



The solar contribution to air conditioning systems for residential buildings

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Abstract

The synchronizing of cooling loads with solar radiation intensity is an important advantage when we utilize solar energy in cooling or air conditioning in residential buildings. Practical experience confirms that appropriate design of these systems can achieve good results to use solar energy in air conditioning projects if they compared with conventional systems. This paper aims to investigate the theoretical behavior of thermal parameters and their interaction in absorption cooling systems powered with solar energy, which use thermal storage tank and auxiliary heater, with flat plate solar collectors. To achieve this goal, a computational program is prepared to estimate the behavior of different thermal characteristics and coefficients of an absorption cycle, like coefficient of the performance (COP) and solar useful heat gain, in range of generator temperature varies between 80 and 100°C, and an evaporator temperature varies between 5 and 15°C, for a climatic conditions of Aleppo, where the cooling loads data, solar radiation intensity or other information were introduced. We found that there is a good agreement between our computational results with comparison to practical results, or the measurements of installed projects. The results assure too, that it is suitable to install solar assisted absorption cycle of air conditioning system in climatic conditions such as that of Aleppo.

Keywords: Solar cooling; Solar buildings; Air conditioning

1. Introduction

Insuring the appropriate comfort conditions for cooling and air conditioning purposes in summer season is one of the main futural applications of solar energy especially in regions, which enjoy with reasonable higher rates of solar intensity on a long period of the year.

Many solar assisted AC and cooling systems have been installed in different countries for residential buildings, and the researches are going on to reach economical and efficient thermal systems if they compared with conventional systems [1,2].

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The advantage of solar assisted cooling is the synchronization of cooling loads with solar radiation intensity [3,4].

2. The main parts of solar AC system

Most cooling systems assisted by solar energy, are composed of four main parts, they interact together as integrated unit, these parts are shown in Fig. 1 [5,6].

A solar AC system may operate under any of the following situations:

- When the solar energy is available, and the cooling is needed, the heat is supplied to the cooling cycle from solar collectors directly.
- When the solar intensity is available and there is no need for cooling, so the gained heat from the solar collectors is added to the storage.
- When the solar intensity is available and there is no need for cooling, while the storage has been fully, in this circumstance the solar energy will be discarded.
- When the solar energy is not available and the storage tank has already stored, so the storage tank may be used to supply the heat to the cooling cycle.
- When neither of the solar energy is available nor the storage tank hasn't stored energy, the auxiliary source of energy must be used.

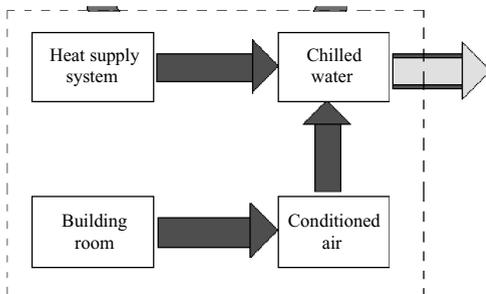


Fig. 1. The main parts of a solar assisted air conditioning system.

3. Computational program for system calculations

3.1. Solar collector calculations

A suitable PC program has developed to determine the cooling loads, which must be extracted from the building every month in cooling season, we assume that the flat plate solar collectors which are located on the roof of the building has an area 80 m², and the absorptivity of the collectors is ($\alpha = 0.9$) and the ($Fr = 0.75$), the overall heat transfer coefficient of the collector is ($U = 6 \text{ W/m}^2 \text{ Co}$), which determined by the manufacturer, we can write the solar collector efficiency [7]:

$$\eta_{\text{coll}} = Fr \times \left[(\alpha \cdot \tau) - \frac{U_{\text{coll}} (T_{\text{in}} - T_{\text{amb}})}{I_s} \right] = \frac{Q_{\text{ucoll}}}{I_s \cdot A_{\text{coll}}} \tag{1}$$

where T_{in} is the water input temperature to the collector, T_{amb} the ambient temperature, I_s (W/m^2) solar radiation, Q_{ucoll} (W) useful heat from the solar collector, A_{coll} (m^2) the total area of the solar collector.

In other hand the useful heat gain from the solar collector is given as a function of temperature difference by equation:

$$(\text{W}) \quad Q_{\text{ucoll}} = m_{\text{coll}} \cdot Cp_w (T_g - T_{\text{in}}) \tag{2}$$

This energy is supplied to absorption cycle and T_g is the water outlet temperature from the collector.

The additional needed heat for the generator of the cooling cycle is supplied from the auxiliary heater.

The COP for cooling cycle is determined as a ratio of the heat extracted by the evaporator to the heat added in the generator, COP is given by the equation [1,7]:

$$\text{COP} = \frac{Q_E}{Q_g} \tag{3}$$

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