

Vacuum membrane distillation for an integrated seawater desalination process

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ABSTRACT

Seawater desalination by reverse osmosis (RO) is widely used for drinking water production. In order to reduce the volume of brines and to increase recovery, a new approach is proposed in the frame of the European MEDINA project. It lies on a combination of RO and vacuum membrane distillation (VMD) in order to over concentrated RO retentates and to reduce their volume. Indeed, VMD can be used for concentrated salty solutions, because concentration polarization and temperature polarization might be non limiting even for quite high salt concentrations. The objective of this paper is to provide some first trends on the feasibility of using VMD for enhancing the global process recovery. The approach is firstly based on simulations for highly concentrated solutions using a VMD modeling based on Knudsen diffusion through the membrane which was improved to take into account highly concentrated waters. The model was validated by experimental results obtained with different salty solutions and with both flat-sheet and hollow fiber membranes. Simulations were then performed to estimate possible performance with brines and over-concentrated seawater in order to choose the best operating conditions for membranes of different permeability. The influence of vacuum pressure, temperature and feed water velocity was studied. As for more diluted solutions the main sensitive operating parameters are temperature and vacuum pressure. A compromise between high permeate flux obtained in these conditions and specific energetic consumption (without taking into account energy recovery) for the separation process was also discussed. Simulations showed that high permeate flux can be expected even for highly concentrated waters. With these chosen operating conditions, experiments with natural seawaters showed a permeate flux decrease with time that may be caused by some salt crystallization on the membrane, deposit of NOMs and biofouling. However, this fouling is reversible and easily removed by a hydraulic washing. These preliminary results with highly concentrated waters show the potential interest of the use of vacuum membrane distillation as an integrated process with RO. Further experiments will focus on experiments with real seawaters to study more deeply fouling and biofouling phenomena for over-concentrated solutions.

Keywords: Membrane distillation; Brine disposal; Seawater desalination; High concentrations; Integrated approach

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