VAPOR ADSORPTION WATER COOLER USING SOLAR THERMAL ENERGY

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Abstract - *Heat driven cooling technologies like vapor absorption and adsorption systems are environmentally friendly. Use of thermal compression in these systems saves precious and fast-depleting fossil fuel resources. Solar energy and low-grade waste heat can be effectively used in running these cooling systems. The present work focuses on the development of a solar-powered vapor adsorption based cooling system, which have the potential to be a carbon-free alternative to vapor compression cooling cycles, especially for meeting domestic and office requirements. A test unit of adsorption water cooler has been developed with a dish collector type solar water heater installed on the roof.*

Key Words: Adsorption ,Solar thermal Energy ,Water cooler ,renewable ,parabolic dish collector ,solar irradiance etc.

1.INTRODUCTION

Economic growth of the country is based on consumption of electricity. We are living in a world that faces acute shortage of power to satisfy our daily needs. There is a resurgence of interest on different types of renewable energy technologies including solar thermal energy because of growing environmental concerns and the demand for more enhanced energy security . Refrigerator and water cooler consumes 40% of the electricity among the household articles.

Worldwide, most cooling and refrigeration systems are powered by electricity. Due to the growing cooling and refrigeration demand, peak-load problems in the electricity grid in countries with high cooling load are forever increasing. Thermally driven cooling technologies emerge as promising alternatives and are set to play a key role in the efficient conversion of energy in the field of building air-conditioning and refrigeration. Today, thermally driven cooling technologies are used mainly combined with direct heat source, waste heat, and cogeneration plants. And all these heat sources are conventional fuel based sources. Thermally driven cooling cycles can also operate with solar thermal energy because of the near coincidence of peak cooling loads with the available solar power.

Investigators have examined many aspects of research such as the thermodynamic analysis of the basic cycle, the effect of variations in cooling water temperature, the improvement of mechanical design, the evaluation of performance under conditions of reduced capacity or transient start-up, and the full scale testing. However, in recent years the increasing interest in energy conservation and the efficient use of energy has led to a new methodology and a powerful approach to analyze the solar processes and installations.

1.1 ADSORPTION REFRIGERATION SYSTEM

Adsorption refrigeration technology has been reported to be in use as early as in the 1920s. In the United States, an adsorption chiller powered by the hot gases from burning coal and utilising sulphur-dioxide as refrigerant was used to air-condition railway carriages. The development of adsorption based systems progressed comparably to vapor-compression systems for some years.

However, the development of better and smaller compressors from 1920s and application of synthetic refrigerants like freons during 1930s pushed the development of adsorption systems to the backseat. With the post-depression boom in the economy well underway during this period, refrigerators became a household appliance in the western countries. Due to their compact construction, high efficiency and safe operation, vapor compression technology came to dominate the commercial market and interest in adsorption refrigeration technology declined. After the oil crisis of the 1970s, interest in renewable energy technology resurfaced. Adsorption refrigeration systems were developed with the objective of rational use of energy and were thus powered either by solar energy or by waste heat. As the ecological problems faced by the use of CFCs and HCFCs came to be highlighted during the 1990s, research into new adsorbent-adsorbate pair as well as better methods of heat and mass transfer began in order to improve the efficiency of these systems.

1.2 SOLAR POWERED ADSORPTION REFRIGERATION SYSTEMS

Solar powered adsorption systems make use of solar radiation to effect desorption of the refrigerant from the desiccant pores. Solar energy may be used directly to heat up the adsorbent bed as in the case of some fixed-bed adsorption systems that operate in 24-hour-long cycles; or indirectly, by making use of solar collectors to heat up water which is then cycled through the adsorbent bed. In contrast to systems powered by conventional energy sources, solar powered systems have no adverse environmental effects. Refrigeration and air conditioning systems powered by solar radiation have an implicit advantage that the peak demand for cooling is in phase with the availability of solar energy. Also, the heat collection arrangement used in these systems can be extended to provide hot water in winter months in residential installations. In domiciliary as well as office use, safety and low maintenance requirements area major factor. This gives adsorption systems a comparative edge over absorption systems which may be prone to hazardous chemical leaks or corrosion of parts. Consequently, adsorption systems have a longer service life..

2. DISH COLLECTOR INFORMATION

Parabolic dish and receiver experiment is carried out with manual tracking. Tracking of the system is expected to have a maximum gain compared to the non-tracking mode. The experiment is conducted at an average wind velocity of 3.43 km/hr.

Fig -1: Parabolic dish collector

The experiment is conducted for the parabolic dish and receiver in the operation with tracking during every 30 minutes and taken readings at every hour. The parabolic dish operation with manual tracking and the energy generated in the water receiver is calculated from the analysis. The water in the receiver is heated to a temperature greater than 90^{o}C by 4-5 hours per day.

A maximum temperature of 98^{0}C was obtained corresponding to maximum irradiance of 753W/m^{2}.

Table -1: Solar collector observation

SOLAR IRRADIANCE W/m^{2}	HOT WATER TEMPERATURE ^{0}C
594	85
635	90
753	98

2. COLD WATER INFORMATION

The variation in cold water temperature with irradiance and the outside temperature considered as the major parameter for the analysis. The cabin is completely insulated.

Table -2: Solar collector observation

SOLAR IRRADIANCE W/m^{2}	TEMPERATURE OF COLD WATER IN STORAGE ^{0}C
594	28
635	25
753	20

2. OBSERVATION

The temperature of normal water was 32^{0}Cand the hot water temperature obtained was 98^{0}Cand cold water temperature was 20^{0}C.It is observed that the temperature rise of hot water and temperature drop of cold water varies with the amount of solar irradiance and time of day.

3. CONCLUSIONS

Critics of renewable energy often cite the fact that technology such as solar only produce energy when the sun shines. Another problem lies is in effective utilization of the solar radiation. By this system we can provide an economic efficient and feasible solar water cooler.

Although the technical feasibility of solar-powered vapor adsorption based refrigeration is well-established, the present systems are still bulky and costly in comparison to vapor compression systems due to low specific cooling power of the adsorption chillers, which is caused, partly by the intermittent nature of operation and also by the poor heat and mass transfer properties of the existing solid adsorbents. It is clear that these systems offer environmentally clean alternative technology.

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