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Experimental Analysis of Summer Air Conditioning System Using PCM

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ABSTRACT

This report deals with experimental analysis of summer air conditioning system with the use of Phase Change Material to increase its Co-efficient of Performance. The idea of phase change materials (PCM) used for the purpose of storing thermal energy is to make use of the latent heat of a phase change, usually between the solid and the liquid state. Since a change of phase involves a large amount of latent heat of energy at small temperature changes, PCMs are used for temperature stabilization and for storing heat with large energy densities in combination with rather small temperature changes. The usage of PCMs is on one hand a question of a high energy storage density, but on the other hand it is very important to be able to charge and discharge the stored energy with a thermal power, that is suitable for the desired application. In the work presented, the analysis on air conditioning system is done with and without the use of Phase change material and their respective co-efficient of performances is calculated

Keywords: *air conditioner, phase change material (PCM), latent heat storage, poly ethylene glycol (PEG 400), copper, refrigerant (R22), co-efficient of performance.*

I. INTRODUCTION

- It is true that the rapid industrialization has led to unprecedented growth, development and technological advancement across the globe. It has also given rise to several new concerns. Today we should face the global warming and ozone layer depletion on the one hand and spiraling oil prices on the other hand have become main challenges.
- Excessive use of fossil fuels is leading to their sharp diminution and the nuclear energy is not out of harm's way. In the face of imminent energy resource crunch there is need for developing thermal systems which are energy efficient. Thermal systems like refrigerators and air conditioners consume the large amount of electric power. So it is necessary to develop energy efficient refrigeration and air conditioning systems.
- Fossil fuels are used to produce energy. But these fossil fuels are present in limited amount under the earth's crest. So scientist from all over the world is trying to find new and renewable energy sources. One of the options is to develop energy storage devices like thermal energy storage system which has the potential to attain energy savings, which in turn reduce the environment impact related to energy use.
- The pollutants coming from the combustion of these fuels are increasing the temperature of earth rapidly which caused the invention of air conditioning system to reduce the temperature of air inside the system. This led to increase in

demand for air conditioning greatly during the last decade. Large demands of electric power and limited reserves of fossil fuels have led to surge of interest with an efficient energy application.

- Electrical energy consumption has been varied significantly during the day and night according to the demand by industrial, commercial and residential activities. In hot and cold climate countries, the major part of the load variation is due to domestic space heating and air conditioning respectively.
- This variation leads to utilization of energy in different amount at different time due to which of electricity price changes according to use.
- Better power generation/ distribution management and significant economic benefit can be achieved if some of the peak load could be shifted to the peak load period that can be achieved by thermal energy storage for heating and cooling in various application.
- Thermal energy storage (TES) is the temporary storage of high or low temperature energy for the later use. It bridges the time to gap between energy requirements and energy use. Among the various heat storage techniques of interest, latent heat storage is particularly attractive to its and ability to provide a high storage density at nearly isothermal conditions.
- Phase-change thermal energy storage systems offer other advantages, such as a small temperature difference between storage and retrieval cycles, small sizes of unit and low weight per unit storage capacity. One of prospective techniques of storing thermal energy is the application of phase change materials.
- Cold thermal energy storage (TES) and the use of phase change materials (PCM) are an advanced energy technology that has recently attracted increasing interest in industrial refrigeration applications are such as process cooling, food preservation and air conditioning.The vehicle's propeller is shrouded, allowing closer access to specific targets or areas of interest and preventing the user from risk or injury so it is much safer than an open blade or propeller.

II. METHODOLOGY

Before the experiment is carried out, certain arrangements are made for the introduction of Phase Change Material in Air Conditioning system.

For the placement of the Phase Change Material, a definite method is chosen so that its presence has certain amount of influence on the working system and on the environment in which the Air Conditioning system is placed.

Evaporator is the important component where refrigerant is expanded and evaporated and it acts as a heat exchanger that transfers the heat from the area to be cooled to a boiling temperature thereby achieving the effect of air conditioning.

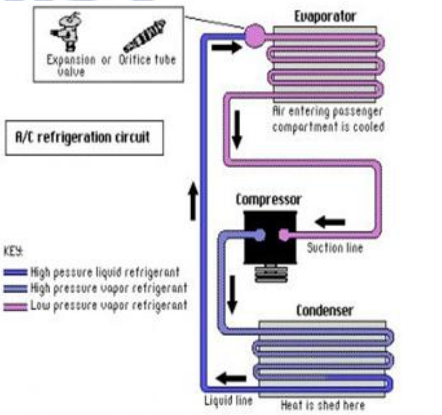

Fig. 2.1. Air conditioning circuit

So, the evaporator coils are chosen for the placement of Phase Change Material and the effect on the coils has huge influence on the overall working of the Air Conditioning system.

Now, the technique by which the Phase Change Material is placed around the evaporator coil needs to be found. And hence, one of the ways in which the evaporator coils can be covered with Phase Change Material is by covering the evaporator coil with another coil of larger diameter than that of the evaporator coil and that is also made of the same material as that of the evaporator.

Materials like aluminium can also used to cover the evaporator coils. But due to the following characteristics and properties, copper is chosen over aluminium.

2.1 Heat transfer characteristics

As the transfer of heat takes place in the coils, it is very important for the metal to have good heat transfer characteristics. Copper has a heat transfer coefficient higher than aluminium. That means, copper is a better heat exchanger than aluminium.

2.2 Cost and Pliability (The quality of being easily bent)

Copper is costlier than aluminium, which increases the cost of making an air conditioner and thereby the price of air conditioner. To reduce the unit cost of manufacturing ACs, aluminium has become the favourite choice of manufacturers.

Another factor to be considered is pliability. Aluminium as compared to copper, has a better ability to be bend into the shapes desired. Hence to make a coil of same size and shape, approximately three times more copper is required, making the process costlier.

However, to bring down the cost of AC with copper coils, thinner and thinner copper coils are being made now days.

2.3 Strength and reliability

Copper is much easier to repair on field than aluminium. Many times, when aluminium coils are damaged they need replacement. The coils made out of copper are much stronger than aluminium. Hence they are durable. These days, thin copper coils are being used due to its high cost. The new refrigerants that are replacing the old HCFCs operate at higher pressure, which makes the thin copper coils susceptible to leakages. This has made copper less durable, high maintenance and the life span of the coils has also reduced.

2.4 Ease of maintenance

As the condenser coils are placed in the unit that is usually placed outside the house; it is exposed to harsh climates and dust and this needs regular cleaning for better functioning. Having said that, copper coils are easy to clean and maintain, as they are durable. While aluminium coils are not strong and so need to be kept in heavy-duty cabinet to protect them from damage. This makes them difficult to clean and maintain.

2.5 Corrosion

Corrosion plays as very important role in determining the life of an Air Conditioner. Corrosion damages the coils that hampers the heat transfer process and also results in leakage. Hence it is very essential to protect the coils from corrosion. Corrosion damages are higher in humid climates and for people living near seacoasts and salty water bodies, as the moisture content in air is higher in such areas.

Copper is subjected to Formicary corrosion, but cleaning the coils regularly and maintaining them with care can control it. The bigger problem is with aluminium coils. The joints of these coils to copper tubes are subject to galvanic corrosion. Galvanic corrosion occurs when two dissimilar metals are in contact in the presence of an electrolyte such as moisture.

Due to corrosion, a non-conducting layer is formed over the coils, which reduces its heat exchange capacity. Today many modern technologies have been developed to protect the coils against corrosion and thus increase the life of ACs.

So, coils that are made of copper that are of larger dimensions are than the evaporator coils are used in covering.

The number of evaporator coil passes in a standard Air Conditioning system ranges between 25-30. So, for better experimentation of Air Conditioning system with Phase Change Material, the number of evaporator coil passes has been reduced to 10.

To reduce the number of passes in the evaporator coil, the evaporator unit that is already present in the Air Conditioning system is removed. Before removing the evaporator coils, the refrigerant that is already filled inside the Air conditioner is exhausted to prevent any insidious attack to the person handling the evaporator tube.

Cutting operation is carried out at the spots where the refrigerant enters the evaporator and the also at the spot where refrigerant leaves the evaporator. This results in the complete removal of the evaporator coils. This cutting operation is done with the help of hacksaw.

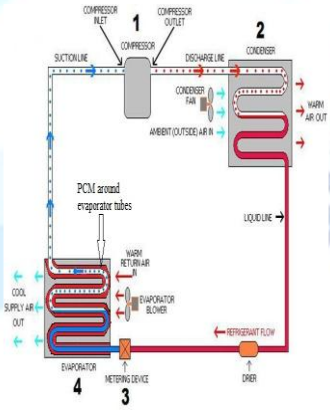

Figure 2.2 Air conditioner with PCM wounded evaporator coil

New copper tubes of diameter of the originally sized evaporator coils (0.5 inches) and copper hollow tubes of diameter larger than that (0.75 inches) are placed such that their axes are coaxial in nature.

These tubes are bended manually such that they form 10 passes. And one end of both these tubes is welded to the openings that are present due to the removal of the previously present evaporator tubes.

Before the other end of the tube is closed, the hollow space between the two copper tubes is filled with Phase Change Material (Ethylene glycol + Water). The Phase Change Material is pressured into the tube so that it is distributed uniformly through the tubes.

Now the other end of the tube is either sealed with the help of a temporary joint such as M-seal or it is permanently sealed with by means of welding the two ends of the tubes.

Before charging the system with the refrigerant, the system was checked thoroughly for leaks. And finally, the system is filled with the refrigerant(R-22).

Figure 2.3 working of AC with and without PCM

During above experimentation following parameters will be checked

1. Temperature and pressure measurement without PCM.
2. Temperature and pressure measurement with PCM.
3. COP of Air Conditioning system without PCM.
4. COP of Air Conditioning system with PCM.

To measure these following parameters, temperature and pressure gauges are incorporated at various places. The temperature sensors are incorporated at

- Evaporator inlet (T4)
- Evaporator outlet (T1)
- Condenser inlet (T2)
- Condenser outlet (T3)

These temperature gauges are connected to the Digital temperature indicator so that the temperature measured is indicated in its display. Pressure gauges are also placed to measure the pressure at various inlets and outlets. They are measured at

- Evaporator inlet (P4)
- Evaporator outlet (P1)
- Condenser inlet (P2)
- Condenser outlet (P3)

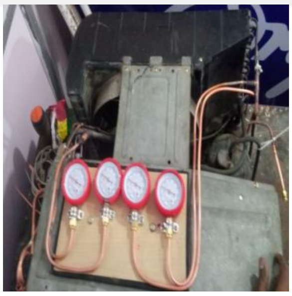

Figure 3.4 Assembly of Pressure gauge

The temperature and pressure readings without the use of Phase Change Material are found before filling of the PCM in between the copper tubes

III. RESULTS AND DISCUSSION

3.1. Reading Without PCM:

Temperature value:Table 3.1.

S.No	**Evaporator outlet**	**Condenser Inlet**	**Condenser outlet**	**Evaporator inlet**	**COP**
	T_1 in ·c	**T_2 in ·c**	**T_3 in ·c**	**T_4 in ·c**	
1	4	44	32	2	1.48
2	6	48	41	2	1.37
3	3	52	40	-1	1.35
4	4	54	39	-2	1.37
5	5	56	40	1	1.39
6	2	53	42	-1	1.38

3.2. Reading With PCM:

Table 3.2.

	T_1in ·c	**T_2 in ·c**	**T_3 in ·c**	**T_4 in ·c**	
1	9	61	45	2	1.55
2	8	62	46	1	1.57
3	10	62	47	2	1.59
4	10	64	44	3	1.52
5	10	63	47	3	1.60
6	9	65	43	1	1.57

3.3 Comparison Charts:

3.3.1.COP Vs Time

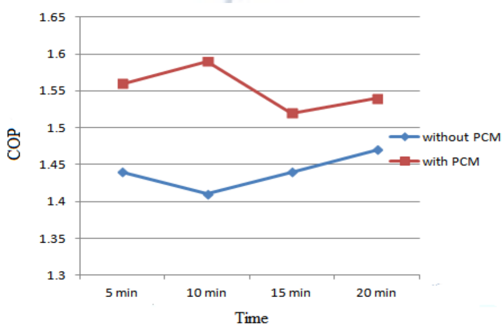

Figure 3.1 Comparison of COP with time

3.3.2 Refrigeration Effect Vs Time

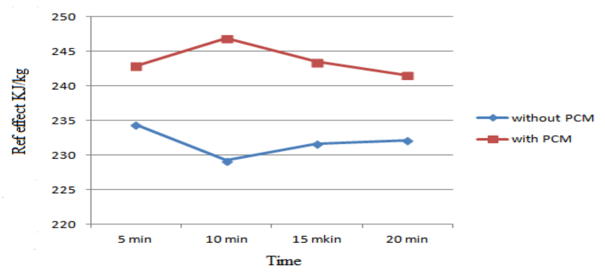

Figure 3.2 Comparision of refrigeration with time

3.3.3 Mean Evaporator Temperature Vs Time

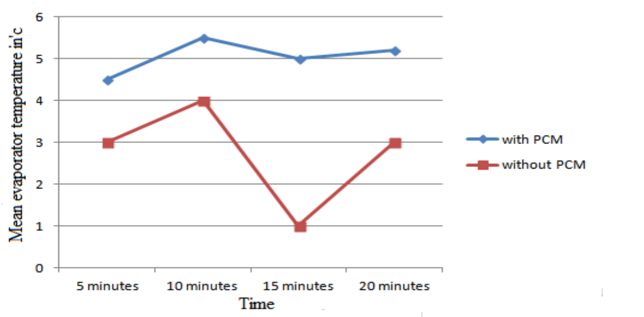

Figure 3.3 Comparison mean evaporator temperature with time

3.3.4 COP Vs Mean Evaporator Temperature

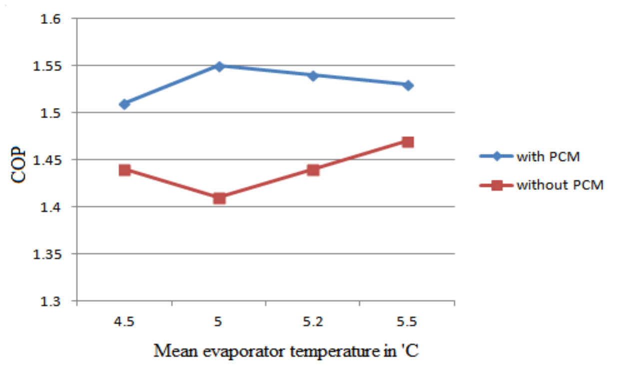

Figure 3.4 Comparison of COP with evaporator temperature

3.3.5 Compressor Vs Time

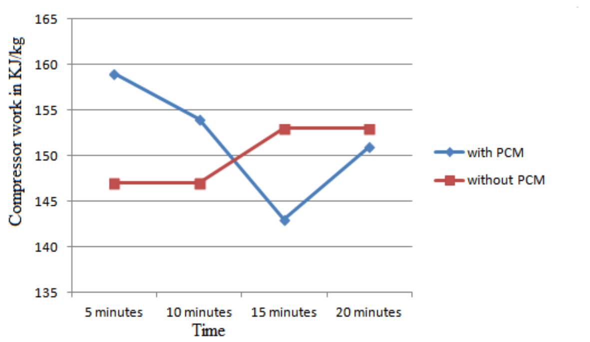

Figure 3.5 comparision of Compressor work with time

IV.CONCLUSION

A very important criterion on today's world is to reduce the consumption of electricity. Since Air Conditioners have proved to be the need of near future. It is necessary to improve the working of Air Conditioners by increasing their coefficient of performance and reduce the use of electricity.

The various inlet and exit temperatures and pressures of different components of an air conditioning system were found on both (with and without the use of Phase Change Material) and their corresponding coefficients of performance were calculated.

So through this experimental analysis of air conditioning, it is found that the coefficient of performance of the air conditioning system has increased by the use of phase change material by a mean value of 0.13

REFERENCES

[1] Application of phase change materials and pcm-slurries for thermal energy storage, A. Heinz, W. Streicher Institute of Thermal Engineering,Graz University of Technology 8010 Graz, AUSTRIA.

[2] PCM energy storages and PCM wall construction elements, Schranzhofer, H., Puschnig, P., Heinz, A., Streicher, W., (2006), Validation of a TRNSYS simulation model for, Ecostock 2006 - Tenth International Conference on Thermal Energy Storage, May 31 – June 2, 2006, USA.

[3] Development of Novel Polymer Phase Change Material for Heat Storage Application, Amin Al Robaidi. International Journal of Materials Science and Applications. Vol. 2, No. 6, 2013, pp. 168-172. doi: 10.11648/j.ijmsa.20130206.11

[4] Handbook of air conditioning and refrigeration, by Shan K. Wang.

[5] Performance Optimization of Air Conditioning System of ATM Room Using PCM as TES, Ajinkya Deshpande , Rohan Jadhav ,Vikrant Kale, Milind Nerpagar, Sachin Bansode , Nilesh Patil, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 6, June 2016