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Numerical investigation on solar absorption chiller with LiBr-H_2O operating conditions and performances

Raluca Porumb[a], Bogdan Porumb[a], Mugur Balan[a]*

[a]*Technical University of Cluj-Napoca, Bd. Muncii 103-105, Cluj-Napoca, 400641, Romania*

Abstract

The study presents a numerical investigation on operating conditions and performances of a solar absorption chiller with LiBr-H_2O. The working cycle of the investigated solar cooling equipment was modelled based on thermodynamic principles by the use of the software platform Engineering Equation Solver and was validated based on similar studies reported in literature. Further it was investigated the influence of the operating conditions like solar hot water temperature, cooling water temperature and cold water temperature, on the coefficient of performance of the solar absorption chiller and on the conditions of crystallisation. The numerical model of the solar absorption chiller working cycle proved to be capable to describe the behaviour of the equipment and to evaluate the safe operating conditions from the crystallisation point of view and from degassing point of view.

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Keywords: Absorption cooling, air conditioning, COP, crystallisation, solar energy

1. Introduction

Solar absorption chillers are designed to adapt their cooling production to the variable demand of air conditioning applications, determined exactly by the variation of solar radiation [1].

* Corresponding author. Tel.: +4-026-440-1670; fax: +4-026-441-5490.
E-mail address: mugur.balan@termo.utcluj.ro.

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The solution of LiBr-H_2O is reported to ensure values of the coefficient of performance (**COP**) of the solar absorption chillers, higher than the majority of the working solutions available on the market [1; 2].

Several studies were carried out during the time, in order to establish mathematical models for the thermal and transport properties of the LiBr-H_2O solution [3], [4], [5], [6].

The modelling of the working cycle of the absorption chillers with LiBr-H_2O was used based on different techniques such as those based on TRNSYS [7; 8; 9] and [10]. The thermal modelling was used in [11; 12; 13; 14] or [2]. An interesting dynamic model was used in [15] while an analytic model was used in [16]. The software Engineering Equation Solver (EES), was used to calculate absorption chillers with solution of LiBr-H_2O in [11; 17; 18] or [13].

Both modelling and experiment were used in [15] [19] or [20], while several other studies are based only on experiment [21; 22] [23] or [24].

The purpose of this study is to develop a mathematical model of a solar absorption chiller with LiBr-H_2O and to evaluate the influence of the operating conditions such as the temperature of the hot water provided by the solar thermal system, the temperature of the cooling water and the temperature of the cold water, on the coefficient of performance (**COP**) of the solar absorption chiller on the conditions of crystallisation and on the degassing zone. This study is continuing previous concerns in the field of solar engineering at the Technical University of Cluj-Napoca [25; 26; 27; 28; 29; 30].

2. Material and method

The energy scheme of a solar cooling system is presented in Fig. 1.

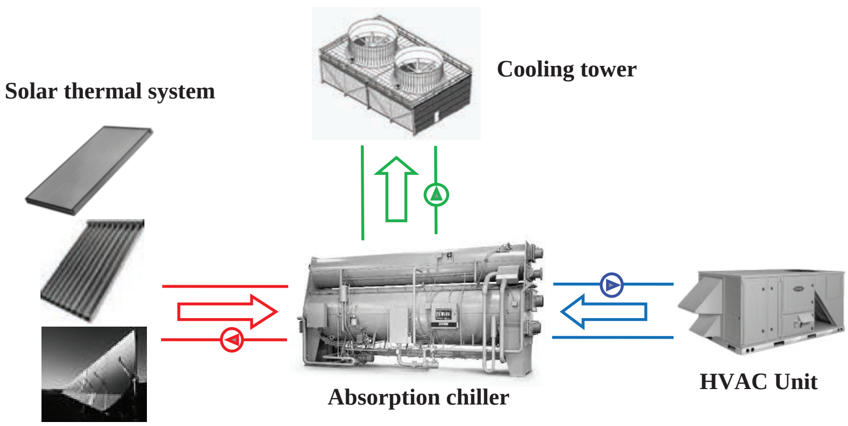

Fig. 1. Energy scheme of a solar cooling system.

The study concerns the solar absorption chiller of single stage type with solution of LiBr-H_2O. The two major advantages of LiBr-H_2O comparing to NH_3-H_2O for the use in solar air conditioning applications are the need of lower temperatures of the hot water powering the equipment and the higher coefficient of performance (**COP**). Thus, the absorption chillers with LiBr-H_2O can be powered by hot water of temperature higher that 80°C while the absorption chillers with NH_3-H_2O can be powered only by hot water of temperature higher that 150°C. The **COP** of LiBr-H_2O absorption chillers is varying around the value of 0.7 while the **COP** of NH_3-H_2O absorption chillers is varying around the lower value of 0.5 [1].

The solar thermal system can be composed by different types of solar thermal collectors: flat thermal collectors (**FTC**), evacuated thermal collectors (**ETC**), heat pipes collectors (**HPC**) or parabolic through collectors (**PTC**). **FTC**, **ETC** and **HPC** collectors are capable to provide hot water in the same temperature range of (80…95) °C and **PTC** collectors are capable to provide hot thermal agent at (160…360) °C [1].