Solar evaporative cooler

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Abstract:
With the increasing world energy shortage, and potential environmental problems tied to the abusive use of electrical energy, comfort air conditioning using mechanical refrigeration systems will be facing a lot of restrictions in the future. Mechanical refrigeration systems have been and are still used predominantly in comfort air conditioning (AC). The major drawbacks of these systems are the energy consumption and the refrigerating fluid being used. Evaporative cooling systems can provide an excellent alternative for comfort AC if the climatic conditions are right for the application. In this article we will present a domestic evaporative cooler using solar energy.
Key words: Solar cooling, Dry bulb temperature, Wet bulb temperature, Relative Humidity, Humidity ratio, Latent heat, Sensible heat.

Introduction

Air conditioning equipments using mechanical refrigeration have known a very rapid development in the last decade. From domestic to large scale commercial air conditioning units, recent market analysis shows that the demand for air conditioning equipments keep growing rapidly, to appoint where the last electrical Black Out we have known was traced directly to the abusive use of electrical energy. Even though recent technical development have improved the energy efficiency of these systems, we are still facing more restrictions in the near future, unless still more energy efficient systems are developed and new sources of energy are being used.
Electrical energy used by today air conditioning equipments comes essentially from central power plants using fossil fuel, and the products of combustion generated contain large amount of green house gases, therefore contributing directly to the global warming. Still, another problem with air conditioning equipments using mechanical refrigeration is the refrigerating fluids being used, which once liberated in the atmosphere have a direct impact on the ozone layer. Also, the production of these refrigerating fluids in industrial quantity has a direct impact on the environment (air and water pollution, global warming, etc…).

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Evaporating cooling equipments don't use any chemical refrigerant, they rely only water and air to produce a fantastic cooling sensation if the climatic conditions are correct for the application (high land and southern climatic conditions). Also, the electrical energy used by these systems is much less than in air conditioning equipments using mechanical refrigeration.
With the possible integration of solar energy in these systems, they can compete vigorously with classical air conditioning equipments when the climatic conditions are correct for the application (conditions with a large wet bulb depression). And , the recent technological development of the two-stage evaporative cooler , will certainly result in a much wider use of these systems (industrial applications).

Evaporative cooling equipments

Evaporative cooling equipments have been around for centuries. They are simple, effective, economical, and can provide very good comfort and health conditions if the climate is favorable .The sizing procedure is straightforward and depend mainly on the number of air change per hour (NA/Hr) of the occupied space .The operating principle is very simple(fig.1).
Water is continuously circulated with a small centrifugal pump. The media pad is kept permanently saturated with water. Dry and warm air is drawn trough the wetted media pad. The water eventually reaches and maintains a temperature equal to the wet bulb temperature of the incoming air. After, this state of equilibrium has been reached , water temperature will lower the dry bulb temperature of the incoming air more or less according to the efficiency of the evaporative cooler.

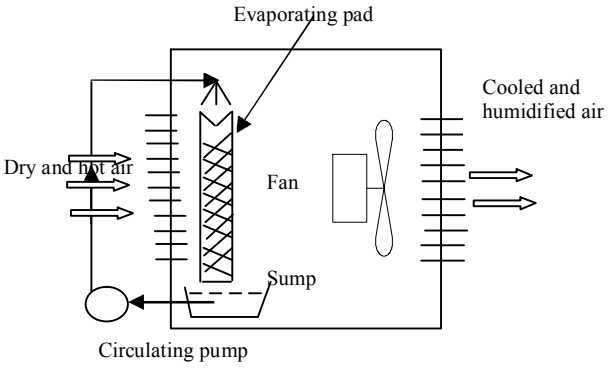

Figure.1. *Schematic of the humidifier*

Construction

The housing is made from pre-painted sheet metal. The back side of the housing contains a fibrous materials (aspen wood fiber) kept saturated with water. A rigid media pad is also available. A DC motor driven pump lifts water from the sump located in the bottom of the housing and delivers it to a perforated channel located at the top. The water drips through the evaporating pad to keep it wet and is collected back in the sump located in the bottom of the housing. A DC motor driven fan draws outside air through the evaporative pad. DC power is furnished by two PV solar panel of seventy five Watt each.

Principle of operation:

The evaporative pad is kept saturated with water. As air flows through the evaporative pad, it loses sensible heat; which causes its dry bulb temperature to drop, and gains latent heat which causes its humidity ratio to rise (fig.2 , fig.3 and fig.4)
A note of precaution should be made: For this type of application 100% outside air is brought into the occupied space, so provision should be made to allow the same amount to escape, in order to avoid air saturation.

Humidifying efficiency = actual dry bulb change / theoretical dry bulb change

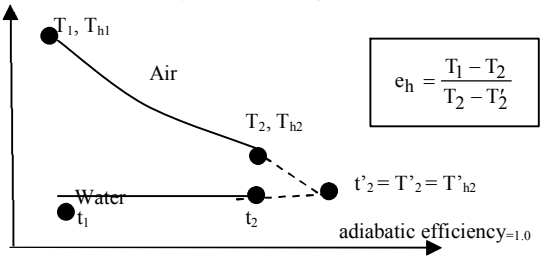

Figure 2 . Temperature Profile for evaporative cooling process.

It is important to note that the efficiency of the evaporative cooler depend on several factors, as the evaporative pad thickness, the air velocity, the dry and wet bulb temperature of the outside air, etc..

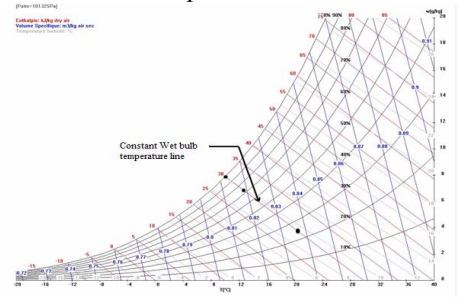

Figure 3 . Psychrometric chart representation for evaporative cooling PROCESS.

Figure4. Experimental model

Discussion and conclusion

Evaporative cooling equipments work well in the hot and arid southern regions, which constitute practically the two third of the country. They have no impact whatsoever on the environment. The water consumption is not very excessive (however this could be a problem in certain places). Energy consumption is much less than in classical air conditioning equipments. Possible application in greenhouse, poultry and cattle growing buildings. Considerable improvement in the cooling efficiency can be obtained with the use of two stage evaporative cooler. Another possible application of the evaporative cooler is in desiccant cooling system.