient sludge degradation. However, the technology is limited by the accumulation of sludge compounds (fouling) on and within the membranes, which reduce the performance of the filtration process. Therefore, several studies have been performed in order to characterize and limit fouling in MBR. It is still not well described how the different sludge fractions (flocs, bacteria, colloids, extracellular polymeric substances (EPS) and macromolecules) influences fouling (1). The resistance-in-series experimental approach is often applied (1) but the method uses an indirect approach to assess the contribution of sludge fractions as it is assumed that fractions resistances are additive.

Aim

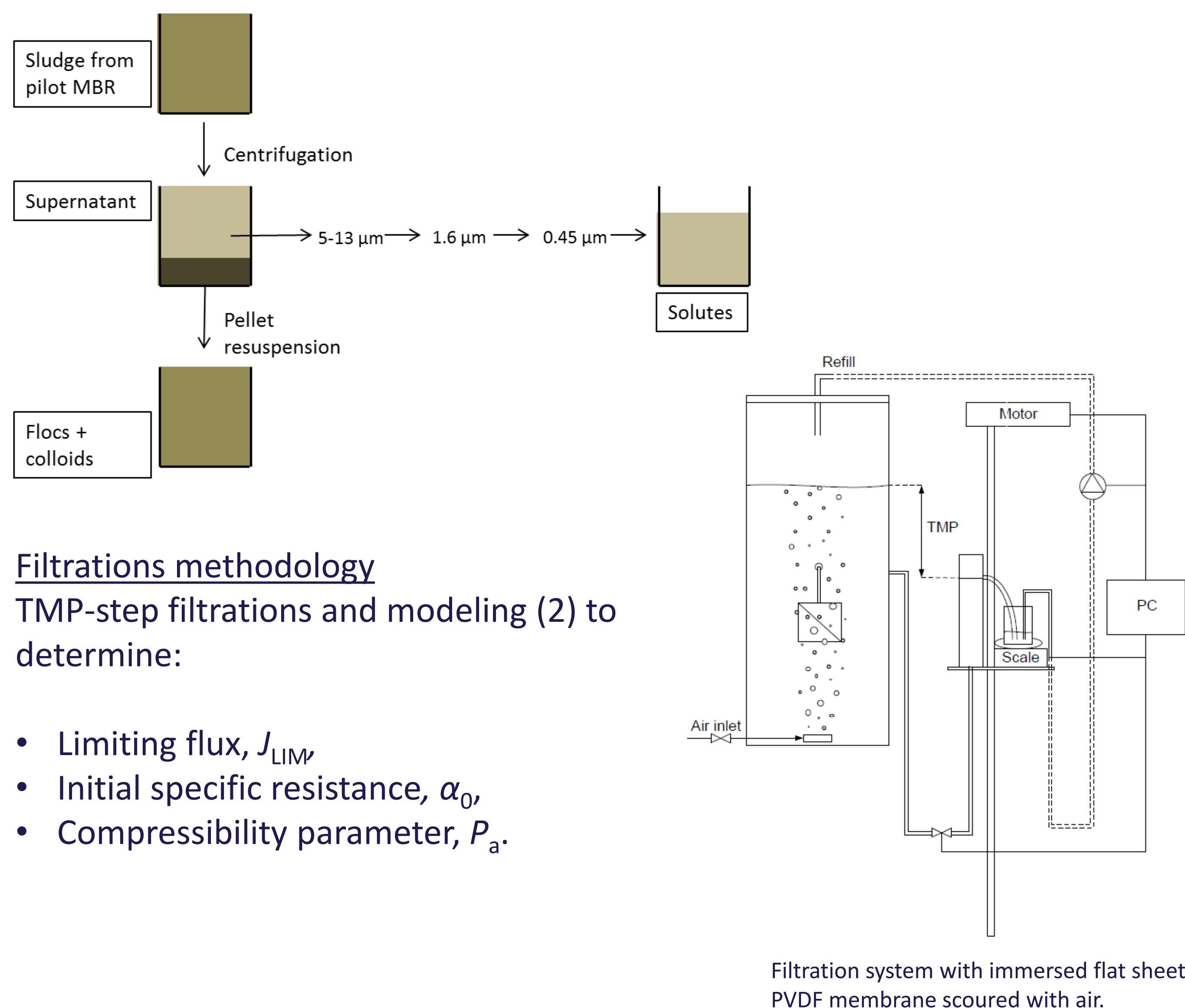
To analyze the fouling potential of different sludge fractions with an alternative approach: analyzing the relevant fractions and their filtration properties individually by transmembrane pressure (TMP) stepping experiments. Sludge supernatant, solutes and flocs are extracted from sludge samples and model solutions of EPS and bacteria are produced, to investigate their filtration properties.

Methodology

Sludge compounds filtration properties

Filtrations of:

- Fractionated sludge samples (see figure below)
- A model solution of extracellular polymeric substances (EPS) containing protein and humic acid
- *Pseudomonas* UK4 in phosphate buffer
- Model supernatant of EPS and *Pseudomonas* UK4 in concentrations ranging from $1 \cdot 10^5$ cells/mL to $1 \cdot 10^9$ cells/mL

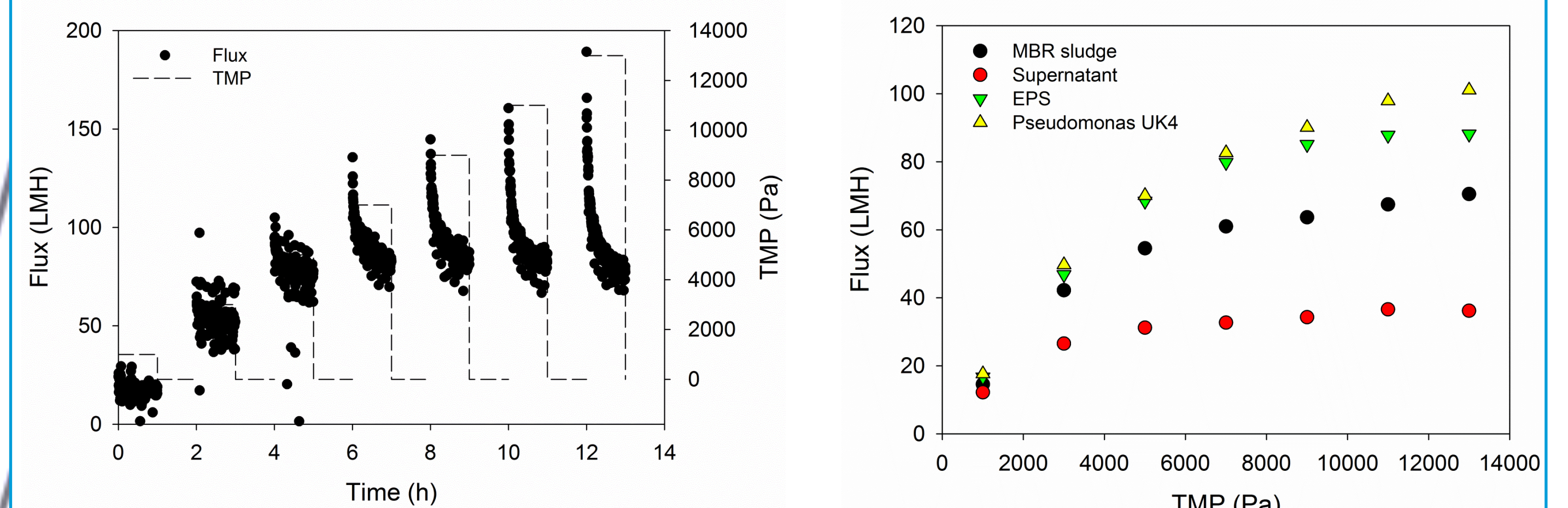


Filtrations methodology

TMP-step filtrations and modeling (2) to determine:

- Limiting flux, J_{LIM}
- Initial specific resistance, α_0
- Compressibility parameter, P_a

Sludge compounds filtration properties



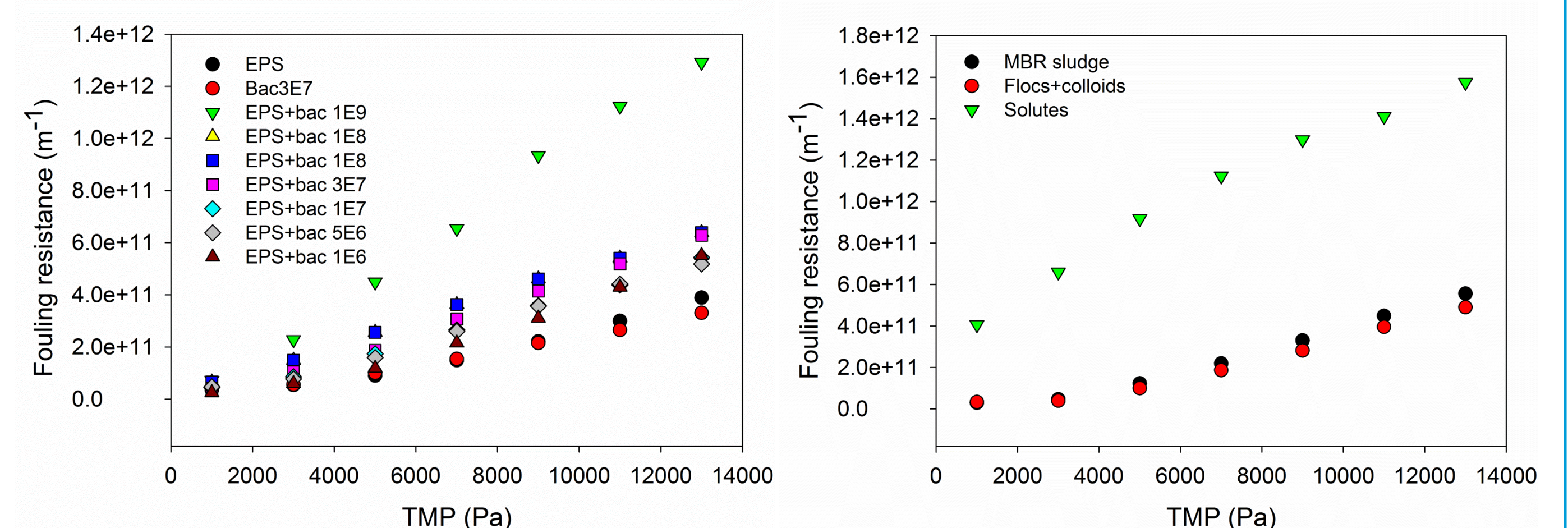
Flux and TMP vs. time in a TMP-step filtration experiment.

Flux after 60 min filtration vs. TMP for filtrations of different sludge compounds.

Limiting flux and fouling layer specific resistance and compressibility parameters for filtrations of sludge supernatant, model EPS and *Pseudomonas* UK4 bacteria.

	Sludge	Supernatant	EPS	<i>Pseudomonas</i> UK4
SS (g/L)	9.57	0.68	0.03	0.003
J_{LIM} (LMH)	70	37	88	101
R_c (1/m)	$4.2E+11$	$1.0E+12$	$3.3E+11$	$2.8E+11$
α_0 (m/kg)	$9.9E+10$	$5.8E+12$	$1.7E+13$	$3.1E+14$
P_a (Pa)	504	2160	6480	(incompressible)

Flocs and bacteria influence on fouling



Fouling resistance after 60 min filtration of solutions with EPS and bacteria in varying concentrations.

Fouling resistance after 60 min filtration of fractionated sludge samples.

Findings

- Single cell bacteria and EPS suspensions show lower filtration properties than MBR sludge in terms of lower flux and higher specific resistance of fouling layers.
- Single cell bacteria and EPS solutions form fouling layers that are less compressible than MBR sludge and supernatant.
- For EPS and bacteria suspensions, higher concentrations of bacteria showed higher degree of fouling.
- The resistances of fouling layers formed by single sludge fractions are not additive. Sludge flocs are beneficial for filtration, as they form a fouling layer with low specific resistance and high permeability.
- Future investigations should involve changing the relative content of solutes, colloids and bacteria to sludge flocs in MBR sludge rather than analyzing single fractions filtration properties.

References

1. I.-S. Chang, R.W. Field, Z. Zhanfeng, Desal. And Water Treat. 8:1-3 (2009) 31-36.
2. M.K. Jørgensen, T.V. Bugge, M.L. Christensen, K. Keiding, J. Membr. Sci. 409-410 (2012) 335-345

Acknowledgments

This study is funded by the EcoDesign MBR strategic research center. Lisbeth Wybrandt is acknowledged for experimental assistance.