THE EFFECT OF STERILIZATION ON KEY FILTRATION PERFORMANCE PARAMETERS OF A COMMERCIAL POLYMERIC ULTRAFILTRATION MEMBRANE

A. Nastouli[1,2], S.I. Patsios[1,*], A. Tsirigka[1], M. Harasek[2], A.J. Karabelas[1]

[1] Chemical Process and Energy Resources Institute, CERTH, Thermi, Thessaloniki, Greece
[2] Institute of Chemical, Enviromental and Bioscience Engineering, TU Wien, Vienna, Austria
* patsios@certh.gr

ABSTRACT

Fermentation is a well-known biotechnological process for the production of various products, where sterile conditions are typically required.[1,2]. Membrane processes can be integrated with fermentation for the selective separation of the products from the fermentation broth, for cell recycling or for employing a continuous fermentation process.[3] Many commercial ultrafiltration (UF) membranes, used in biotechnological applications as well as in wastewater treatment, are made from polyvinylidene fluoride (PVDF), which is preferred due to its chemical and oxidation resistance, high strength, and high thermal stability.[4,5] When sterile conditions are necessary, in the case of hybrid biotechnological/membrane processes, the membranes should be also sterilized.[1,3]. Thermal sterilization, with saturated steam under pressure, is the most widely used method.[6]

The objective of this study was to evaluate the effect of the sterilization process (i.e. at 121 °C temperature for 20 min), on the filtration performance of a commercial PVDF hollow fiber UF membrane (PURON® MBR, Koch Separation Solutions). A hand-made membrane module, of 235 cm^2 filtration area was constructed and sterilized (while immersed in deionized water) multiple times in an autoclave (121 °C, 20 min). Clean water flux tests were performed after each sterilization step, to assess the effect of thermal sterilization on the clean-water permeability of the membrane. To characterize the membrane concerning its typical pore size and its fouling properties, dextran rejection tests[7] were also performed, after each cycle of sterilization (10 cycles in total).

Permeability was quite constant, varying between 800 and 1000 $L \cdot m^{-2} \cdot h^{-1} \cdot bar^{-1}$, while typical pore size was in the range 30 to 100 kDa. The clean-water permeability results are similar to the reference values of the commercial membrane[8], whereas the experimental pore size estimates, were slightly lower than the expected typical pore size (i.e. 30nm). Concerning fouling behaviour, the trans-membrane pressure (TMP) increase rate ($\Delta TMP/\Delta t$) for the steam-sterilized membrane varied between 0.5 and 3.0 mbar/min, whereas for the pristine membrane the TMP increase rate was 7.0 mbar/min. The results show that commercial PVDF UF membranes are a viable alternative to high-cost ceramic UF membranes for fermentation processes that require heat sterilization.

KEYWORDS: Ultrafiltration, PVDF, Steam Sterilization, Fermentation

REFERENCES

[1] Restaino, O.F., Cimini, D., De Rosa, M., Catapano, A., De Rosa, M., Schiraldi, C., (2011). *Microb. Cell Fact.* 10 (1): 1-10.
[2] Wang, C., Li, Q., Tang, H., Zhou, W., Yan, D., Xing, J., Wan, Y., (2013). *J. Chem. Technol. Biotechnol.* 88 (3): 444-448.
[3] Krige, A., Nicol, W. (2015). *Process Biochem.* 50 (12): 2004-2011.
[4] Lorain, O., Marcellino, S., Deratani, A., Gassara, S., Duchemin, I., Espenan, J. M., (2020). *Water Pract. Technol.* 15 (2): 356-364.
[5] Wang, W., Xu, X., Zhang, Z., Zhang, P., Shi, Y., Ding, P., (2021). *Colloids Interface Sci. Commun.* 43 (1-2): 100433.
[6] Armenante, P. M., Akiti, O., (2019). *Chemical Engineering in the Pharmaceutical Industry: Drug Product Design, Development, and Modeling*: 311-379.

[7] Zydney, A. L. and Xenopoulos, A., (2007). *Journal of Membrane Science*, 291 (1-2): 180-190.
[8] Joss, A., Böhler, M., Wedi, D., Siegrist, H., (2009). *Water Sci. Technol.* 60 (2): 497-506.