Journal of Membrane Science & Research

journal homepage: www.msrjournal.com

Editorial Note

Progress on Membrane Distillation and Related Technologies

Mohamed Khayet[1,2,*] Carmen García Payo[1]

[1] *Department of Applied Physics I, Faculty of Physics, University Complutense of Madrid, Avda. Complutense s/n 28040 Madrid, Spain*

[2] *Madrid Institute of Advances Studies of Water (IMDEA Water Institute), Calle Punto Com n° 2, 28805 Alcalá de Henares, Madrid, Spain*

Email: khayetm@fis.ucm.es

It was 53 years ago when the first Membrane Distillation (MD) patent was filed [1] and 49 years ago when the first MD paper was published [2]. Since then, a tremendous progress has been made on all aspects of MD science and technology going from membrane and module engineering, theoretical approaches and simulation to industrial implementation.

Briefly, MD is a non-isothermal membrane separation process used for water treatment in general, and desalination field in particular, including the treatment of brines produced by industrial reverse osmosis desalination plants. It is a thermally driven transport of vapor through non-wetted porous membranes by vapor pressure difference between two sides of the membrane pores as a driving force (i.e. water chemical potential difference). In this process, both heat and mass transfer through the membrane take place simultaneously. Different MD configurations are considered in order to apply the mentioned driving force (direct contact membrane distillation, DCMD; sweeping gas membrane distillation, SGMD; vacuum membrane distillation, VMD; air or liquid gap membrane distillation, AGMD or LGMD and their hybrid modes) [3, 4].

The observed growing interest on MD technology is due to various reasons, especially to its advantageous characteristics. For instance, in MD the temperatures lower than in the conventional distillation and the operating hydrostatic pressures lower than in the pressure-driven membrane processes (e.g. reverse osmosis, nanofiltration, microfiltration) can be applied. Therefore, renewable energy sources such as solar energy and waste heat sources were used to run different MD pilot plants [5]. Furthermore, this technology exhibits high rejection factors of non-volatile solutes from water (i.e. not only distilled water can be produced by MD but also ultrapure water with a great interest for some special industries like semi-conductors or pharmaceuticals).

We, the guest Editors, have been asked by the Editor-in-Chief of *Journal of Membrane Science & Research* (JMSR) to coordinate this interesting special issue, which is oriented to the most recent progresses made so far on MD technology in general. This issue covers multidisciplinary MD topics including both experimental and theoretical research studies such as membrane preparation and modification by O.B. Seng et al. *(Performance of chemically modified TiO2-poly (vinylidene fluoride) DCMD for nutrient isolation and its antifouling properties);* membrane optimization using response surface methodology by T. Vazirnejad et al. *(Application of salt additives and response surface methodology for optimization of PVDF hollow fiber membrane in DCMD and AGMD)*; membrane module design by A. Ali et al. *(On designing of membrane thickness and thermal conductivity for large scale membrane distillation modules)*, different MD applications going from the separation of non-volatile solutes from water such as nanoparticles by O.B Seng et al. *(Nanoparticle separation using direct contact membrane distillation and its fouling study)*, to the removal of volatile solute such as broths separation in membrane bioreactors (e.g. ethanol, citric, acetic and lactic acids, glycerol and 1,3-propanediol) by M. Gryta *(The application of membrane distillation for broth separation in membrane bioreactors)* or the application in food industry concentrating fruit juices by A. Boor et al., *(Concentration of colourful wild berry fruit juices by membrane osmotic distillation via cascade model systems)*, and a preliminary evaluation of MD energy requirement by Z. Xie et al. *(Preliminary Evaluation for VMD Energy Requirement)*.

The contents of this special issue through the mentioned peer-reviewed papers also include different MD configurations (DCMD, AGMD, VMD, and osmotic membrane distillation, OMD), a comparative study between MD configurations, different membrane characterization techniques, studies on fouling phenomena as well as long-term application of MD among others.

Despite the observed enormous success of MD technology during last 10 years, there are still numerous and serious issues to be addressed in order to guarantee its continuous progress. Fields of great future perspectives are the use of different renewable energy sources (solar energy, wind energy, geothermal energy, etc.) looking at the reduction of the MD water production cost; comprehensive analysis of water production costs and specific energy consumption are demanded providing that dispersed and confusing calculations were reported based on simulations or costs assumptions [6]; design of advanced membranes and modules for MD in order to reduce further the heat lost by conduction through the membrane and increase therefore the thermal efficiency of the process; explore the proposed MD pilot plants for long-term applications; study of scaling and/or crystallization fouling; etc.

Last but not least we, the guest Editors of this special issue, wish to express our appreciation to all authors and co-authors for their interesting and comprehensive contributions, the reviewers for their valuable comments and the editorial team of the *Journal of Membrane Science & Research* (JMSR) for their incessant assistance, patience and supports.

References

[1] B.R. Bodell, Silicone rubber vapor diffusion in saline water distillation, United States Patent Serial No. 285,032 (1963).

[2] M.E. Findley, Vaporization through porous membranes, Ind. & Eng. Chem. Process Des. Dev. 6 (1967) 226-237.

[3] M. Khayet, T. Matsuura, Membrane Distillation: Principles and Applications, Elsevier, The Netherlands, 2011.

[4] M. Khayet, Membranes and theoretical modeling of membrane distillation: a review, Adv. Colloid Interface Sci. 164 (1–2) (2011) 56-88.

[5] M. Essalhi, M. Khayet, Fundamentals of membrane distillation, pp. 277-316 in Pervaporation, Vapour Permeation and Membrane Distillation Principles and Applications, A. Basile, A. Figoli, M. Khayet, Woodhead Publishing, imprint of Elsevier, Cambridge (UK), 2015.

[6] M. Khayet, Solar desalination by membrane distillation: dispersion in energy consumption analysis and water production costs (a review), Desalination 308 (2013) 89-101.