Investigation of a Solar Adsorption Refrigeration Unit
Kudakwashe Faith Nhanga, MS Mechanical Engineering
Supervisor: Dr. Patrick Phelan
MORE Program, Ira A. Fulton Schools of Engineering

Introduction

Most refrigeration systems used in the world today use the vapor compression cycle. A vapor compression refrigeration system is generated by electrically and water-seaking fluids which are not eco-friendly and input higher energy costs compared to the solar adsorption refrigeration. Solar adsorption refrigeration reduces the compressor and utilizes the sun as the main source of energy which is of great importance in the transition to renewable and sustainable energy technologies. However, the following are some of the disadvantages which limit this way and adaptability of this system:

- Low coefficient of performance
- High specific mass and volume
- High cost of commercial systems

Problem Statement and Solution

To aid in the shift from more harmful and expensive modes of refrigeration towards the use of renewable and cheaper resources for the process of refrigeration, it is necessary to design an energy and cost efficient solar refrigeration system.

Aims

We propose to counter the drawbacks of solar adsorption refrigeration noted above, particularly the low performance of the system. To accomplish this goal, our research objective is to analyze and improve the performance of a pilot-scale water evaporated tube solar adsorption refrigeration unit under ambient conditions.

Research Questions

1. How do atmospheric conditions affect the performance of the system, particularly, the amount of adsorption and desorption that takes place in the system?
2. How can the system be designed to ensure that it operates efficiently (COP) under different climatic conditions?

Methodology (Set-up)

The system was set up as shown in the sketch in Figure 1a and b, below.

- For this experiment, a DESWALT TD 03 Rolls Molded Lunch Box Cooler, Heavy Duty Ice Chest with a 56.8 cm diameter created to allow the glass tube to enter the evaporator section of the condenser/evaporator section.
- A stainless steel tube was placed inside the bottom of the glass tube with a diameter of 6.5 cm and a length of 180 cm.
- The zinccooler was equipped with a perforated stainless-steel side of 25 cm, and then inside the glass tube. The perforated tube had a 0.64 mm and 3.18 mm diameter.
- The stainless-steel side was attached to the rubber stopper placed at the top of the system.

The experiment was conducted outside to measure the system works under ambient conditions.

Methodology (Tests)

- The system was set up as shown in the sketch in Figure 2a and b, below.
- For this experiment, a DESWALT TD 03 Rolls Molded Lunch Box Cooler, Heavy Duty Ice Chest with a 56.8 cm diameter created to allow the glass tube to enter the condenser/evaporator section.
- A stainless steel tube was placed inside the bottom of the glass tube with a diameter of 6.5 cm and a length of 180 cm.
- The zinccooler was equipped with a perforated stainless-steel side of 25 cm, and then inside the glass tube. The perforated tube had a 0.64 mm and 3.18 mm diameter.
- The stainless-steel side was attached to the rubber stopper placed at the top of the system.
- The rubber stopper in turn was punctured to allow a metal tube access to the glass tube and this was connected to the vacuum pump to evacuate the glass tube.
- Two thin copper pipes were placed inside the evaporator section, while four more were placed along the length of the glass tube to note the temperature change of the system.
- Two PLATINUM 1000W 12V EMF coils (1000 W) were placed a meter away from the setup shown below and these provided the radiation required for the experiment.
- As shown in Figure 3, it was necessary to summarize the system with a reflective surface increase the radiation getting to the glass tube.
- The experiment was also conducted outside to measure the system works under ambient conditions.

Results

The amount of water required for the condenser section was determined to be 3.33 kg, thus the DESWALT TD 03 cooler was used. The equation below was used to determine the amount of energy absorbed by the water in the evaporator section:

\[ \text{Energy absorbed} = \frac{\text{Mass of water} \times \text{specific heat at constant pressure} \times \text{temperature change} \times \text{ambient temperature of the sun}}{\text{conversion factor}} \]

For the experiment, the input heat energy to the system was determined by the area of the glass tube.

In Figure 2a & b, temperature readings were recorded at 9 AM, 11 AM, and 1 PM. The temperature of the water was taken at 1 PM. The experiment was run for a period of 2 hours.

![Graph showing temperature readings](image-url)

Conclusion

The results show that, the solar adsorption refrigeration can be used to: 1) cool food; 2) cool the system under different climatic conditions.

Future Work

Even with the slight improvement in the COP, there are several measures that can be implemented to improve the efficiency of the system. The work will focus on improving the vacuum seal further as well as the efficiency of the solar system under ambient conditions.

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References