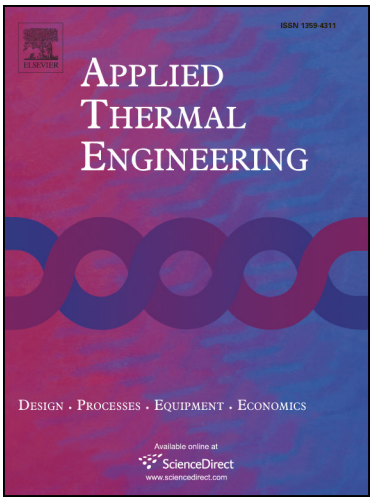

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Energetic evaluation of a double-effect LiBr-H_2O absorption heat pump coupled to a multi-effect distillation plant at nominal and off-design conditions

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Abstract

This paper presents the experimental characterization of a double-effect absorption heat pump (DEAHP) using lithium bromide-water (LiBr-H_2O) which recovers the low-energy latent heat from the last effect of a multi-effect distillation (MED) plant. The experimental facility is located at the Plataforma Solar de Almería (PSA) and the test campaign has been performed with the aim to find the best operating strategies that minimize the energy consumption and maximize the energetic efficiency of the DEAHP-MED system taking also into account the distillate production of the MED unit. For this purpose, the impact of the variation of the input variables by which the DEAHP-MED system can be controlled (MED inlet hot water flow rate, MED inlet hot water temperature, the live steam flow rate and the DEAHP cooling water flow rate) on the coefficient of performance (COP), the performance ratio (PR) and on the total distillate production, has been analysed in two different coupling schemes between the DEAHP and the MED unit (indirect and direct). The results revealed that in direct mode, the rise in the live steam flow rate has the greatest impact on the distillate production and the increase of the MED inlet hot water flow rate and the DEAHP cooling flow rate on the COP. In the indirect mode, the rise in the MED inlet hot water temperature was the most influential in both parameters. The maximum COP, distillate production and PR was 2.08±0.34, 2.42±0.07 m^3/h, and 18.53±1.94, respectively in the direct mode and 2.04±0.39, 1.92±0.11 m^3/h, 16.67±3.42, respectively the indirect mode. Moreover, empirical correlations that forecast the PR and the distillate production as a function of the COP were developed from the characterization results and were validated statistically by the coefficient of determination (R^2) and the adjusted R^2(R^2_{adj}).

***Keywords*:** Thermal desalination; Absorption heat pump; Multi-effect distillation; Energetic efficiency; Experimental characterization; Empirical equations

1. Introduction

One of the best options to make an MED process competitive with respect to reverse osmosis is to increase its energy efficiency. There are different possibilities but the most efficient one is recovering part of the thermal energy rejected in the distillation process with a heat pump, Adsorption Heat Pump (ADHP) or Absorption Heat Pump (AHP). The recovery and thus the energy efficiency of the system are higher when the AHP has two generators (double-effect absorption heat pump, DEAHP), so it is of great interest to couple MED units with DEAHPs.