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A novel lithium bromide absorption chiller with enhanced absorption pressure☆

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ABSTRACT

Although lithium bromide absorption chillers (LBACs) are widely used to provide thermal comfort by utilizing waste heat, they suffer from low efficiency. This paper presents an experimental investigation on a novel reformed LBAC based on the absorption principle of the lithium–bromide/water solution in the sub-steady equilibrium state that is, enhancing absorption pressure in the absorber and decreasing temperature in the generator of the novel LBAC. The novel LBAC results in the increment of double refrigeration capacity and the improvement of COP coefficient of performance (COP) by 1.5 times when the absorption pressure of the novel LBAC enhances from 1.2 kPa to 2.2 kPa.

1. Introduction

For the fields of refrigeration and air-conditioning, the priority task is to improve the efficiency while develop energy-efficient products with low equipment cost. In view of growing HVAC market, a lithium bromide absorption chiller (LBAC) with its unique characteristics plays an important role in the market. The LBAC consumes low grade energy, uses water as the refrigerant, and is non-polluting technology to the environment. Therefore, it is quite important to improve its performance by reducing the energy consumption. The absorber is one key component of the LBAC since it directly affects the cooling efficiency and energy consumption. At present, most studies on the LBAC mainly focus on improving the existing characteristics of lithium bromide and water absorption and improving new absorption pair solution. Chen and Wu [1,2] experimentally studied the equilibrium pressure, equilibrium temperature and gas composition of NH_3–H_2O–LiBr ternary mixture for its application in industrial absorption chillers and heat pumps. Xie et al. [3] investigated the relationship of coefficient of performance (COP) of a lithium–bromide absorption chiller with solution concentration of LiBr/H_2O. Papaefthimiou et al. [4] developed a mathematical model for analyzing the heat and mass transfer process of LiBr–H_2O absorption on a horizontal tube, and a good agreement with the test data was obtained. De Lucan et al. [5] and Wei and Zhang [6] added formats and lithium–nitrates in the lithium bromide solution and analyzed the effect of generation temperature, condensing temperature, and evaporation temperature on the system performance. This action was found to lead the COP to increase by 30% and the solution circulation rate to decrease by 12%. Shin and Seo [7] studied the dynamics of a double-effect LiBr–H_2O absorption chiller through a dynamic model. The Marangoni effect mechanism was studied by [8–10] to find more effective additives to replace current widely used surfactant, zinc diethyl alkyl alcohol in lithium bromide absorption chiller/heat pump. A heat and mass transfer experiment of falling liquid film of laminar flow was investigated on the absorber of a lithium bromide absorption chiller by Yoon et al. [11,12]. It is found that separating a pre-cooling absorption cycle and an adiabatic absorption cycle can improve the vapor absorber pressure and enhance the driving force of the solution absorption [13,14]. The effect of absorber vapor pressure on the absorption effect and machine performance was analyzed theoretically by Wang et al. [15] and all of the vapor absorption pressure, solution sub-cooling and absorption driving force increases for the same cooling water flow rate. Xie et al. [16] studied the influence of varying solution mass flow rate, solution concentration and cooling water flowing rate on the performance of a lithium bromide absorption chiller to get the results of reducing the inlet temperature of cooling water in the absorber and increasing cooling capacity. Yin [17] modeled the performance of a micro scale LiBr–H_2O double-effect absorption chiller in order to analyze the chiller performance and improve chiller design technology.

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