EXPERIMENTAL ANALYSIS ON HOUSEHOLD REFRIGERATOR THROUGH THE INTEGRATION OF LATENT HEAT STORAGE ELEMENTS IN WIRE AND TUBE CONDENSER AND PELTIER MODULE AT THE EVAPORATOR

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ABSTRACT: This study evaluates the influence of latent heat storage elements on the condenser temperature of a commercial household refrigerator and the effect of peltier module on the evaporator. Latent heat storage elements are used to reduce the condenser temperature as they are used to store the latent heat. So the work compression can be reduced. Peltier module is used to increase the suction temperature of the evaporator. In this work the experiments are conducted to know the effect of the both on the performance of the house hold refrigeration system

Key words- R134a, peltier module , phase change material.

I INTRODUCTION

Domestic refrigerator is a common household appliance that consists of a hermally insulated compartment and a heat pump that transfer heat from the inside of fridge to its external environment so that the inside of the fridge is cooled to a temperature below the ambient temperature of the room.

It also consists of the following four basic components

Evaporator

Compressor

Condenser

Expansion device

It works on Vapour compression refrigeration cycle.

There are many methods that enhance the COP of VCRS .Out of all methods ,two methods are applied in my present research on domestic refrigerator

They are

1. peltier module is placed at evaporator for better cooling in freezer zone and at compressor inlet for heating purpose that refrains moisture droplets entering into compressor. So, compressor work input is reduced and then the COP of the VCRS is increased. The following depicts the peltier effect how works on cooling and heating

A peltier effect is a temperature difference created by applying a voltage between

two electrodes connected to semi conductor material. By applying a low voltage DC power to a thermoelectric module from one side to other. One module face therefore , will be cool while the opposite face is simultaneously heated. By changing in polarity (plus and minus) of the applied DC voltage will cause heat to be moved in the opposite direction. Consequently, a thermoelectric module may used for both heating and cooling thereby making it highly suitable for precise temperature control application. This phenomenon can be useful when it transfer heat from one medium to another medium

2. High latent heat material is incorporated i.e phase change material (pcm) is incorporated at the condenser to remove heat from the condenser and change to ambient temperature

The following paragraph depicts about the phase change material

A phase-change material (PCM) is a substance with a high heat of fusion which, melting and solidifying at a certain temperature, is able to store and release large amounts of energy. Heat is absorbed or released when the material changes from solid to liquid and vice versa; therefore, PCMs are classified as latent heat storage units.PCM can be used in condenser to store energy and can provide additional cooling in the refrigerator. It can absorb heat from the condenser when the system is not working

II LITERATURE REVIEW

Mayank Awasthi[1], The global increasing demand for refrigeration in field of refrigeration air-conditioning, food preservation, vaccine storages, medical services, and cooling of electronic devices, led to production of more electricity and consequently more release of CO2 all over the world which it is contributing factor of global warming on climate change. Thermoelectric refrigeration is new alternative because it can convert waste electricity into useful cooling, is expected to play an important role in meeting today energy challenges

- A. A TER Cooling system is has been designed and developed to provide active cooling with help of single stage 12 V TE module is used to provide adequate cooling. First the cooling load calculations for this TER compartment considered under study were presented. The retention time achieved was 52 min with the designed module in this project. In order to achieve the higher retention time, another alternative was incorporate. This consists the additional heater on heat sink. The highest retention time achieved was 57 mins.
- **B.** Zalba et al. [2], studied the performance of a latent heat storage system with solid, liquid phase change . This paper also provides a review of studies dealing with thermal energy storage (TES) using phase change materials . This paper contains a complete review of the types of material which have been used as latent heat storage materials, their classification. Characteristics, advantages and disadvantages and the various experimental techniques used to determine the behaviour of these materials in melting and solidification. The paper contains listed over 150 materials used in research as PCMs and about 45 commercially available PCMs.

Rehman et al. [3] investigated the performance improvement of a simple Vapor Compression Refrigeration system by using a Phase Change Material at the Evaporator. A PCM box is built in which the liquid PCM will flow and circulate. The evaporator is kept within the PCM box so that a conductive heat transfer between the refrigerant and the PCM can take place. Due to this enhanced heat transfer, the COP of the system has increased. Use of water as the PCM has been suggested, but there could be an improvement in the selection of the PCM material

In my research on domestic vapor compression system. Peltier module is introduced at the evaporator to increase the suction temperature that refrains moisture droplets and decreases the compressor work input.PCM is incorporated in the condenser that removes heat from the condenser and then it increases the refrigeration effect. Here organic material is used as PCM to maintain temperatures between 32 to 42. The PCM used is a combination of some salts and additives

III EXPERIMENTAL SET UP

In my study on domestic refrigerator system is to enhance the COP by using peltier module at the evaporator and PCM material at condenser.



Fig a. Thermoelectric module



Fig b. Peltier module



Fig c :Peltier module at evaporator



Fig d:PCM



Fig e: PCM at condenser

A) Power consumption in KW OF VCRS



Above graph indicates the comparison of power consumption f VCRS in normal cycle with peltier module ,PCM and both . power consumption of domestic VCRS with PCM is 1.178 KW and with peltier module is 1.21KW.when both are used in domestic vcrs power consumption is decreased to 1.08KW. PCM

B) COMPARISON OF POWER CONSUMPTION DECREASE IN PERCENTAGE



The above graph shows the comparison of power consumption decrease in percentage on domestic VCRS in normal cycle with PCM,PELTIER MODULE and both. When PCM and PELTIER MODULE is used ,Power consumption in percentage is 5.4% and 8.6% respectively. When both are used ,the power consumption is 21%

C) COMPARISON OF COP OF VCRS THROUGH EXPERIMENTS



The cop of the domestic VCRS on normal cycle is 2.73 and with PCM and peltier module is 2.96 and 2.9 respectively. When both PCM and PELTIER MODULE is used ,the COP of VCRS is 3.21

D) INCREASE OF COP IN PERCENTAGE WHEN COMPARED TO NORMAL CYCLE



The above graph shows the comparison of the cop increment in percentage with normal cycle on domestic VCRS. With PCM and peltier module , the cop increment in percentage is 8.6% and 6.2% .when both PCM and PELTIER MODULE is used , the cop increment in percent is 17.6 %

E) TIME VS. EVAPORATOR TEMPERATURE



IV) CONCLUSION

Performance analysis is conducted on vapour compression refrigeration system with R134a as refrigerant. The system is analysed for four cases .those are normal cycle .PCM,PELTIER MODULE and combination of PCM and PELTIER MODULE .the system is analysed for performance parameters like Refrigeration effect, compressor work and COP and they are investigated.

In my study on domestic vapour compression refrigeration system with PCM at condenser and PELTIER MODULE at evaporator.the power consumption is decreased by 21% and over all COP is increased by 17.6% when compared with normal cycle.Hence it can be concluded that the PCM at condenser and PELTIER MODULE at evaporator has better performance and take less time for the same freezing capacity when compared with normal cycle

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