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Performance of Solar Power Refrigerator Using Different Materials:
A Comparison

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ABSTRACT

Now a day's refrigerators are very essential parts of human life and cannot sustain our life without these. But these became more commercial so that simple solar power refrigerators working on evaporative cooling principle are essential. These Solar-powered refrigerators are able to keep perishable goods such as medicines; meat and dairy cool in hot climates, and are used to keep much needed vaccines at their appropriate temperature to avoid spoilage with less cost. This paper presents the design and fabrication of solar power refrigerators by using different materials. Finally, heat transfer coefficients have been calculated for different models making with different materials in order to get better cooling effect within a less time period.

KEYWORDS

Evaporative Cooling, Heat Transfer, Refrigerator, Solar Power, Sustainability

INTRODUCTION

The refrigeration is an important technology in that, it slows down the growth of bacteria. In doing this, it lowers the risks of diseases. This is because bacteria exist all around us including in the foods that we eat. When the bacteria are supplied with enough nutrients and favorable climatic conditions, they grow rapidly and hence can cause illnesses. Refrigeration technology comes in hard to stop the rapid multiplication of the bacteria and this is a benefit to the society in that its chances of falling ill from bacteria illness.

A lot of advancement happens in our world today, and that includes the advancement in the features of a refrigerator. The first model developed consumes only a small amount of power consumption but today it consumes more energy than usual. Large unit of freezers consumes about 4 kilowatt hour per day. Its energy consumption is even greater when constantly being opened. Hence, simple solar power refrigerators working on evaporative cooling principal becomes an alternative. These Solar-powered refrigerators are able to keep perishable goods such as medicines; meat and dairy cool in hot climates, and are used to keep much needed vaccines at their appropriate temperature to avoid spoilage with less cost.

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It works on evaporative cooling principal. In this process when the fridge is placed in a warm environment, the sun's energy causes the outer part of the fridge to 'sweat'. Water evaporates from the sand or wool and heat energy is transferred away from the inner cylinder, which therefore becomes cooler. The design is ideal for use in the developing world because it doesn't require electricity.

Literature Review

Lamp and Ziegler (1998) investigated that the energy consumption has been reduced for refrigeration, however, cannot be dependent solely on the enhancement of efficiency. Reduction in the use of synthetic refrigerants and production of CO_2 provide a new opportunity for solar refrigeration. Considering that cooling demand increases with the intensity of solar radiation, solar refrigeration has been considered as a logical solution. In the 1970s solar refrigeration received great interests when the world suffered from the oil crisis that had been initiated by Arab members of OPEC. There were many projects for development or demonstration of solar refrigeration technologies and solar refrigeration continued to be an important issue in the 1980.

Rudischer et al. (2005) proposed solar electric vapour compression refrigeration systems are limited and only a few systems are found in literature. Several solar electric refrigeration systems were designed for autonomous operation and packaged in standard containers.

Fanney et al. (2001) stated that although higher efficiencies are reported from laboratories, a high-performance solar panel sold in the market yields about 15% efficiency under the midday sun in a clear day. A study on building-integrated solar panels reported an overall efficiency of 10.3%.

Fischer and Labinov (2000) mentioned the development of a 10 kW air conditioning system expecting COP of 2.0 with ambient temperature at 35^0C. Although a thermo-acoustic system has a very simple construction with no moving part, cooling power density is low and no machine has been reported with a reasonably large capacity for air conditioning.

Restuccia et al. (2004) developed a chiller based on a similar composite and reported COP of 0.6 at the condenser tempera-ture of 35^0C and the generation temperature between 85 and 95^0C.

Henning (2004) stated that from a thermodynamic point of view, the dehumidification process is not much different from a closed sorption pro-cess. Neglecting the enthalpy changes in the air flow, the same heat will be required to remove 1 kg of water from a sorbent regardless it is in a closed vessel or it is in a humid air stream. Therefore, in principle, the COP of an open desiccant system is similar to its closed counterpart. For example, COP of 0.7 was said achievable with a solid desiccant cooling system under ''normal'' operating conditions.

Wang and Oliveira (2005) stated that current solar ad-sorption technology can provide a daily ice production of 4–7 kg per unit square meters of solar collector with a so-lar-to-cooling COP between 0.1 and 0.15.

Saman et al. (2004) elucidated that adsorption chillers seem to be comparable with absorption chillers in terms of maximum achievable COP. But their cooling power densities are much lower. Adsorption technology may be competitive in large solar cooling systems where its low power density is not a problem. For small- or medium-size solar cooling systems, it tends to be too bulky and expensive

Wang et al. (2004) reported that the most commonly used chemical adsorbent in solar cooling applications has been calcium chloride ($CaCl_2$). Calcium chloride adsorbs ammonia to produce $CaCl_2.8NH_3$ and water to produce $CaCl_2.6H_2O$ as a product.

Tokarev et al. (2002) developed a composite material by impregnating calcium chloride in MCM-41 (a silicate) matrix. A COP of 0.7 was achievable with condenser and generation temperatures at 40^0C and 110^0C, respectively.