Effect of consolidation and compression of biofouling layer on the performance of membrane bioreactors

SA Yala, VL Pillay

Stellenbosch University
Iyunivesithi
Universiteit

1. Background

- Despite the increase in the use of membrane bioreactor in wastewater treatment, fouling has remained a major operational challenge[1].
- Membrane fouling results into significant decline in membrane's performance and an increase in the operational cost[2].
- Hydrodynamic drag has been reported as one of the main contributors to fouling in membrane systems[3].
- However, the effects of hydrodynamic drag on membrane fouling in membrane bioreactors (MBR) and consequently its performance, has not been well researched.

2. Objectives

To experimentally quantify and model the effects of hydrodynamic drag on the performance of a membrane bioreactor

Note: -Only the modelling work is presented in this poster
-Experimental work is on-going

3. Methodology

3.1 Description of the problem

- Biological suspension of composition s is filtered at a flux J through a membrane which allows liquid through while retaining solids.
- A fouling layer is formed, and it grows in thickness with time, L (t), as filtration proceeds.
- As the liquid flows through the layer, it imparts hydrodynamic drag that compresses it, giving rise to solid compressive stress, P_s
- Compression changes the layer's properties such as solidosity ε_s and permeability k. This in turn increases pressure drop across the cake ΔP_c , decreases the flux and consequently increase the fouling resistance which decreases the ease of membrane cleaning.
- Therefore, a governing model equation relating the fouling layer characteristics, flux and ΔP_c will be generated to help analyse the effect of compression on the performance of MBRs in terms of volume processed and fouling resistance.

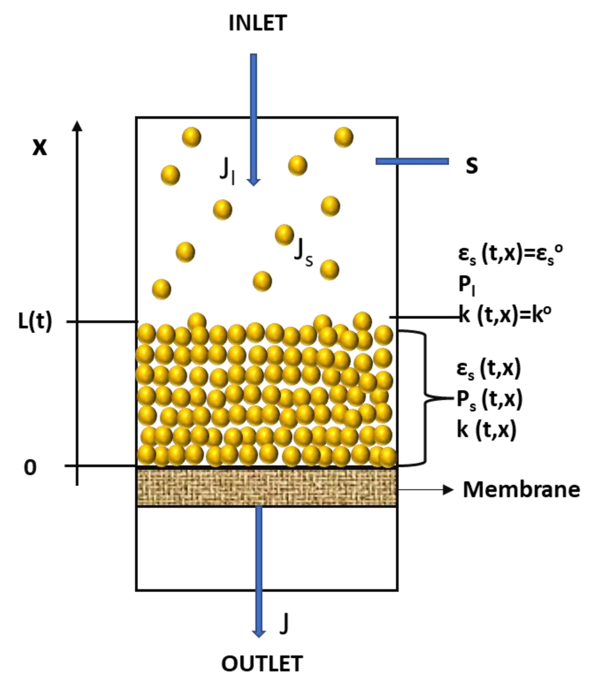
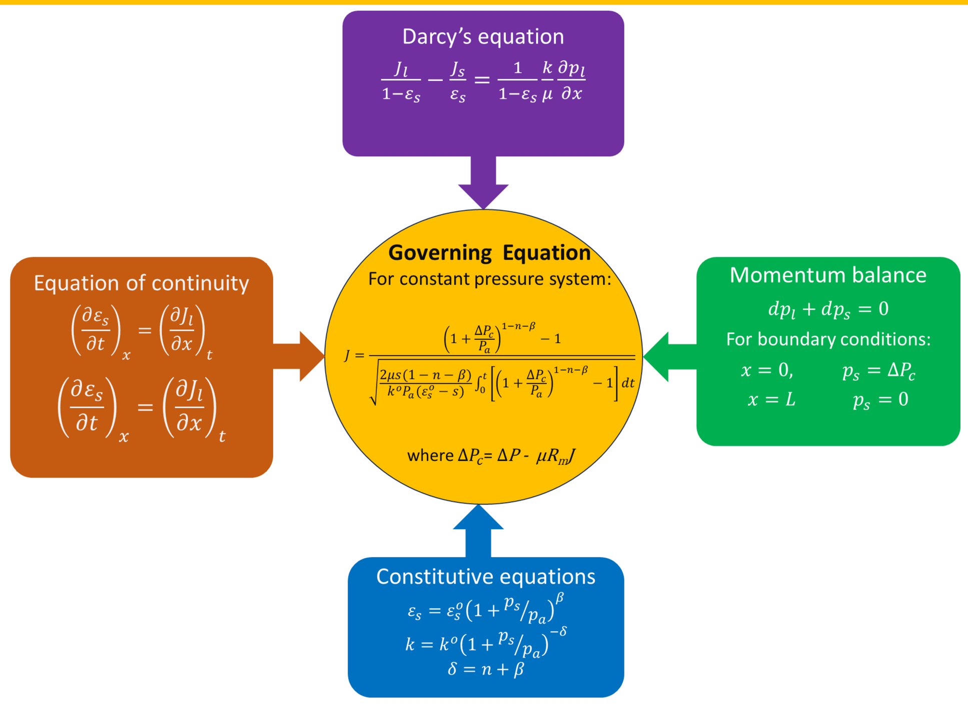


Fig 1: Schematic diagram of fouling layer formation and compression model

3.2 Model equation



3.3 Solution algorithm

The algorithm was used to calculate the volume processed and the fouling resistance at different hydrodynamic drag (applied pressure)

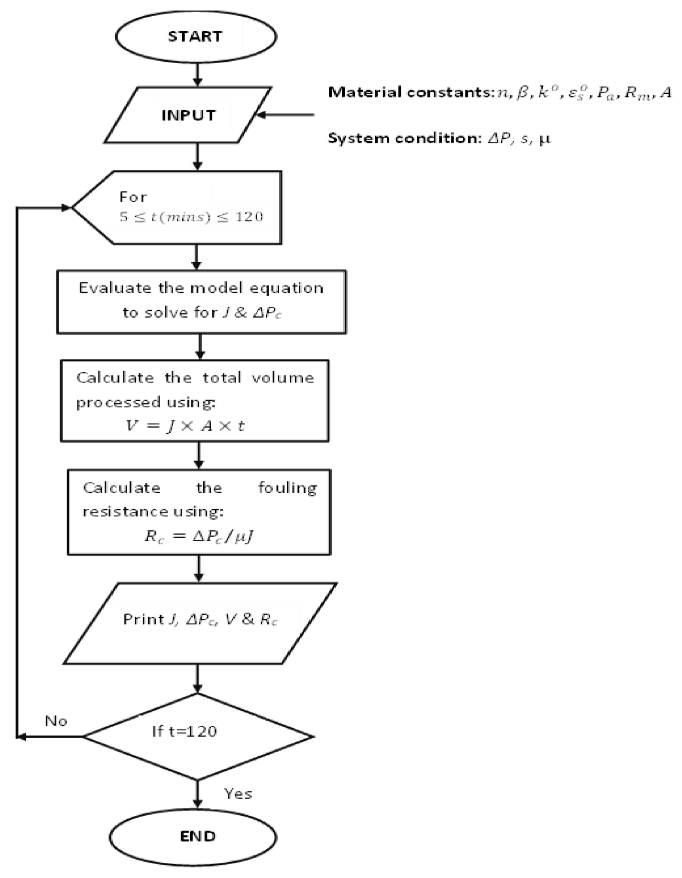


Fig 2: Solution algorithm for the calculation of MBR performance parameters from the model equation

4. Results

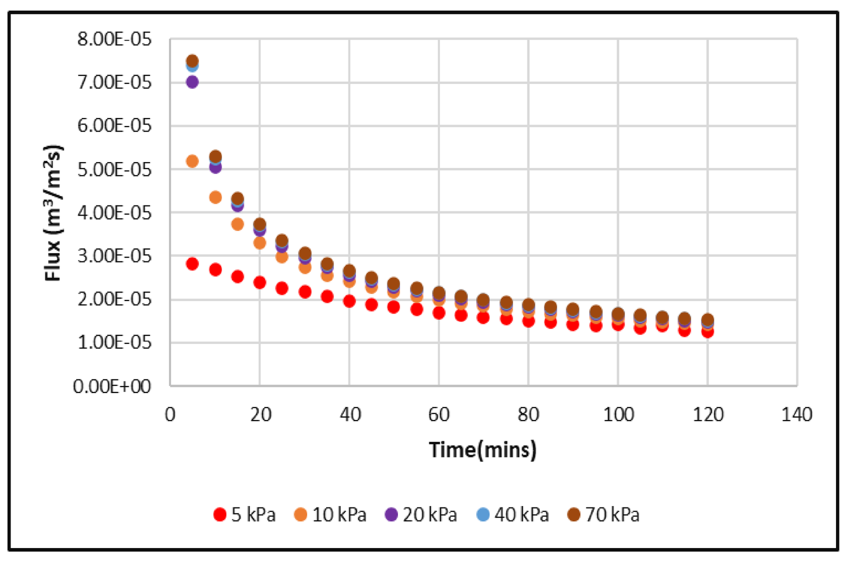


Fig 2: Flux profile for filtration runs done at different applied constant pressure

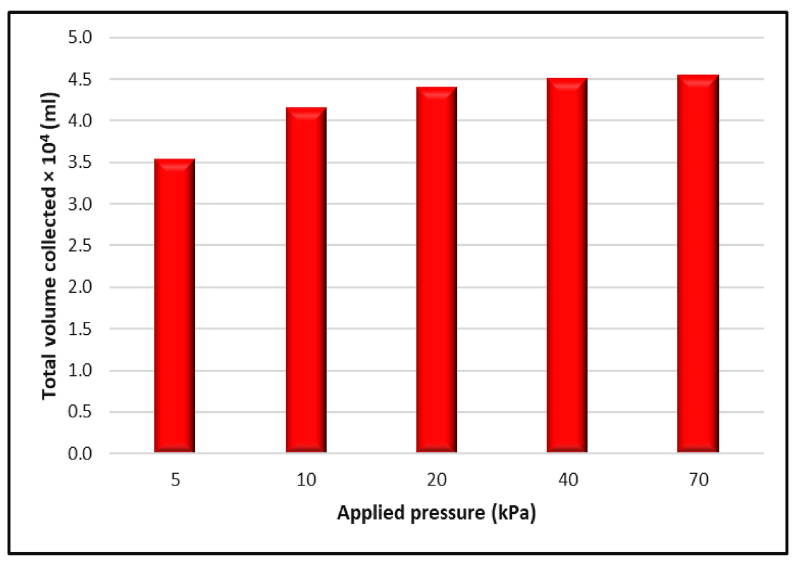


Fig 3: Total volume processed at the end of a 2-h filtration run done at different applied constant pressure

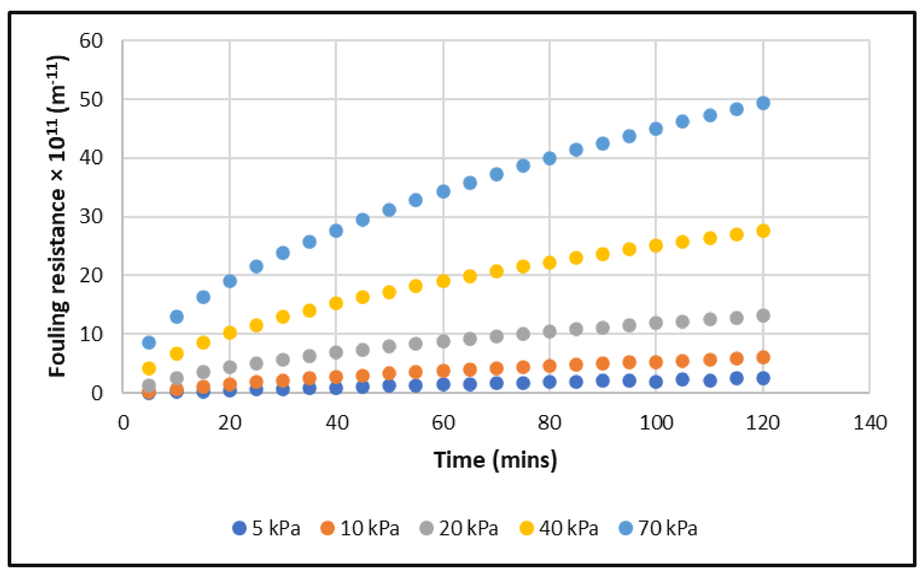


Fig 4: Fouling resistance profile for filtration runs done at different applied constant pressure

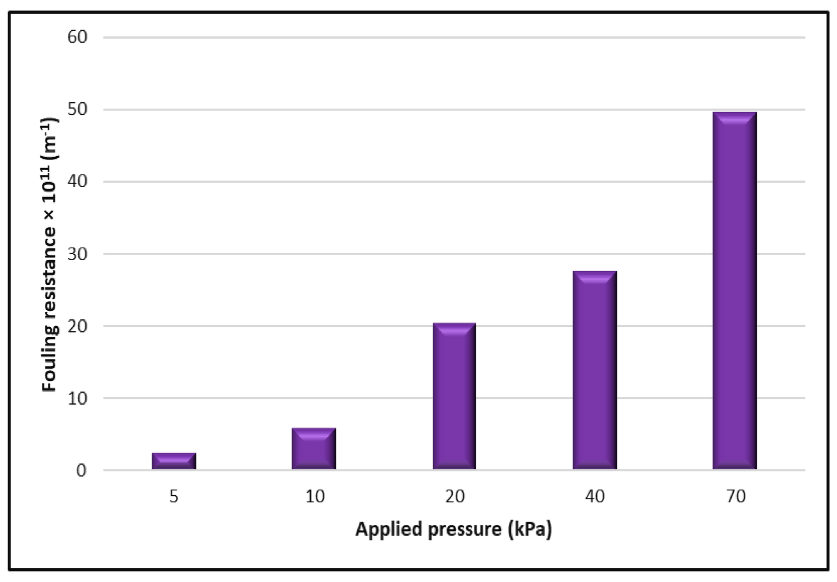


Fig 5: Fouling resistance at the end of a 2-h filtration run done at different applied constant pressure

5. Conclusion

- A model equation relating the fouling layer characteristics and membrane bioreactor performance has been developed in this study.
- The developed equation has been used to predicting the performance of MBR at different hydrodynamic drag conditions
- Compression due to hydrodynamic drag affects the performance of MBR in terms of volume processed and fouling resistance
- An increase in hydrodynamic drag increases the amount of volume processed until a certain level, then a further increase does not necessarily translate to a rise in volume processed. Instead, it increases the fouling resistance which will negatively affect ease membrane cleaning

References: **[1]** Sutrisna, P.D., Kurnia, K.A., Siagian, U.W.R., Ismadji, S. & Wenten, I.G. 2022. Membrane fouling and fouling mitigation in oil–water separation: A review. *Journal of Environmental Chemical Engineering*. 10(3):107532.
[2] Campinas, M., Viegas, R.M.C., Silva, C., Lucas, H. & Rosa, M.J. 2021. Operational performance and cost analysis of PAC/ceramic MF for drinking water production: Exploring treatment capacity as a new indicator for performance assessment and optimization. *Separation and Purification Technology*. 255:1174
[3] Bagheri, M. & Mirbagheri, S.A. 2018. Critical review of fouling mitigation strategies in membrane bioreactors treating water and wastewater. *Bioresource Technology*. 258:318–334.

Postgraduate Symposium 2023
Chemical Engineering