Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Engineering 44 (2012) 24 – 26

Procedia Engineering

www.elsevier.com/locate/procedia

Euromembrane Conference 2012

[OA02]

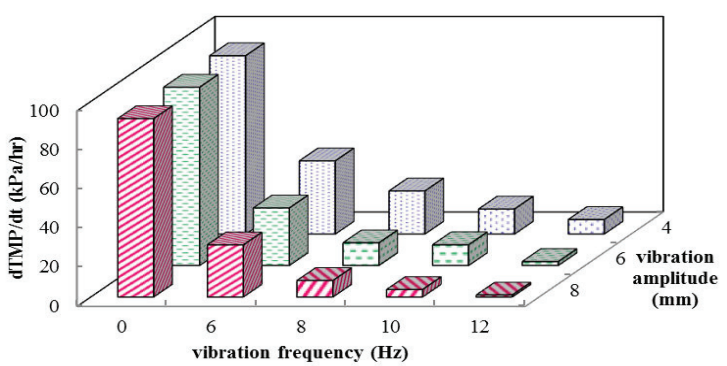
Fouling control of submerged hollow fibre membranes: The effect of vibrations and fibre looseness

T. Li*[1,2], A.W.K. Law[1,2], M. Cetin[1,2], A.G. Fane[1,2], F. Wicaksana[1,2]

[1]Nanyang Technological University, Singapore, [2]Singapore Membrane Technology Centre, Singapore

The submerged membrane bioreactor (SMBR) is widely used in wastewater treatment because it can produce high quality water in a reduced reactor size and also minimize sludge production (Lesjean *et al*., 2004). However, its application is still hindered by problems associated with concentration polarization and membrane fouling. For fouling mitigation, the use of hydrodynamic shear stresses on the membrane surface is recognized as one of the most effective techniques (Wicaksana *et al*., 2006; Jaffrin, 2008). Hydrodynamic shear stresses can be generated on the membrane surface by either moving the fluid next to the membrane or by vibrating the membrane surface. Vibrating the membrane module can induce dynamic shear stresses on the membrane surfaces thus has the potential for fouling mitigation (Genkin *et al*., 2006).

In the present study, we examine the improvement of fouling control of hollow fibre membranes with mechanical up and down sinusoidal vibration in a dead-end filtration of an inorganic solution. A group of 13 PAN Hollow fibres with outer/inner diameters of 1.7/1.0 mm vibrating at moderate frequencies (0-15Hz) and small amplitudes (0-12mm) were submerged vertically in a 4g/L Bentonite solution. Experiments were then conducted at both constant permeate flux and constant suction pressure conditions. The results showed that the mechanical vibration can improve the membrane filtration performance. The permeate flux generally increased with increasing vibration frequency and amplitude (see Fig. 1). It was also found that the membrane performance can be greatly improved when the vibration frequency or the vibration amplitude increased beyond a threshold magnitude. For example, over 90% reduction in the membrane fouling rate was achieved at 8mm amplitude and 8Hz frequency with vibration compared to no vibration. The cake filtration law was applied to analyze the cake resistance on the membrane surface. It can be found that cake resistance was significantly reduced with greater vibration frequency and amplitude which resulted in the lower membrane fouling and better permeate flux.



doi:10.1016/j.proeng.2012.08.295

Fig. 1 Fouling rate at different vibration amplitudes and frequencies, constant permeate flux =30LMH

A small degree of membrane looseness was also evaluated in this study. Experiments were conducted with tight fibres, 1% and 2% looseness. The results showed that a small looseness of 1% was able to further reduce the membrane fouling and increase the permeate flux under vibration. This improvement can be significantly attributed to the additional movement of the fibres induced by the looseness. The vibration enhancement factor increased with increasing vibration frequency and it reached as high as 3 for 1% looseness, which was much higher than for the tight fibres (see Fig. 2). However, very little improvement was noted for all the vibration frequencies when the fibre looseness increased from 1% to 2%. The results confirmed that the fibre looseness can improve the membrane performance with vibration, and only a looseness of 1% would be sufficient to realize the improvement. This is important as too much looseness could cause fibre damage.

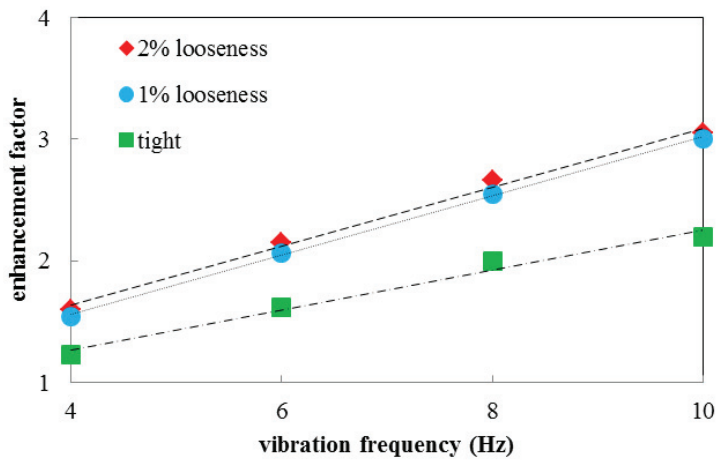


Fig. 2 Vibration enhancement factor for tight and loose fibres at different vibration frequencies, vibration amplitude = 8mm

Overall, the results from the present study confirm that vibrations are an effective way to improve submerged hollow fibre membrane performance and the effect is enhanced by a small degree of fibre looseness. At high vibration frequencies and amplitudes, the cake layer resistance can be reduced substantially by vibrations due to the dynamic shear enhancement on the membrane surface. A small degree of looseness (≤1%) would save energy as the intensity of vibration can be reduced to achieve the same effect.

Acknowledgements

The authors gratefully acknowledge Environment and Water Industry (EWI) Singapore for research funding support. The valuable suggestions from Prof. William Bill Krantz from University of Colorado and collaborations from Dr Adrian Yeo from Singapore Membrane Technology Centre are also gratefully acknowledged.

References

G. **Genkin**, T.D. Waite, A.G. Fane and S. Chang, (2006). The effect of vibration and coagulation addition on the performance of submerged hollow fibre membranes. Journal of Membrane Science, 281(1-2), 726-734.

M.Y. **Jaffrin**, (2008). Dynamic shear-enhanced membrane filtration: A review of rotating disks, rotating membranes and vibrating systems. Journal of Membrane Science 324(1-2): 7-25.

B. **Lesjean**, S. Rosenberger, J.C. Schrotter, A. Recherche (2004). Membrane-aided biological wastewater treatment - an overview of applied systems. Membrane Technology 8: 5-10.

F. **Wicaksana**, A.G. Fane, and V. Chen, (2006). Fibre movement induced by bubbling using submerged hollow fibre membranes, Journal of Membrane Science, 271 (1-2), 186-195.

Keywords: vibration, hollow fibres, looseness, shear