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Literature Review on Application of Evaporative Air Coolers Coupled With Solar Water Heater for Dehumidification of Indoor Air

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ABSTRACT

In hot and humid conditions the need to feel relaxed and comfortable has become one of few needs and for this purpose utilization of systems like air-conditioning and refrigeration has increased rapidly. This technology can efficiently serve large latent loads and greatly improve indoor air quality by allowing more ventilation while tightly controlling humidity. Despite increasing performance and mandatory energy efficiency requirements, peak electricity demand is growing. In this project the novel setup consists of solar water heater along with copper windings for dehumidification of the surrounding air present inside a room because of continuous use of air conditioners which also enhances the concentration of CFC's in the atmosphere. Application of evaporative air cooler coupled with solar water heater comprises of water as a brine solution for heat exchanger and also passing through the condenser. Experimental results show that solution with 30% concentration can be regenerated up to 50% using solar energy.

Keywords: Solar Water Heater, Dehumidification, Evaporative Air Cooler, Heat Exchanger.

I. INTRODUCTION

This paper reveals the comfort conditions achieved by the device for the human body. In summer (hot) and humid conditions feel uncomfortable because of hot weather and heavy humidity. So it is necessary to maintain thermal comfort conditions. Thermal comfort is determined by the room's temperature, humidity and air speed. Radiant heat (hot surfaces) or radiant heat loss (cold surfaces) are also important factors for thermal comfort. Relative Humidity (RH) is a measure of the moisture in the air, compared to the potential saturation level. Warmer air can hold more moisture. When you approach 100% humidity, the air moisture condenses—this is called the dew point.Room occupants also add heat to the room since the normal body temperature is much higher than the room temperature. The present air cooling methods are evaporative coolers, air conditioning, fans and dehumidifiers. But running these products need a source called electricity. The producing of electricity is ultimately responsible for hot and humid conditions, i.e., global warming. Need of such a source which is abundantly available in nature, which does not impose any bad effects on earth. There is only one thing which can come up with these all problems is solar energy.

In hot and humid areas, interest in utilizing solar powered-cooling systems for air-conditioning and refrigeration purposes has been growing continuously. Being considered as one path towards more sustainable energy systems, solar-cooling is comprised of many attractive features. This technology can efficiently serve large latent loads and greatly improve indoor air quality by allowing more ventilation while tightly controlling humidity. On the other hand, solar-powered air conditioning has seen renewed interest in recent years due to the growing awareness of environmental problems such as global warming. Solar collector/regenerator (C/R) systems can achieve liquid regeneration at lower temperatures which is suitable for buildings with high outdoor air requirements in high humidity areas. Several solar-driven refrigeration systemshave been proposed and most of them are economically justified. [1]

The rise in living standards is leading to increased air-conditioning demand, especially in the Summer time in high temperature areas. It is necessary to develop new sources of cooling, which could be less dependent on electric energy. The use of indirect evaporative cooling is a relatively new method of cooling air in air-conditioning systems which looks very promising, both in terms of reduced electricity consumption and in the area of using less ozone depleting refrigerants, since its working medium is water. [2]

The Absorption cycle is a process by which refrigeration effect is produced through the use of two fluids and some quantity of heat input, rather than electrical input as in the more familiar vapor compression cycle. [3]

II. PROPOSED SYSTEM

The system comprises an air evaporative air cooler which functions as an absorber and is coupled with solar water heater, functions as a desiccant regenerator. Water is regenerated in the evaporative cooler (desiccant regenerator) which is supplied with hot air from a copper tube air/water heat exchanger. Water from the solar water heater is circulated through the heat exchanger to heat the flowing air. Strong solution from the outdoor unit is directed to the indoor unit and weak solution from the indoor unit is pumped to the regenerator via a solution pump. Room humid air is blown and dehumidified in the indoor unit. This system actually functions as humidity pump. Direct contact between air and desiccant is carried out in the packing used in the evaporative cooler to increase the contact area. For the purpose of heat recovery, solution heat exchanger is applied to cool the strong solution coming out from the regenerator (outdoor unit).

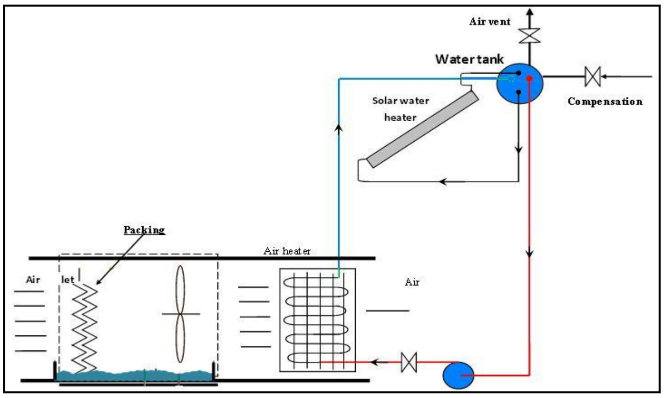

Figure 1. Schematic diagram of solar powered desiccant dehumidification system

Single-pass Forced circulation

In this case, cold water from the feed tank is fed into the solar collector through a pump. An electrically-operated temperature sensor (TS) at the outlet of the solar collector senses the water temperature. These TS can be set at any variable temperature. When temperature of water in the solar collector reaches the set point, the TS, through the control panel, operates the pump, removing the hot water from the solar collector to the storage tank. As the colder water (below the set point) reaches the sensor, the pump stops.

Advantages

1. Since only hot water enters the storage tank, there is no mixing of hot & cold water. Hence hot water can be used throughout the day.0
2. There is no need for cold water feed tank to be a higher level than the solar systems. This could be viewed from cost & aesthetics point.

Limitations

1. Apart from using electricity to run the pump, the system depends on its availability throughout the day for its functioning.
2. More expensive as compared to thermo-syphon systems.

Applications

1. Hotels, Hospitals etc where hot water is used throughout the day.
2. Boiler feed where fixed temperature hot water is required.

Problems Associated with Round-Year Operation

The analysis of the previous section brings important conclusion: the high efficiency of the exchanger can lead to the additional energy consumption connected with providing safe operating conditions during winter season. On the other hand, in summer time high efficiency of the considered unit is well required and it is not connected with additional costs. The solution to the abovementioned problem depends on the climate region, where such exchanger is applied. Systems operating in warmer regions are characterized with high cooling demand and low heating demand. The temperatures during the winter season in such climate conditions are usually above 0oC. This problem is even more complicated in the regions with temperate climate, where cooling demand in summer and heating demand in winter are similar. This problem can only be solved with compromise optimization method applied individually to each air-conditioning system. The size and type of the exchanger is determined on the basis of main source of heating and cooling power, outdoor and indoor conditions.

III. Objective of Project

To make aware about the non-conventional energy sources for the reduction in environmental pollutions. This product is preferably suitable for villages, because they face lot of dehumidification problems in rainy season. And for offices and schools which runs in day to which save energy. So would like to develop product which runs by solar energy and provide a proper dehumidifying effect when coupled with solar water heater effect at lower cost. Study focuses on two aspects: it tries to analyze advantages and disadvantages of application of different types of indirect evaporative air coolers in dehumidifying applications and tries to study the aspect of round-year application of one, selected unit.

IV. Future Recommendations

Expanding on the work presented in this thesis, the following recommendations are made for the future research:

1. Test additional fluids with varying thermo physical properties. Example: Nano Fluid
2. Improve accuracy of measurements by using data logger.

In order to accurately measure the heat transfer capabilities of the test heat pipes, the heat loss to the environment everywhere except at the tank sink should be minimized. This can be accomplished by setting up a vacuum chamber for the test, or insulating the copper pipe and the tank.

V. Conclusion

The use of water as a working fluid yields a maximum efficiency as compared to other fluids in heat exchanging purpose by means of Heat Exchangers. In the proposed design, air humidifiers are applied for dehumidification of processed air and regeneration of liquid desiccant. Also, system efficiency is defined in terms of operating cycle efficiency and system design parameters. Effect of indoor and outdoor parameters on the required regeneration temperature has been highlighted.

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