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Performances of a three-effect plate desalination process

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Abstract

The EasyMED process is composed of an association of simple "human-size" elementary cells. The plates, frames and grids constituting each cell are easy to construct and transport [1]. The cells can be combined in parallel and series to form evaporators with variable capacity. In order to demonstrate the performances of this new process, a laboratory unit was constructed. It is composed of five evaporation-condensation cells. Three operate in series and two in parallel. The distillation of synthetic salted water is studied and brine is recycled to avoid consumption and waste of large quantities of salt. The heat carrier fluid is hot water produced by electric devices. The influence of operating parameters like heating fluid flowrates, temperature difference between effects is investigated. The optimal film flowrate deduced from previous tests is 200 L/h/cell [1]. The average distilled water production is 0.95 m^3/d. The distillate conductivity is less than 12 μS/cm. The measured thermal performances are satisfactory: thermal efficiency $\approx$77%, gain output ratio $\approx$2.6. The overall heat transfer coefficients between condensation cell and evaporation cell of the next effect reached 2500 $W.m^{-2}.K^{-1}$ for a temperature difference of 3–4°C. The coefficient between heating cell and evaporation cell of the first effect is around 1100 $W.m^{-2}.K^{-1}$. These performances are promising, and by increasing the number of effects in series in a larger industrial unit, the GOR will be largely increased and the specific consumption decreased.

Keywords: Multiple effect distillation; Heat transfer; Plate; Evaporation; Thermal desalination

1. Introduction

The EasyMED project supported by the European Commission under the 5th Research Framework Programme, aims to contribute to the technological development of an improved cost and energy efficient plate multi-effect distillation (MED) desalination process. The proposed innovative thermal

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process will contribute to the diversification of MED processes recognised as a promising technology for the desalination world market.

A first laboratory study on a single-effect unit with a transparent wall [1] enabled to optimize the design of the falling film distribution system and to find good operating conditions. The second step consists in testing this new process design with a pilot composed of three effects in series (see schematic view on Fig. 1) in order to validate the innovative EasyMED concept: vapour flow inside the system from the evaporation zone to the condensation one in order to supply energy for the following effect.

A three-effects unit was therefore constructed in Nancy to test the performances with synthetic seawater circulating in closed loop in order to demonstrate the feasibility of the process. After a step of technical and geometric design optimisation, the thermal performances were measured for different experimental conditions. The results of this laboratory study have been later used for the design of a pre-industrial unit to be tested in Mediterranean Sea shore [2].

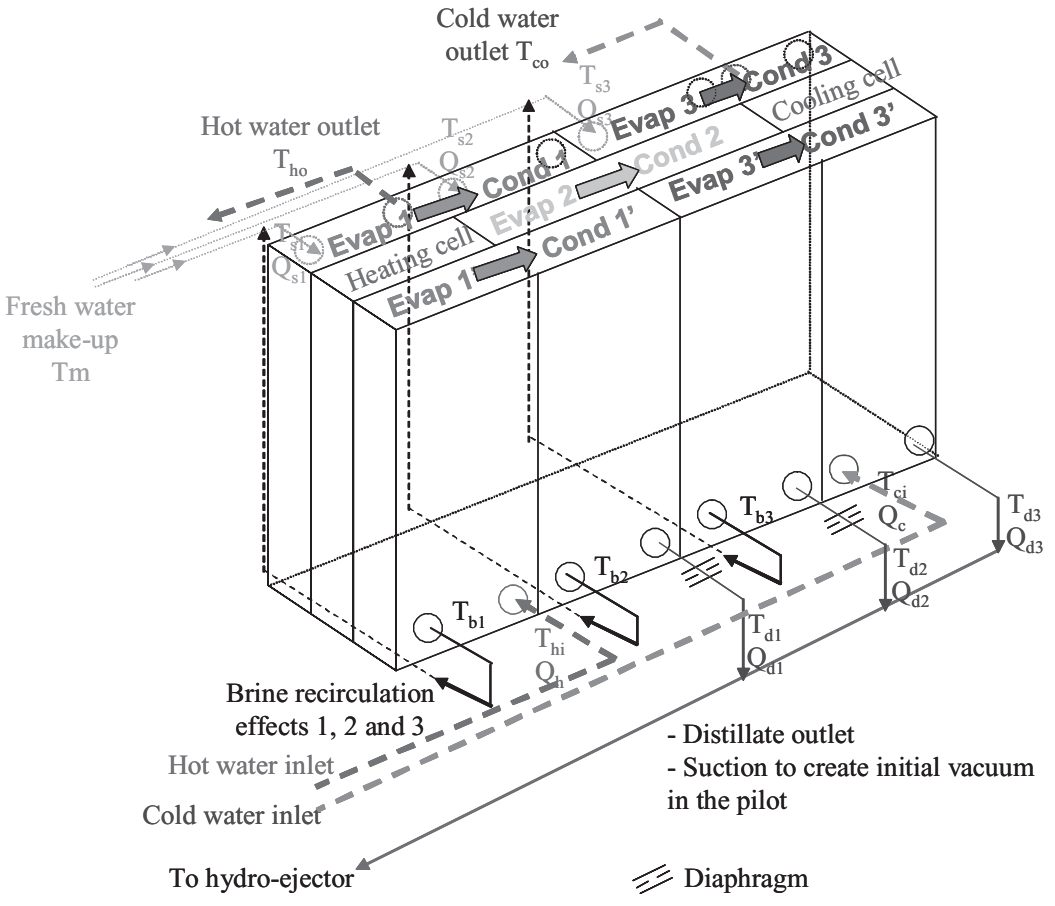

Fig. 1. 3-D view of the pilot with inlets (i) and outlets (o). Subscripts: h, heating fluid; b, brine; s, salted water; d, distillate; c: cooling fluid. T denotes temperature and Q denotes volume flowrate.