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Hourly performance prediction of ammonia–water solar absorption refrigeration

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A B S T R A C T

This paper deals with the hourly performance investigation of solar absorption refrigeration (SAR) system with evacuated tube collector and ammonia–water (NH_3–H_2O) solution. The SAR system is presented to simulate the system characteristic variations using hourly atmospheric air temperature and solar radiation data for Adana province in Turkey. The evaluation is performed for the maximum temperature occurrence day on July 29. First, the variations of various parameters, such as absorption refrigeration machine efficiency, condenser capacity and heat transfer rate in the generator and absorber during the day, are calculated for different cooling capacities and generator temperatures. Later, the minimum evacuated tube collector surface area is determined. According to the obtained results, the SAR system is considerably suitable for home/office-cooling purposes between the hours 09:00 and 16:00 in the southern region of Turkey such as Adana province. The most suitable performance of the absorption cooling system is calculated for the generator temperature values equal to or higher than 110 °C. The performance coefficient of the cooling ($COP_{cooling}$) varies in the range of 0.243–0.454 while that of the heating ($COP_{heating}$) changes from 1.243 to 1.454 during the day. Evacuated tube collector area for a 3.5 kW cooling load capacity is found to be 35.95 m^2 for the region at 16:00 whereas it is 19.85 m^2 at 12:00.

1. Introduction

Energy is considered as a major agent in the generation of wealth and an important factor in economic development [1–4]. With developing technology, the rapid increase in world population, increasing thermal loads, life standards and comfort demands in conjunction with architectural characteristics and trends, the demand for energy and its use for cooling are ever increasing [5]. In a world of continuously growing scarcity of primary energy as well as of an insurmountable irreversible environmental impact, due to human activity onto the biosphere, it is of utmost importance to look for alternatives to traditional energy sources [6]. The main advantages concern the reduction of peak loads for electricity utilities, the use of zero ozone depletion impact refrigerants, the decreased primary energy consumption and decreased global warming impact [7].

In summer, particularly under tropical climate, air conditioning has the highest energy expenditure in buildings [8]. During recent years, research aimed at the development of technologies that can offer reductions in energy consumption, peak electrical demand, and energy costs without lowering the desired level of comfort conditions has intensified. Alternative cooling technologies that can be applied to residential and commercial buildings, under a wide range of weather conditions, are being developed [9]. Reduction of energy consumption for refrigeration, however, cannot be relied solely on the improvement of efficiency. Another method of reducing the amount of energy consumption is solar cooling. Solar cooling applied in buildings is without a doubt an interesting alternative for solving problems of electrical over-consumption in traditional compression vapor air conditioning. Solar energy usage for cooling purpose in buildings offers the advantage of using an inexhaustible and free heat source to meet cooling needs most of the time [8,10]. Considering that cooling demand increases with the intensity of solar radiation, solar refrigeration has been considered as a logical solution [11].

Solar energy occupies one of the most important places among various alternative energy sources [12]. In particular, it has been identified as a convenient renewable energy source, because it is

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