Hybrid Air Cooler
Literature Review and Research trend

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Abstract: To overcome the problem of high electric power consumption in a conventional air conditioner, it must be modified to an extent that it scales back the electricity consumption. To increase the cooling capacity of a conventional desert cooler, it must be redesigned to a level that it can be in contrast with the cooling effect of an air conditioner. The aim of this paper is to design a cooling solution which is different from the conventional system and hence, it can be termed as a Hybrid or Modified Air Cooler as it comprises of not only the conventional desert cooler but the modern Vapour Compression Refrigeration Cycle as well. The hybrid air cooler not only covers the problem of high power losses but also gives a better cooling efficiency. The projected plan envisages a desert air cooling system that lies in between air conditioning and traditional desert cooling systems. It might scale back the electricity consumption compared to air conditioning in moderate hot climate and it provides higher cooling than the traditional desert cooler. Its value will also be below the present air-con systems.

***Keywords*- Evaporative Cooler, Air conditioner, Desert Cooler, Cold Storage, Vapor Compression Refrigeration Cycle.**

I. INTRODUCTION

India is home to an uncommon assortment of climatic districts. Despite the fact that less expensive strategies for warming are accessible during the winter season, strategies for chilling off the hot temperatures during the late spring don't have wide assortment of choices. Air Conditioners and Desert Coolers are the foremost options to beat the heat. Even though both of them have various advantages but the counterpart is dangerously critical. Air conditioners have high starting and running costs, which can't be managed by every one of the general population in a creating nation like India. Air Conditioners give inadmissible outcomes, using a lot of electricity, a large percentage of which is created by coal-burning power plants, air conditioning contributes indirectly to the release of greenhouse gases and other pollutants. In addition, spending too much time in an air-conditioned environment can contribute to health problems such as asthma, tightness in the chest and other respiratory ailments. On the other hand, Coolers despite of being comparatively cheaper with low power consumption, fail to attain high cooling effect. Coolers can become unhygienic very quickly unless maintained properly. Water has to be changed and the water pads have to be cleaned regularly. Coolers are often noisy compared to AC or other cooling devices and don't have controlled temperature drop.

Hence there is a requirement for building up an appropriate room cooling framework. A framework that can tackle the shortcomings of both the cooler and air conditioner. A system which is less expensive and provides a decent cooling effect. A solution which is power efficient and nature friendly. A setup which lies in between air conditioning and traditional desert cooling systems. An arrangement which is portable and user friendly at the same time.

In the recent decades, the demand for air cooling has increased due to high dry bulb temperature and low humidity especially in damp regions like Rajasthan, Andhra Pradesh, Jharkhand, and Odisha. This project focuses on highly humid regions. It comprises of the various components of a Vapour Compression Refrigeration Cycle(VCRS) within the setup of a desert cooler. It involves the installation of the basic components like compressor, condenser, expansion valve and the evaporator along with the elements of a desert cooler like cooler pump, cooler pads, fan blades and cooler motor. It also includes a cold storage vessel which can be used to store water.

II. LITERATURE REVIEW

REFERENCES	SUMMARY OF RESEARCH WORK
P.T. Selvam, H. I. Ahmed, S. N. Kumar, R.Kumaravelan and V.C.S. Gandhi,2014	Their paper states the modification of the dessert cooler in such a way that it consists of two tanks namely top tank and lower tank in which the lower tank is made up of mud as it is porous in nature, absorbs the water and helps in cooling. It is then placed into another pot, the gap is then filled with mud. The inner tank stores the water. When the system is turned on, the pump transfers the water from the lower tank to the cooling pads. The cooling pad is then placed where the heat transfer takes place between the air and the water. The water is thrown out with the help of a fan to the room. The system is also provided with a storage box. The water from the cooling pad passes through the storage box and keeps the contents of the box cool. While testing, they achieved a difference of temperature drop of a 960 cubic feet room by 12^{o}C and for the storage box it drop by 11^{o}C in around 5 hours. (3)
A.K. Sharma,P. Bishnoi, 2013	Their paper suggests the alteration of a desert cooler without a fan or any other electrical part due to which it is very economical. They placed it over the top of a building so that it receives as much air as possible. The air is trapped inside the camber with the help of baffles and is send to the room. They also coloured the chamber in black paint to achieve better cooling .In their testing, the temperature drop achieved was about 10^{o}C in about 5 hours.(5)
S.N. Tripathy, V. Verma, A. Kumar, S. Kumar, 2016	They suggested that in a cooler, the ambient air temperature decreases when it passes through the heat exchanger and along with it humidity of the air also decreases. They proposed a design of the evaporative cooler in which they added an extra pump for the heat exchanger (basically the tubes). The cooled moisturized air from the cooler comes out through the heat exchanger. The moisture gets absorbed by the heat exchanger and the less humid air is supplied to the room. (6)
P. Bhake, S. Joshi, K. K. Mishra, 2017	They proposed a design of an evaporative cooler which reduces the water consumption. They reduced the pump work by eliminating the pump. They used wood wool for evaporative cooling which was placed over the cage. (2)
K.T. Pawale, A.H. Dhumal, G.M. Kerkal, 2017	They generated a nano-refrigerant which included 0.5% of Al2O3 nanoparticles in the base refrigerant which lead to an overall improvement in the performance of the VCRS than that of pure base refrigerant. It was checked and tested on various aspects like COP, Suction and Discharge Temperature of the Compressor, effect on Subcool and Superheat and Compression Ratio, however increase in the percentage of nanoparticles in the base refrigerant resulted in decreased system performance.(1)
C. B. Kothare, N. B. Kothare, 2011	They tried to develop a system which provides both the facilities of a normal air conditioner and a refrigerator and named it Modifier Air Cooler (MDC). The MDC provides better cooling than a desert cooler and it was observed that a temperature of 18 degree celsius was achieved in 360 minutes. Being highly cost effective, it can also serve as a cold pure water storage and a purifier.(9)

III. RESEARCH GAP

Even though several attempts have been made to refine the conventional desert cooler but there has always been a disproportion in its effective cooling and power consumption. Considering all the previous attempts, either the setup was bulky and fixed or the power consumption and time taken were high. So there is a scope of creating a system with a balanced proportion of portability and power consumption.

- There has never been the consideration of using VCRS cycle in the cooler.
- Coolers have always been used for cooling air and no other consideration for using its cooling effect for other purposes.
- To increase the effective cooling, the power consumption was also raised in most of the projects.

IV. COMPONENTS

Objective of this paper is to provide a solution for improving the cooling effect of the conventional desert cooler along with eliminating all the shortcomings of the previously made attempts to modify the conventional desert cooler. The endeavor of the proposed design is to install VCRS cycle in the desert cooler which will scale up the cooling effect to a great extent. All the

components in the cooler will be tailored in such a way that it will not affect its portability. Our design consists of various components which are

- Motor: It is used to provide rotation to the fan which in result sucks the air from the chamber and then transfers it to the room.
- Pump: It provides the circulation of the water in the cooler system.
- Compressor: It is installed to provide the circulation of the refrigerant in the system.
- Evaporator: It helps in heat transfer between the refrigerant and air.
- Condenser: It helps in heat transfer between the air and refrigerant.
- Expansion Valves &Copper Tubes: It is used reduce the pressure of the refrigerant and also controls the moisture content in the delivered air.
- Storage box: It is used for storing the water and then cooling it with the help of air.
- Tap: It is used as an outlet for the stored water.
- Switch: A switch shall be used to regulate the usage of the VCRS cycle.
- Thermostat Sensor: It is used to measure and control the temperature of the room.

V. PROPOSED DESIGN AND METHODOLOGY

Our attempt is to design a system that operates either on the simple conventional feature of the desert cooler or utilizes the VCRS system instead. This will help in scaling down the power consumption when there is no need of achieving high cooling rate in less duration. All the components shall be welded together and since all the components are mounted on the cooler in such an arrangement that portability of the system is not affected; it will not be challenging to fit it in the Indian domestic environment. The proposed design also consists of a storage box which can be used to store water and is cooled with the help of cooled air which can be further used for drinking purposes as it is completely isolated from the system.

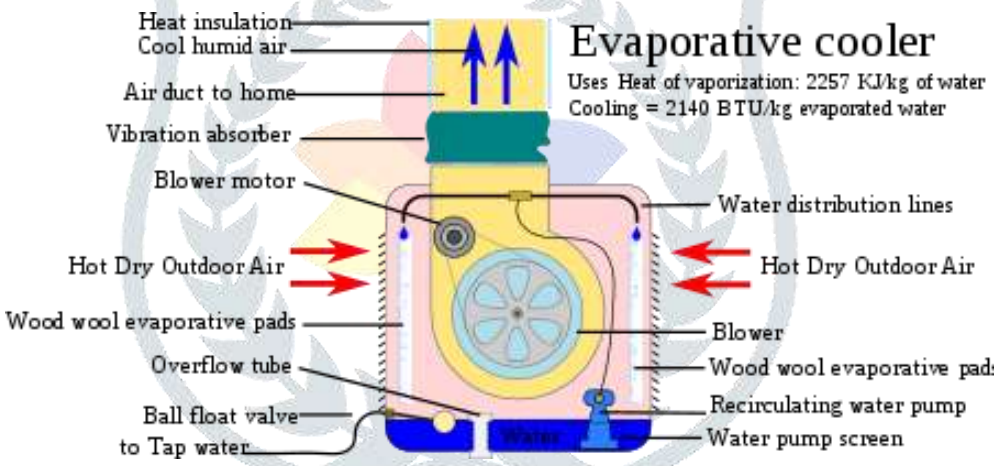


Figure 1- Evaporative Cooler (Source-https://www.pinterest.com)

Motor- An air cooler consists of two motors, one is air blower motor it is a capacitor start run induction motor and the other motor is for circulating water around the grills which is a shaded pole submersible induction motor.

Pump- The pump runs the water through the cooling pads, allowing them to soak the water beforehand. The fan should be run after the tank is full. This helps the cooler to cool the air, as soon as you turn it on.

Compressor- The compressor's use is to pull the low-temperature and low-pressure vapour from the evaporator, through a suction line. Once the vapour is drawn, it will be compressed. This will cause the vapour's temperature to rise. Its main function is to transform a low-temperature vapour in to a high-temperature vapour, to increase pressure. Vapour is released from the compressor into a discharge line.

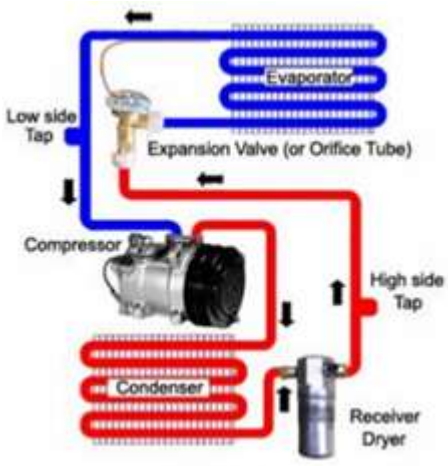
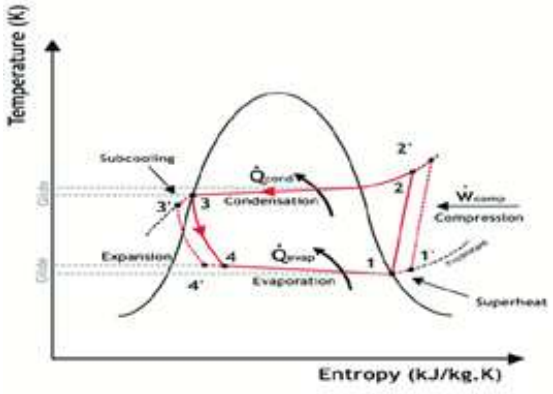


Figure2- Basic Components of VCRS (Source-http://www.fixya.com)

Evaporator- An evaporator is used to turn any liquid material into gas. In this process, heat is absorbed. The evaporator transfers heat from the refrigerated space into a heat pump through a liquid refrigerant, which boils in the evaporator at a low-pressure. In achieving heat transfer, the liquid refrigerant should be lower than the goods being cooled. After the transfer, liquid refrigerant is drawn by the compressor from the evaporator through a suction line. Liquid refrigerant will be in vapor form upon leaving the evaporator coil.

Condenser- Condensation changes gas to a liquid form. Its main purpose is to liquefy the refrigerant gas sucked by the compressor from the evaporator. As condensation begins, the heat will flow from the condenser into the air, only if the condensation temperature is higher than that of the atmosphere. The high-pressure vapor in the condenser will be cooled to become a liquid refrigerant again, this time with a little heat. The liquid refrigerant will then flow from the condenser to a liquid line.



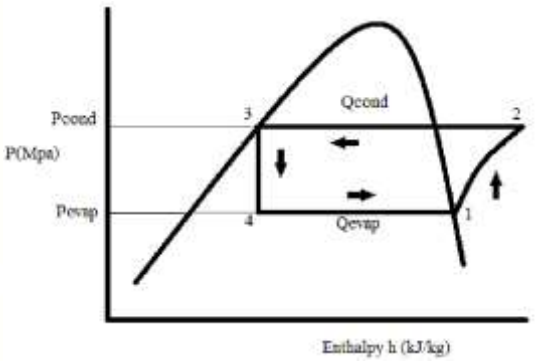


Figure 3.1- T-S Graph of VCRS Figure 3.2- P-H Graph of VCRS

Source- https://www.researchgate.net

Expansion Valves- Commonly placed before the evaporator and at the end of the liquid line, the expansion valve is reached by the liquid refrigerant after it has been condensed. Reducing the pressure of the refrigerant, its temperature will decrease to a level below its atmosphere. This liquid will then be pumped into the evaporator.

Switch- The SPDT (Single Pole Double Throw) switch is a three terminal switch, one terminal is used as input and remaining two terminals are used as outputs. It joins a mutual terminal to one or the other of two terminals. It shall be used to regulate the use of the VCRS cycle.

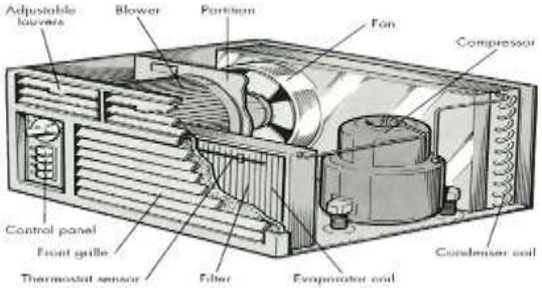
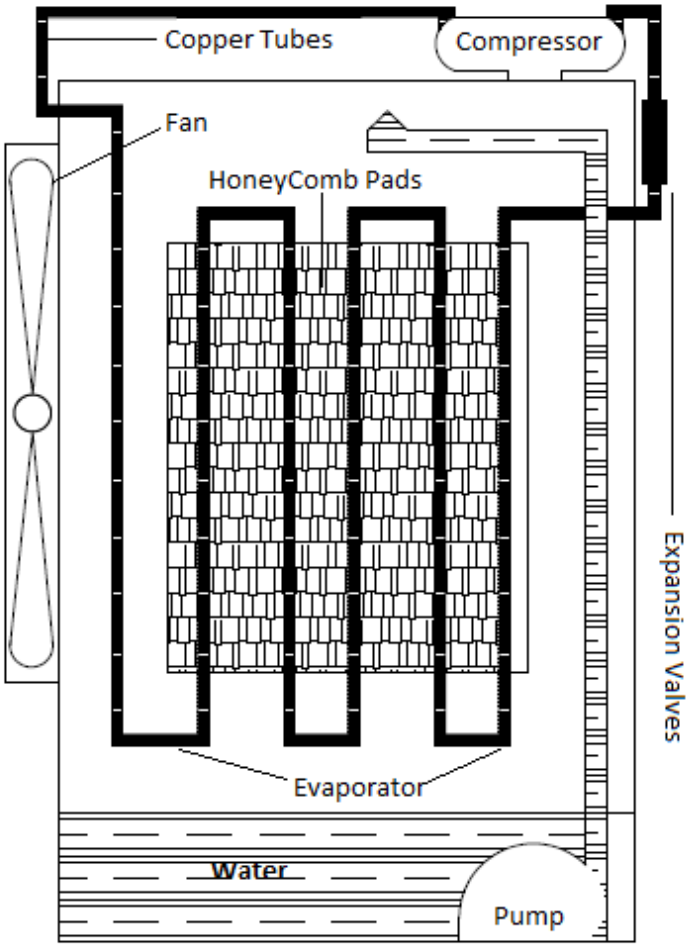


Figure 4- Cut Section of a Window Air conditioner

Source- https://images.google.com/

VI. BASIC DESIGN

The schematic design of our proposed cooler is shown in the figure below-



VII. CONCLUSION

After going through various literature review papers, it was observed that lots of effort has been put into achieve the desired output from the cooler but no matter what some sort of drawback or limitation was ascertained. Our effort is to not only provide a system which eliminates such kind of limitations without losing the basic functionality of the conventional desert cooler but also enhance the usability of it. By proving the storage box, we aspire to increase the functionality of the system as the cooled air will not only be used for cooling the room but the storage box also.

VIII. FUTURE SCOPE

In the modern era of human evolution, we have reached a situation where environmental degradation is increasing by the day. Nowadays, Environmental Protection is a must. Our Project mainly focuses on cutting out environment-affecting factors. In the near future, we believe, environment fortification will constantly increase which is when our project comes into play. We believe it has the potential to grab hold of highly humid region which include most parts of our country, India. It can be further refashioned to develop a compact system including a R.O. Filter System along with a storage space for commodities to build up a compact refrigeration system as a whole.

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