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SURVEY ON REFRIGERATION SYSTEM WITH COMPOSITE ABSORBENT

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ABSTRACT

The sun is source of energy for us. It is harmless and clean energy. The system need to gather its energy is simple, quiet and non-polluting. International environment protection visions have led to the rise of research efforts on development of ozone layer and global warming safe refrigeration technology. Further attention is being given to the use of waste heat and solar energy in the field of engineering refrigerating systems. Solar powered refrigeration and air-conditioning system have been very attractive during the last twenty years, since the availability of sunshine and the need for refrigeration both reach maximum levels in the summer season. The conventional cooling technologies are generally based on the electrically driven refrigeration system. These systems require high levels of primary energy consumption, causing electricity peak loads also employ refrigerants which cause environmental pollution. Solar adsorption refrigeration is an option to increase on the drawbacks of the conventional cooling system. The objective of this project is to set down an alternative eco-friendly refrigeration cycle for producing a temperature usually comes upon in a conventional refrigerator. By manufacturing such type of refrigerator adds new importance to the world of refrigeration. This refrigerator gives some amount of help to the refrigeration world by making it freewheeling from electric power supply and zero running cost.

Keyword - *Adsorption, Adsorbent, Refrigerants, and Solar powered refrigeration (SAR), COPs.*

INTRODUCTION

Refrigeration plays an important role in our world, primarily for the preservation of food, healthcare materials (storage of vaccines, blood and medicine), and human thermal comfort (air conditioning and temperature regulation). Cooling in industrial countries depends heavily on grid electricity which is supplied continuously and reliably to every part of the country. In contrast, refrigeration is required in developing countries to boost agricultural production and commerce, in large areas without reliable source of electricity supply; hence an alternative method of powering refrigeration is necessary. Alternatives to hydro fluorocarbons as refrigerants are naturally occurring substances like ammonia, carbon dioxide, methanol, water and air. These can be used in sorption processes to produce refrigeration and have been studied for the last twenty years as a technological alternative to vapor compression systems. Sorption cooling systems have the advantage of being environmentally friendly as they employ safe and non polluting refrigerants.

Adsorption happens when molecules of one fluid are attached to the surface of another solid or liquid material. Adsorption occurs in solids or in liquids. The adsorbed molecules do not undergo any chemical reaction; they just loose energy when being fixed. Thus the generation of heat of adsorption is involved. The molecules in the adsorbed state are called adsorbents, while the solid surface is called an adsorbent or a desiccant. Desiccants are materials capable of adsorbing water moisture - materials like zeolites, silica gel, molecular sieves, calcium oxide, calcium sulphate, and activated alumina. It is described that desiccants as materials possessing a permanent porous structure that, at low temperatures, acts like a sponge, soaking up the refrigerant. At elevated temperatures, the refrigerant can then be released or desorbed. The forward process (desorption) in adsorption involves the removal of vapor from the porous solid by heating. The heating process can be achieved by using fossil fuels, electrical elements, waste heat or the sun. The reverse process (adsorption); involves the attachment of vapor molecules onto the porous solid.

LITERATURE REVIEW

A detailed literature search was conducted to find out what research has been done in the area of solar assisted cooling, with the aim of obtaining fundamental understandings of solar adsorption systems and to gain useful guidelines regarding designs parameters as applied in both air-conditioning and refrigeration. Solar adsorption refrigeration devices are of importance to meet the needs for cooling requirements such as air-conditioning and ice-making and food preservation in remote areas. They are also noiseless, non - corrosive and environmentally friendly. For the latter reasons, research activities in this sector are on the increase in order to solve the crucial factors which render these systems not ready to compete with the well-known vapor compression system. Environmental-friendly means of air-conditioning and refrigeration are attracting a lot of attention nowadays since traditional methods such as vapor compression cycles require consumption of expensive electric energy and are responsible for emission of greenhouse gases.

Adsorption air-conditioning is an attractive alternative to the latter-mentioned methods. The emphasis when reviewing the research was on the design, evaluation and cost effectiveness of the prototypes.

Li M. et al. explained in paper entitled "Experimental study on dynamic performance analysis of flat-plate solar solid-adsorption refrigeration for ice maker" that a flat-plate solar solid-adsorption refrigeration for ice maker operating with activated carbon or methanol can produce 4–5 kg of ice after receiving 14–16 MJ of radiation energy with a surface area of 0.75 m2, while producing 7–10 kg of ice after receiving 28–30 MJ of radiation energy with 1.5 m^2. [1]

Rekiyat Suleiman et al. explained in paper entitled "Transient Simulation of a Flat Plate Solar Collector Powered Adsorption Refrigeration System" that The study showed that for appreciable desorption of methanol from activated carbon in a cooling system with 0^0C and 25^0C evaporator and condenser temperatures respectively, a temperature of at least 80^0C is required by the adsorbent bed. These parameters were then used in the transient simulation of the cooling system over a period of a typical year.The FPC system gave average values of refrigeration effect of 4814.83 kJ, solar coefficient of performance (COPs) of 0.024, a cooling COP of 0.608 and a heating efficiency of 0.46.[2]

G. Moreno-Quintanar et al. explained in paper entitled "Development of a solar intermittent refrigeration system for ice production" that a solar powered intermittent absorption refrigeration system has been developed at the Centro de Investigationon en Energies of the Universidad National Autónoma de México. The system was evaluated with the ammonia/lithium nitrate / water (NH_3/$LiNO_3$ /H_2O) mixture. The system was designed to produce up to 8 kg/day of ice. The system consists of a Compound Parabolic Concentrator (CPC) with a cylindrical receiver acting as the generator /absorber, a condenser, an evaporator and an expansion valve. The system operates exclusively with solar energy and no moving parts are required. Evaporator temperatures as low as - 11°C were obtained for a period of time up to 8 hours. Coefficients of performance as high as 0. 098 were obtained. These coefficients were 24% higher than those obtained with the same system operating with the binary ammonia/lithium nitrate (NH_3/$LiNO_3$) mixture previously reported in the literature. The results showed that the developed system seems to be a good alternative for refrigeration in zones where electricity is not available [4]

DESIGN OF EXPERIMENTAL SET-UP

In the solar heating subsystem, solar energy gained through the solar collector during daylight hours is transferred to the water in the pipes below it and accumulated in the water tank. As the solar irradiance increases, the temperature of the water tank rises, and consequently the temperature of the adsorbent bed which is immersed in the water tank also rise with an attendant rise in pressure from the evaporator. The temperature of the adsorbent bed is assumed to reach a level very close to the water temperature in the tank (an ideal process). When the temperature of the adsorbent bed reaches the desorption temperature (condenser temperature), desorption of the refrigerant from the adsorption bed is started in the refrigeration subsystem. As the heating of the adsorbent bed progresses, the refrigerant continues to desorb at constant pressure until the adsorbent bed reaches its maximum temperature. The desorption ceases at this temperature and the refrigerant vapor will be condensed into liquid in the condenser. The liquid adsorbate is then transferred and stored in a liquid receiver from where it is passed to the evaporator. At the end of desorption, the circulation through the collector is stopped with a gate valve then the hot water in the first water tank is drained and stored in the hot water storage tank for domestic use. The water tank is then filled with cold water which rapidly cools down the adsorber; this initiates the cooling-adsorption-evaporation process. The adsorbent bed temperature drops with a reduction in system pressure to Pe, the evaporator pressure. When the adsorbent bed reaches the evaporating pressure, the bed will begin to adsorb the refrigerant from the evaporator. The liquid refrigerant in the evaporator vaporizes by absorbing heat energy from the water stored in the evaporator, thereby cooling the water and producing ice. In this study, we have an experiment that contains factor that we think they will be an important part of the way we study about how the system works. Those factors are:

i. Composite Adsorbent
  - 75% Silica Gel & 25% Activated Carbon

ii. The time interval
  - This factor contains seven levels for each cycle i.e. seven levels for desorption cycle (day cycle) and seven levels for adsorption cycle (night cycle)

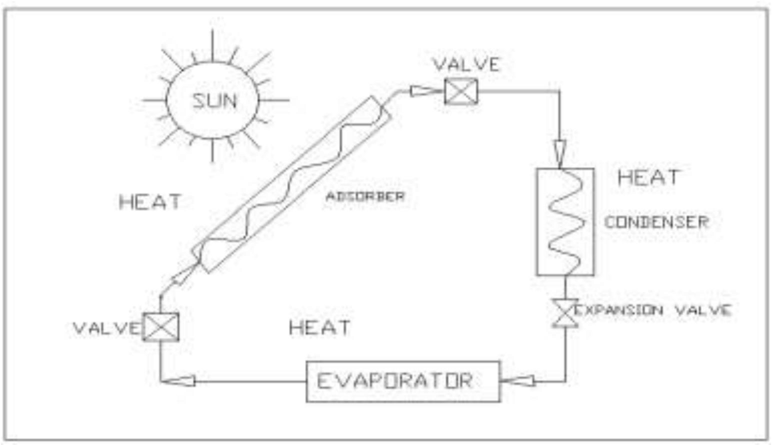

fig -1: Cycle flow diagram for the machine

CONCLUSIONS

This study shows that solar powered adsorption refrigeration can be effective, economic, practicable and an eco-friendly option for Kano in the northern region of Nigeria with abundant sunshine. A solar powered adsorption-cooling fridge employing silica gel as well as activated carbon-water vapour pair was planned, established and evaluated. The natural cooling procedure was sufficient. Condensing temperature averaged at 35ºC. Test results show that only chilled water with temperatures between 7 and 11ºC is produced. Vegetables and fruits with preservation temperatures in the range of 4 to 10ºC are within the scope of the present system. . The coefficient of performance of 0.058 obtained was rather low. The low collector efficiency and useful coefficient of performance are indicative of the inefficiencies in both the collector and the evaporator. The low coefficient of performance of 0.046 might have been produced by air leaking into the system, the thickness of silica gel and activated carbon packing, the conductivity of silica gel & activated carbon with calcium chloride and water combination, the ineffectiveness of silica gel and activated carbon adsorption capability, solar irradiation and the ambient temperature. As a result solar adsorption cooling requires careful manufacturing methods, since any leakage causes refrigerator malfunction. The refrigerants do not diffuse well through air, and air obstructs the adsorption, condensation and evaporation processes

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