Study of the performances of different configurations of seawater desalination with a solar membrane distillation

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ABSTRACT

The object of this study is the comparison between two configurations of hollow fiber module for seawater vacuum membrane distillation. The first one is a module membrane in series with a solar compound parabolic collector (CPC). The second configuration is a hollow fiber module integrated in a cylindrical absorber of CPC. A model describing the operation of a hollow fiber module, with and without recycling, will be developed. This model determines the instantaneous variation of the temperature of each element of the installation with the distillate flow variation. A comparison of each module production is carried out. A mathematical model describing the performances of different configurations for membrane hollow fibers shows that: (1) The permeate flow for the integrated configuration is always higher than that of not integrated. It can be multiplied by two and even more. (2) The recycling of concentrate makes it possible to improve the production. This is due to the high level temperature at the exit of the module. (3) The energy recovery from the distillate will make it possible to increase the production and to reduce the plant size.

Keywords: Desalination; Modelling; Configuration; Hollow fiber module; Integrated

1. Introduction

Membrane distillation (MD) is a thermal membrane separation process which uses hydrophobic porous membranes to separate a solution physically. The process driving force is the difference between the vapor pressure between the two sides of the membrane [1,2]. The hydrophobic nature of the membrane prevents liquid solutions from entering its pores due to the surface tension forces. As a result, liquid/vapor interfaces are formed at the entrances of the membrane pores. The principle of separation by MD is based on the liquid/vapour equilibrium which controls the selectivity of the process [3–6].

The principal interests of MD compared to other popular separation processes are the lower operating temperatures than the conventional distillation, the lower operating pressures than the pressure-driven processes, the less demanding membrane mechanical properties and the high rejection factor achieved when solutions containing no-volatile solutes [7,8], as well as the greater contact specific area due to the installation compactness, the modularity and the possibility of automating the process easily.

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