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Water Desalination by Membrane Distillation with MFI Zeolite Membranes

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Abstract : Nowadays, water scarcity may be considered one of the most important and serious questions concerning our community: in fact, there is a remarkable mismatch between water supply and water demand. Exploitation of natural fresh water resources combined with higher water demand has led to an increased requirement for alternative water resources. In this context, desalination provides such an alternative source, offering water otherwise not accessible for irrigational, industrial and municipal use. Considering the various drawbacks of the polymeric membranes, zeolite membranes represent a potential device for water desalination owing to their high thermal and chemical stability. In this area wide attention was focused on the MFI (silicalite, ZSM-5) membranes, having a pore size lower (about 5.5 Å) than the major kinetic diameters of hydrated ions. In the present work, a scale-up for the preparation of supported silicalite membranes was performed. Therefore, tubular membranes 30 cm long were synthesized by using the secondary growth method coupled with the cross flow seeding procedure. The secondary growth presents two steps: seeding and growth of zeolite crystals on the support. This process, decoupling zeolite nucleation from crystals growth, permits to control the conditions of each step separately. The seeding procedure consists of a cross-flow filtration through a porous support coupled with the support rotation and tilting. The combination of these three different aspects allows a homogeneous and uniform coverage of the support with the zeolite seeds. After characterization by scanning electron microscope (SEM), X-ray diffractometry (XRD) and Energy-dispersive X-ray (EDX) analysis, the prepared membranes were tested by means of single gas permeation and then by Vacuum Membrane Distillation (VMD) using both deionized water and NaCl solutions. The experimental results evidenced the possibility to perform the scale up for the preparation of almost defect free silicalite membranes. VMD tests indicated the possibility to prepare membranes that exhibit interesting performance in terms of fluxes and salt rejections for concentrations from 0.2 M to 0.9 M. Furthermore, it was possible to restore the original performance of the membrane after an identified cleaning procedure. Acknowledgements: The authors gratefully acknowledge the support of the King Abdulaziz City for Science and Technology (KACST) for funding the research Project 895/33 entitled ‘Preparation and Characterization of Zeolite Membranes for Water Treatment’.

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