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Comparative Analysis of Domestic Refrigerator by using Water Cooled Condenser with Air Cooled Condenser

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Abstract - *A household refrigerator is a common household appliance that consists of a thermally insulated compartment and which when works, transfers heat from the inside of the compartment to its external environment so that the inside of the thermally insulated compartment is cooled to a temperature below the ambient temperature of the room. Heat rejection may occur directly to the air in the case of a conventional household refrigerator having air-cooled condenser or to water in the case of a water-cooled condenser.Different experimental and theoretical comparison will performed to evaluate the performance of domestic refrigerator by using water cooled condenser. In this, experimental study performance of water cooled condenser is compared with the air cooled condenser in a domestic refrigeration system.*

Key Words: **Domestic refrigerator, air cooled condenser, water cooled condenser, COP, Refrigerating effect, Heat extraction rate.**

1.INTRODUCTION

Condensers and evaporators are basically heat exchangers in which the refrigerant undergoes a phase change. Next to compressors, proper design and selection of condensers and evaporators is very important for satisfactory performance of any refrigeration system. Since both condensers and evaporators are essentially heat exchangers, they have many things in common as far as the design of these components is concerned. However, differences exist as far as the heat transfer phenomena are concerned. In condensers the refrigerant vapour condenses by rejecting heat to an external fluid, which acts as a heat sink. Normally, the external fluid does not undergo any phase change, except in some special cases such as in cascade condensers, where the external fluid (another refrigerant) evaporates. In evaporators, the liquid refrigerant evaporates by extracting heat from an external fluid (low temperature heat source). The external fluid may not undergo phase change, for example if the system is used for sensibly cooling water, air or some other fluid. Earlier different types of condenser slides air cooled condenser, water cooled condenser is been used in a domestic refrigeration system. Air cooled condenser is most popular condenser for a refrigerator. Many researches done in a past ion the condenser, one of them is water cooled condenser.Heat transfer rate increased by using this condenser.

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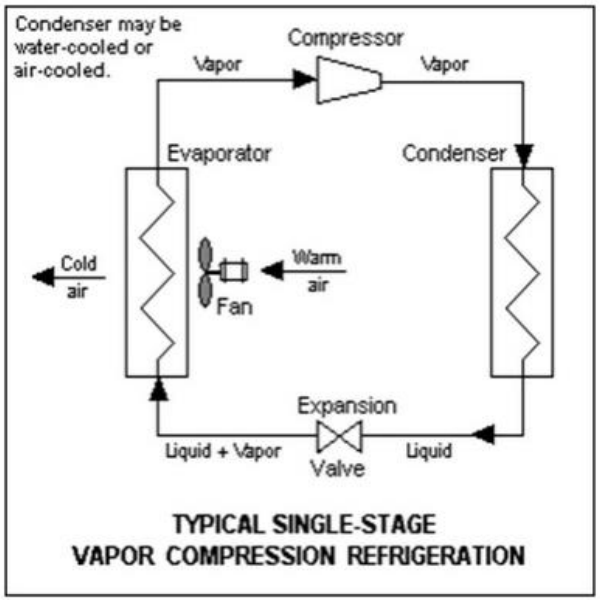

Fig-1: Vapour Compression Refrigeartion System

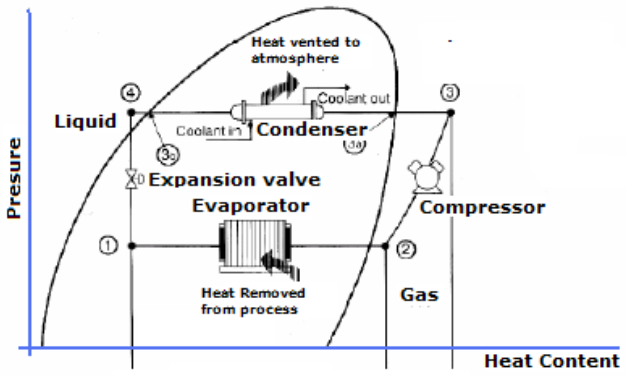

Fig-2: Vapour Compression Refrigeartion Cycle on p-h chart

2.EXPERIMENTAL SETUP AND TEST PROCEDURE

This section provides a description of the facilities developed for conducting experimental work on a domestic refrigerator. The technique of charging and evacuation of the system is also discussed here. Experimental data collection was carried out in the research laboratory of our institution. The experimental setup of the test unit and apparatus is shown in the Figures.

2.1 Experimental System

Different experimental and theoretical comparison will performed to evaluate the performance of domestic refrigerator by using water cooled condenser. In this, experimental study performance of water cooled condenser is compared with the air cooled condenser in a domestic refrigeration system. To perform the experiment 165L refrigerator is selected which is designed to work with R-134a. It is consists of an evaporator, air cooled condenser,Receiver,expansion device and reciprocating compressor. The refrigerator was instrumented with two pressure gauges at inlet and outlet of the compressor. The temperature at six different points is taken by seven temperature sensors are mounted to measure the compressor inlet temperature, compressor delivery temperature, evaporator inlet temperature, evaporator outlet temperature, the freezer temperature, cabinet temperature and atmospheric temperature. An ammeter is mounted at the inlet of the compressor to measure the power supply and voltmeter is also used for voltage of supply.

Fig-3: Domestic refrigerator

Fig-4: Refrigerator with water cooled condener

3. COMPARATIVE ANALYSIS OF AIR COOLED CONDENSER AND WATER COOLED CONDENSER AT 40 WATT CONDITION

3.1 Comparative analysis between Coefficient of Performance of air cooled and water cooled condenser.

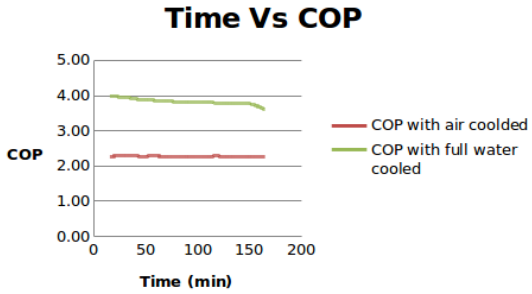

Chart-1: Coefficient of Performance of air cooled and water cooled condenser.

The above graph shows that the COP of air cooled condenser is between the range 2-2.5 & the COP of water cooled condenser is between the range 4-3.6. Thus the conclusion is made that the COP of the water cooled condenser is higher than air cooled because of lower pressure difference between evaporator & condenser at 40 watt condition.

3.2 Comparative analysis between Refrigeration effect of air cooled and water cooled condenser.

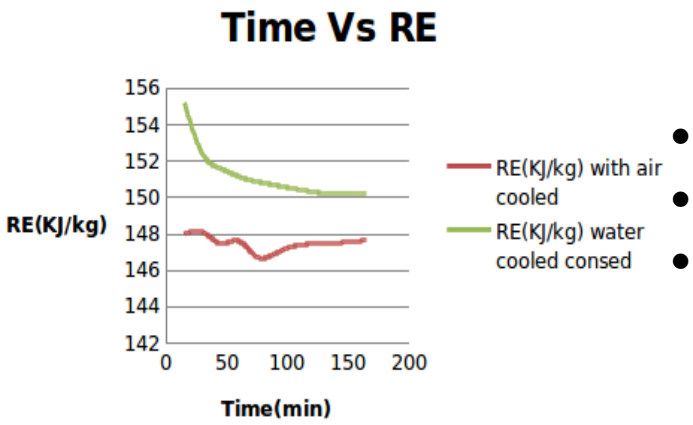

Chart-2: Refrigeration effect of air cooled and water cooled condenser.

This Fig shows the comparative analysis between refrigeration effect(KJ/kg). This shows that the refrigeration effect of air cooled condenser is within the range 148-147 and RE(KJ/kg) of water cooled condenser is within the range 150-156. Thus the conclusion is that the RE(KJ/kg) of of water cooled condenser is higher than air cooled condenser. This is because the condenser outlet temperature of water cooled condenser is more cooled than both at 40 watt condition..

3.3 Comparative analysis between Heat extraction rate of air cooled and water cooled condenser.

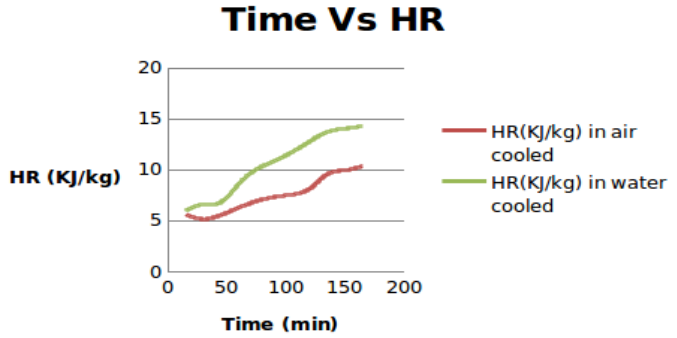

Chart-3: Heat extraction rate of air cooled and water cooled condenser.

The above fig for heat rejection rate of air cooled & water cooled condenser shows that HR(KJ/kg) in air cooled condenser is having range between 5-10(KJ/kg) & HR(KJ/kg) of water cooled condenser is between the range 6-14(KJ/kg), thus it concludes that the heat rejection rate is higher in case of water cooled condenser at 40 watt condition.

4. CONCLUSION

In the overall experimentation the domestic refrigerator with air cooled condenser has replaced with water cooled condenser. The testing and analysis with all the three conditions has performed. Thus the conclusions are listed as follows:

The domestic refrigerator worked normally and efficiently with water cooled condenser.

By using water cooled condenser COP of the system has increased between 55% to 86% at 40 watt condition.

The maximum temperature achieved from condenser is 60°C. Thus recovery of heat from condenser reduces the heat load to surrounding & it makes surrounding comfortable.

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