Windows Evaporative Cooler

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Abstract **- Window evaporative cooler is an efficient and effective solution for conditioning a confined space or area in developing nations. In locations having high dry bulb temperatures and low relative humidity such as deserts application of evaporative coolers is highly effective and for places with humid weather conditions slight modification of cooler is needed to serve the purpose of cooling after dehumidification.**

keywords **- window, cooling system, evaporative cooling, dry, humid climate**

I. Introduction

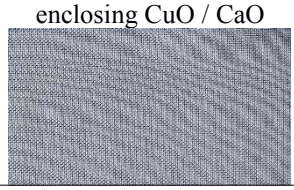
Window Evaporative Cooler (also called as Evaporative Air Conditioner, swamp box, desert cooler and wet air cooler) is a device that cools air through the evaporation of water. Evaporative cooling differs from other air conditioning systems, which use vapor-compression or absorption refrigeration cycles. Evaporative cooling uses the fact that water will absorb a relatively large amount of heat to evaporate (that is, it has a large enthalpy of vaporization). The temperature of dry air can be dropped significantly through the phase transition of liquid water to water vapor (evaporation). This can cool air using much less energy than refrigeration. In extremely dry climates, evaporative cooling of air has the added benefit of conditioning the air with more moisture for the comfort of building occupants.

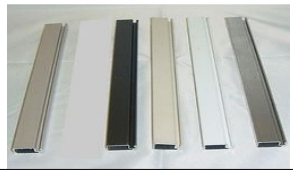
II. Design of the Evaporative Cooler

In developing nations with a tropical climate, vegetation is largely available and hence, commodities like grass and greenery are amply available which can be used for generation of products which can serve the consumer. The design shown below reflects the use of eco-friendly materials which can provide for the required cooling in dry/humid environment.

Figure 1 – Schematic design of Window Evaporative Cooler

Table I

Components of the Window Evaporative Cooler		
No	***Item***	***Description and Function***
1	SWM-500 MESH enclosing CuO / CaO 	The SWM-500 Mesh has a pore size opening of 25 micron which serves to arrest most of the airborne particles and which result in good filtration system. The mesh is filled with CuO / CaO which acts as a deliquescent material and absorbs moisture from the air thereby converting this unit into a dehumidifier.

2	VELCRO STRIP ATTACHING DEHUMIDIFIER WITH ALUMINIUM FRAME	Velcro strip is used for attaching dehumidifier with Aluminum frame using SPEB7 adhesive
3	RECTANGULAR ALUMINIUM FRAME 	This is the main frame used for the design and consists of two parts: The upper section consists of two rectangular aluminum channels which house the flexible plastic tubes, and which can provide for flow of water and spraying of the same over the cooling blanket.
4	COOLING BLANKET 	This is made by enclosing activated charcoal dust or activated carbon within a porous material like wood wool or grass which will act as a cooling media. The activated charcoal dust filters the air and absorbs most of the pollutant gases or the toxins which will lead to increase in pure air supply within the enclosed space. The wood wool is made from pine wood and these fibers function to absorb the heat through latent heat of vaporization. They provide a surface area for the air particles to adhere to and then to vaporize which will allow for cooling.
5	MOSQUITO NET ATTACHED TO FRAME WITH VELCRO	The mosquito net is attached to the outermost side of the Aluminum frame facing into the inside of the room. This provision is made in-order to avoid insects and other creatures from entering the confined space
6	FLEXIBLE PLASTIC PIPES WITH HOLE ON TOP REGION 	Flexible plastic or PVC pipes which fit in aluminum frame will be used to circulate the water using a submersible pump. The pipe system will have holes at the top which will allow for spraying of the water on the cooling blanket.
7	CLAMPS TO ATTACHED THE ALUMINIUM FRAME WITH BOTTOM CONTAINER	The aluminum frame used to construct the window is divided into two parts: Upper and Lower which are attached to each other using clamps. The lower half is also used as a water collector or container and has the submersible pump to circulate the same
8	SPLITTER TO ATTACH TUBING TO WATER PUMP	The splitter is used to attach the tubing to the submersible pump and split the tube into two parts which are used for attaching with two plastic pipes
9	REFILL PLUG	The refill plug is used to fill the water in the tank made of the aluminum frame and will provide for fresh water as a coolant
10	WATER PUMP (SUBMERSIBILE) 	A submersible water pump operated by Arduino UNO microcontroller will be used for circulating the water from the tank through the aluminum frame and over the cooling blanket
11	DRAINAGE PLUG	A drainage plug is provided for the removal of water and for the maintenance purpose of the evaporator cooling window

III. Working of the Evaporative Cooler

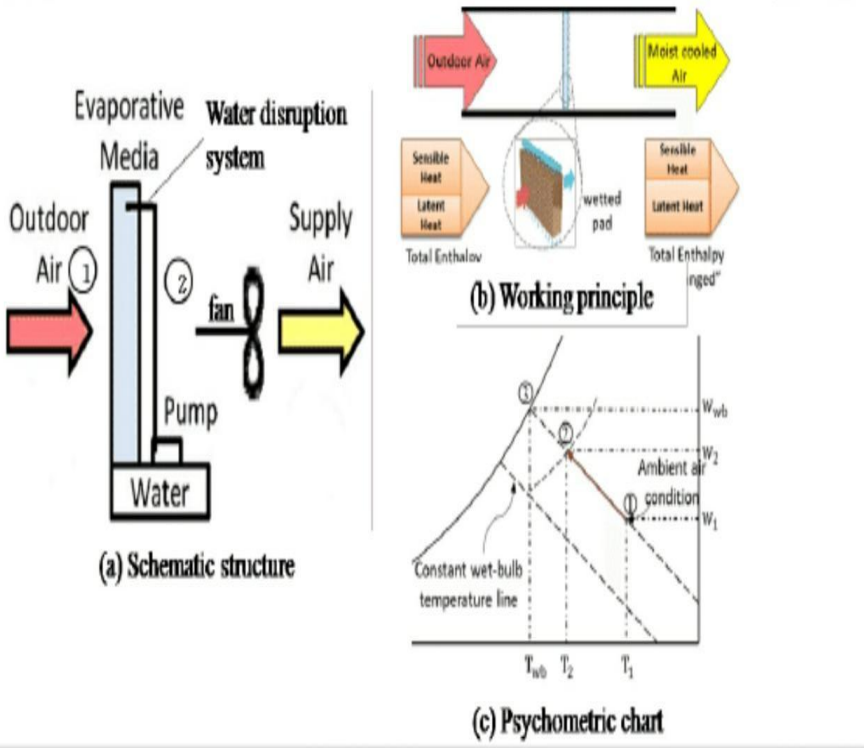


Figure 2 – Working of the evaporative cooling system and representation of the process on the psychrometric chart

As seen in Figure above, the evaporative cooling window operates on the principle of absorption of latent heat of vaporization [1] [2]. The ambient or outside air is sucked by a fan which moves across the dehumidifier and loses some portion of its humidity to the same. Furthermore, it passes through the cooling blanket which will allow for purification of the air and for the cooling of the air by vaporizing the water sprayed through the window. As seen on psychrometric chart, the curve moves along the constant wet bulb temperature line and thereby the air temperature drops from 1 to 2 and the moisture content rises. Dehumidification followed by cooling will again result in further drop of water vapor content in the air and will result in low humidity but enhanced cooling effect.

The operation of the window cooler in both the configurations of natural convection and forced convection is seen in Figure below.

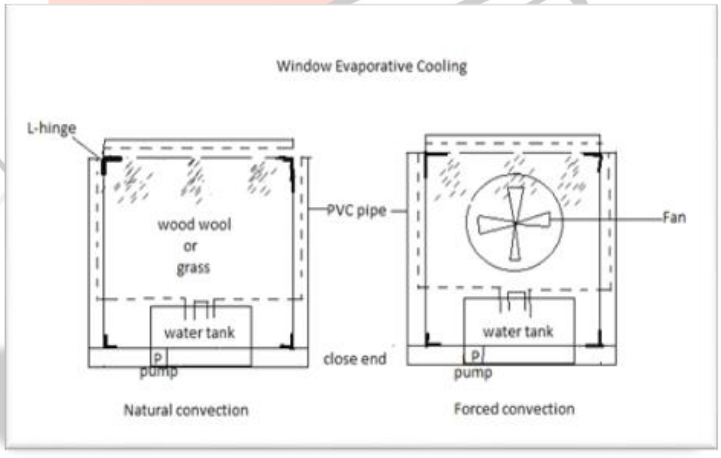


Figure 3 – Evaporator cooling design a) Natural Convection and b) Forced convection

IV. Additional Components in Design

Motor Fan

The purpose of your air conditioner's condenser fan motor is to keep the compressor from overheating. Its job is to cool the superheated refrigerant that moves through the condenser coils of your AC unit, which helps to cool your home. An electric motor is an electrical machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and electric current in a wire winding to generate force in the form of torque applied on the motor's shaft. Electric motors can be powered by direct current (DC) sources, such as from batteries, or rectifiers, or by alternating current (AC) sources, such as a power grid, inverters or electrical generators. An electric generator is mechanically identical to an electric motor, but operates with a reversed flow of power, converting mechanical energy into electrical energy.

Solar panel

Solar panels are comprised of several individual solar cells which are themselves composed of layers of silicon, phosphorous (which provides the negative charge), and boron (which provides the positive charge). Solar panels absorb the photons and in doing so initiate an electric current. They will be used to power the submersible pump and fan and also will be mounted in a way to maximize the solar radiation.

V. Conclusions and Future Work

The proposed design of the evaporative cooler can be used for sliding windows in homes or apartments

Following work will be carried out in the due course for completion of this project

Real-time temperature, humidity measurement using appropriate sensors will be carried out in different locations of tropical environment

Water flow rate will be controlled for always achieving comfort conditions and suitable control system will be designed to achieve the performance criteria

Different fiber diameter studies will be carried out to determine the porosity in theory and to verify the same experimentally.

Relationship between fiber diameter, porosity and cooling performance or COP will be investigated

Efficient dehumidifier design will be incorporated, and the overall prototype will be scaled for mass manufacturing

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