Thermoeconomic evaluation and optimization of LiBr-H₂O double absorption heat transformer driven by flat plate collector

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A B S T R A C T

In this paper, a solar double absorption heat transformer (SDAHT) operating with the LiBr-H₂O solution is proposed to provide high temperature energy. The flat plate collector (FPC) is used to supply the demanded heat input in the present configuration, which will greatly broaden the application scope of the FPCs. The thermoeconomic concept is applied to the evaluation and optimization of the SDAHT, aimed at minimizing its annual capital cost per kilowatt heat capacity (CPK) and payback period (PP). A dedicated computer model in the software Engineering Equation Solver was developed to conduct the study by means of a parametric analysis. The results show that there exists an optimum absorber/evaporator temperature at which some of the parameters such as the operating temperatures and design parameters have been analyzed in detail. Besides, some suggestions derived from the results are also given to assist the engineers in estimation of the economic performance.

1. Introduction

The continuously growing scarcity of primary energy, as well as an insurmountable irreversible environmental impact, is crucial problem for our society. Numerous studies on the development and utilization of renewable energy have been conducted to address this issue [1–4]. Solar energy, among all other available energy resources, is the most abundant, inexhaustible and cleanest till date [1]. Solar energy is one of the most important renewable energies for heating, and a policy target of 300 million m² solar heating is expected in China [5].

Solar thermal collectors are the devices which capture the solar energy and convert it into thermal energy. The solar thermal collectors mainly include flat plate collector (FPC), evacuated tube collector (ETC), compound parabolic collector (CPC) and linear Fresnel collector (LPC). FPC is the most popular and mature technology available commercially for domestic and industrial applications. The FPC has the advantages of durability, high reliability, low cost and easily integration with the building. However, the output temperature is relatively lower compared with other types, which limits the application scope [6]. Meanwhile, there exit plenty of high temperature heat energy demands in the industrial processes, such as drying, sterilization, cooking, cleaning or degreasing and pasteurization, etc. [7]. It is a pity that the FPC cannot satisfy such demands. Double absorption heat transformer (DAHT) attracts broad attentions [8–10], because it can not only utilize the low temperature heat source, but it also completely differs from the vapor compression heat pump employing HFC as working fluids that cause disastrous damage to our environment. It has the advantages of higher gross temperature lift (GTL) and exergy efficiency (ECOP). The integration of DAHT and FPC will greatly broaden the application scope of FPC and output high temperature heat energy to industrial and agricultural production, which is very meaningful.

Many studies on the DAHT have been undertaken by various researchers for system optimization, and design. Rivera et al. [11,12] proposed a type of DAHT configuration and compared it with the
with a new solution cycle and compared it with di
crossers. Horuz and Kurt [20] analyzed DAHTs driven by 90 °C waste
working pairs, which is able to prevent crystallization and corrosion.

Table candidate to replace the conventional water-lithium bromide
refrigerant. The ionic liquid based working pairs are proved to be sui-
ceptable.
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