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Vibrating and patterned membranes for waste water treatment

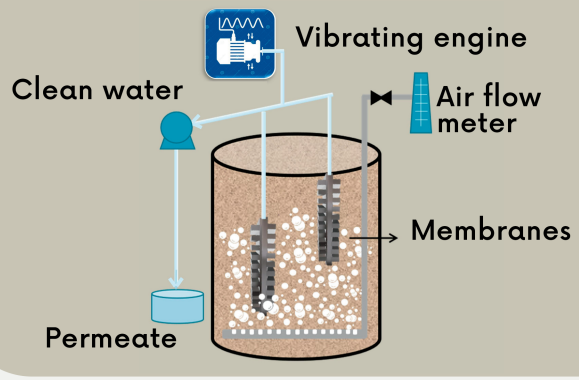
cMACS

Ayesha Ilyas[1], Loren Timmermans[1], Maarten Vanierschot[2], Ilse Smets[3], Ivo F.J. Vankelecom[1]*

Polyvinylidene difluoride (PVDF) based membranes have been used extensively for wastewater treatment. To mitigate membrane fouling, patterned PVDF membranes were prepared via spray-modified phase separation (s-NIPS) which resulted in membranes with large pattern heights of 750 ± 100 µm. Patterned membrane modules were then subjected to magnetically induced membrane vibration (MMV) applied perpendicular to the direction of the pattern to reduce foulant deposition and delay irreversible fouling in a submerged membrane bioreactor (MBR). This combination of surface patterning and membrane vibration resulted in significant fouling reduction due to improved hydrodynamics near the membrane interface.

Membrane fouling control via

Patterning & vibration



Pattered membrane

&

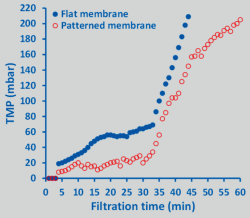
Module vibration

Check it Out

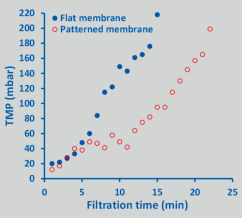
TMP rise

No vibration

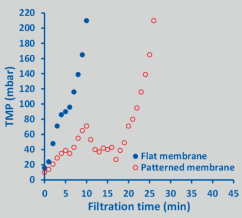
20 L m^{-2} h^{-1}



40 L m^{-2} h^{-1}

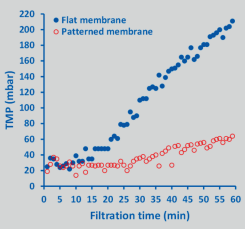


60 L m^{-2} h^{-1}

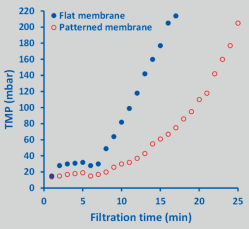


Vibration at 5 Hz

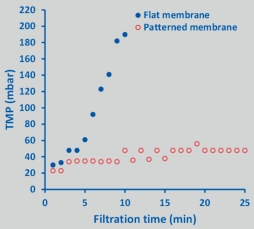
20 L m^{-2} h^{-1}



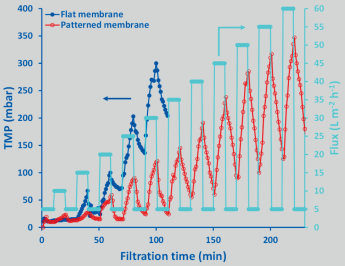
40 L m^{-2} h^{-1}



60 L m^{-2} h^{-1}

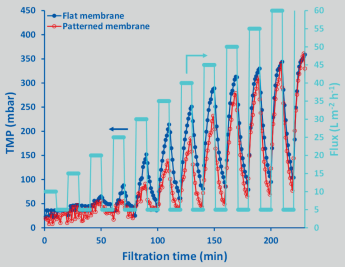


Critical flux



At a critical fouling rate of 10 mbar/min:
- Flat membrane: 20 L m^{-2} h^{-1}
- Patterned membrane: 40 L m^{-2} h^{-1}

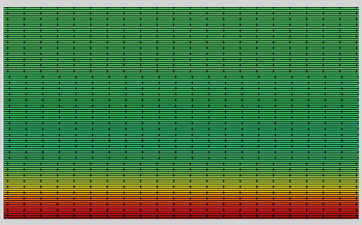
For irreversible fouling after relaxation:
- Flat membrane: 15 L m^{-2} h^{-1}
- Patterned membrane: 30 L m^{-2} h^{-1}



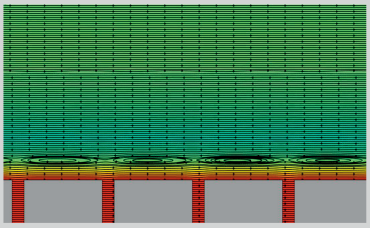
At a critical fouling rate of 10 mbar/min:
- Flat membrane: 25 L m^{-2} h^{-1}
- Patterned membrane: 40 L m^{-2} h^{-1}

For irreversible fouling after relaxation:
- Flat membrane: 25 L m^{-2} h^{-1}
- Patterned membrane: 40 L m^{-2} h^{-1}

CFD Simulation



Anti-fouling mechanism for flat & vibrating membrane:
- Higher surface velocities.
- Improved shear at interface.
- No formation of vortices



Anti-fouling mechanism for patterned & vibrating membrane:
- Higher surface velocities.
- Improved shear at interface.
- Vortices formation.
- Convecting vortices away from the membrane surface, keeping foulants away.

Conclusions

Operational costs associated with air scouring and membrane cleaning can thus be significantly reduced, hence confirming the high potential of s-NIPS patterned membrane combined with the low vibrational shear rate for energy-efficient and cost-effective wastewater treatment.

[1]Membrane technology group, cMACS, Faculty of Bioscience Engineering, KU Leuven, Belgium
[2]Department of mechanical engineering, Group T campus, KU Leuven, Belgium
[3]CREaS, Department of chemical engineering, KU Leuven, Belgium

More about patterned membranes? Explore here!