



Alternative absorption heat transformer configurations integrated with water desalination system



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HIGHLIGHTS

- Alternative configurations of absorption heat transformer are integrated in desalination system and analyzed in detail.
- Crystallization risk is considered.
- Regarding the quantity of distilled water rate, an optimization is performed.

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ABSTRACT

Alternative configurations of absorption heat transformer (AHT) systems using LiBr/H₂O as the working fluid and integrated with a water purification system are analyzed and optimized thermodynamically. The waste heat from a textile factory is utilized to run the AHT systems and the generated high temperature heat is employed for the purpose of desalination. A computer program is developed in EES (Engineering Equation Solver) to investigate the effects of different parameters on four different configurations of AHT and the desalination system. It is shown that applying different modifications can increase the coefficient of performance (COP) of the AHT and consequently the productivity of the desalination system. The maximum rate of distilled pure water reaches 0.2435 kg/s when waste heat from the condenser is utilized by the evaporator. Finally, the risk of crystallization of LiBr is lowered in the modified configurations.

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1. Introduction

Water and energy are two inseparable items that govern our lives and promote civilization. In order to produce potable water from the sea or brackish water several desalination techniques are employed [1]. The most developed and widely practiced desalination method is the distillation process. The distillation of sea or brackish water can be achieved by utilizing a thermal energy source [2]. Large amounts of low-temperature waste heat are released daily from many industrial plants to the atmosphere at temperatures between 60 and 100 °C [3]. Absorption heat transformers (AHTs) can be exploited to utilize this low-grade heat and improve energy efficiency of the plants. The absorption heat transformer (AHT) systems work in a cycle opposite to those of absorption heat pumps (AHPs) in order to increase these low or moderately warm heat sources to more useful levels. A heat transformer is a device, which can deliver heat at a higher temperature than the temperature of the fluid by which it is fed. Absorption heat

transformer systems are attractive for using waste heat from industrial processes and renewable energy sources such as solar and geothermal. In addition, they are interesting systems to upgrade low temperature waste heat to be used in a secondary process.

The AHT system mainly consists of a generator, an absorber, a condenser, an evaporator; two pumps, an expansion valve and a heat exchanger (see Fig. 1). In this system heat is transferred to the working fluid (LiBr/H₂O) in the evaporator and the generator from the hot waste water of an industrial application. The system rejects heat from its absorber and condenser. The rejected heat in the absorber is utilized to provide the required energy in the desalination system. The sequence of processes in the LiBr/H₂O absorption heat transformer (AHT) is as follows: the weak LiBr/H₂O solution (with lower concentration of LiBr) from the absorber goes to the generator via the ECO (solution heat exchanger) and the expansion valve respectively. Superheated water vapor comes out of the generator and then enters the condenser where it is condensed to the saturated liquid. Water pressure is then raised to that of the evaporator by the pump. In the evaporator the water is heated by the waste heat to the saturated vapor. This vapor is then absorbed in the absorber by the strong LiBr/H₂O solution coming back from the generator (state 10). The heat of absorption released in

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