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Review of Solar Powered Air Conditioning Systems

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Abstract

The burning of fossil fuels has caused and is still causing great damage to environment. Some of its effects felt globally are: global warming, depletion of ozone layer and climate change. The ever expanding demand of air cooling for human comforts in hot and humid climates is of great concern. Most of this demand is met by the conventional cooling systems which consume electrical energy, which in turn leads to burning of fossil fuels and hence greenhouse gas which cause depletion of ozone layer are emitted in large quantities. Cooling systems based on solar power have certain advantages over the conventional ones as they don't release any gas which depletes ozone layer or cause global warming. This paper discusses the progress of cooling systems based on solar energy.

Keywords: *Fossil Fuel, Solar Energy etc.*

Introduction

We are living in the twenty first century; a modern society having luxurious lifestyle and many comforts. But one of the greatest challenges of this twenty first century is to meet the energy demand of the society. So far, fossil fuels such as petroleum, coal and natural gas have been the main sources of energy. But soon these non-renewable sources of energy will not be able to meet our energy demands as the demand would double or triple by 2050. This is a matter of great concern as these are depleting resources and they lead to depletion of ozone layer, global warming and change in the climate. Due to increasing comfort expectations, the demand for cooling of indoor air has increased considerably and the most common cooling mechanism used is air conditioning. Air conditioning is vital for maintaining the thermal comfort in hot and humid climates. The greater part of this need is met by the conventional vapor pressure based systems which consume electricity produced by burning of fossil fuels and also generate harmful gasses. The refrigerants used in the conventional vapor compression based system cause ozone layer depletion because they contain chlorofluorocarbons and hydro fluorocarbons. Solar energy is the most easily and plentiful available resource to human society. As the cooling load is small as compared to the availability of solar energy, the solar powered air conditioning systems are most favorable. The heat from the solar radiation is used by the solar assisted conditioning system to drive a thermally driven chiller such as absorption chiller. Evacuated tubes solar are used for solar collecting to produce high temperature.

Solar Air Conditioning Systems

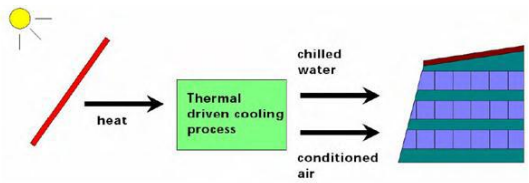

Figure 1 Fundamental Schematic Diagram of the Solar Air Conditioner Adapted from [1]

Sunlight based aerating and cooling (SAC) may be defined as the process of conversion of sunlight based warm vitality (heat) into adapted air. It performs aeration and cools system parts with least negative ecological effects and additionally brings down vitality consumption. Sunlight based cooling helps to reduce Green House Gas emissions, the reoccurring cost and the depletion of non-renewable resources. During the sunny days it provides maximum cooling output. During the afternoon when the sun has reached its level of maximum intensity, solar energy system will integrate with the storage system for storing and enables cooling when desired. A reinforcement heat source might be utilized during the hot and humid days, as it can supply cool air without utilizing the power framework [1]. Environmental impacts as compare to conventional air conditioners are reduced by the Solar cooling systems. A correctly designed SAC helps in saving of energy, reduction of GHG; Sulphur and particulate emissions. Solar cooling chillers use refrigerants that are well disposed to GHG and thus do not contribution to the climate changes [1]. Therefore,

Sunlight based cooling is considered as an optimum technology towards sustainable climatization.

History

The history dates back to 1920s when in USA for the air-conditioning of railway carriages sulfur dioxide and silica gel were used. Limitations foreseen by Montreal (1987) and Kyoto (1997) convention lead to research on warmth driven sorption cooling frameworks. The work of Tchernev [2], started the advancement of sorption refrigeration frameworks controlled by sun oriented vitality in the late 1970s. He reported that zeolite is present coolant adsorbs a lot of water vapor. Grenier [3] constructed a vast icy store powered by sun based vitality of volume 12 m^3 utilizing a zeolite 13x–water blend. The temperature accomplished by the evaporator was as low as 2.5 C and sun based COP of 0.086 was attained. A research facility, adsorption cooling framework utilizing a silica gel–water mix was constructed and tested by Sakoda and Suzuki [4]. The advantages and limitations of the concurrent transport of heat and adsorbate in a cooling system utilizing solar heat were presented by them later. In India, for the cold storage of agricultural products at temperatures of 2–4 C a commercially available low temperature cooling framework for aerating and cooling application has been constructed. It utilizes methanol/silica gel. With the working framework at -2 C chilled water temperature, a warming water temperature of 85 C and a condenser temperature of 30 C the COP of about 0.30 was achieved [5]. An adsorption air conditioning system was developed by Wang [6]. This system was powered by heat sources of temperature 100 C. It had two adsorbers, each one with 26 kg of carbon inside it and methanol was used as a refrigerant. 30 min operation of the system delivered a cooling effect of 3.84 kW and coefficient of performance of 0.15; and 60 min operation produced a COP of 0.21 and 3.03 kW cooling power. An adsorption chiller having cooling of 3.5 kW and having two adsorbers, every one loaded with 35 kg of adsorbent has been developed and tested. The chiller worked at exit temperatures of somewhere around 75 and 95 C, temperatures of heat sink ranging somewhere around 25 and 35 C, and range of minimum temperatures were 10 to 20 C. According to the experimental conditions, the COP varied from 0.4 to 0.6

Solar air-conditioners and its applications

An adsoption chiller was implemented in Jiangsu Province, China. Its purpose was to cool a grain warehouse and it used silica gel–water driven by a low temperature heat source having two indistinguishable chambers and a second stage evaporator. Methanol was used as the working fluid. It was found that with a daily sun powered radiation of around 16 and 21 MJ/m^2, the chiller can supply frosty air with temperatures from 14 to 22.8 C. Also, all around molding arrangement of a green building situated in the Shanghai Research Institute of Building Science, two chillers, like the one above, however with a higher limit are utilized. It is reported that for daily sun based radiation of 19.2 MJ/m^2, the chillers had cooling of around 12 kW and COP of 0.09. Case of structures that as of now utilize sun oriented controlled sorption ventilation systems are presented by European project Climasol [7]. The cases introduced incorporate uses of strong sorption chillers introduced in a college healing center in Freiburg, Germany, and corrective organization Sarantis S.A., in Greece.

Issues

To become more commercially attractive the frameworks must have their size and cost reduced. In order to achieve these goals the most promising alternatives include the change of the warmth administration to expand the COP. It is desirable to utilize refrigerant mass recuperation between two adsorbent beds to increase coefficient of performance and to increase cooling power besides utilization of heat management cycles. Comparison of the COP of frameworks with mass recovery and without mass recuperation was done by Wang [8]. It was observed that the system with mass recovery could deliver a COP from 10% to 100% higher than the system without mass recovery. At lower generation temperatures the contrast between the COPs was higher.

Conclusions

Water and energy are vital necessity for all of us for leading a normal life on this beautiful earth. Solar energy technology is an environmentally safe technology due to the non-production of hurtful or unsafe items/gases, for example, CFCs, simultaneously reducing CO_2 emissions having additional advantage of very low consumption of electricity. To sustain the energy needs, solar energy technology and its usage is very important. Substitution of the electricity produced by burning of fossil fuels for air conditioning by renewable source is the main motivation for solar cooling systems. With minor maintenance costs solar energy can be converted into a chilling capacity as low as 5 C

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