

## PERFORMANCE EVALUATION OF EER ON CONVENTIONAL DOMESTIC REFRIGERATOR WITH WATER COOLED CONDENSER & R600A REFRIGERANT

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**ABSTRACT—Energy consuming is most important role in energy management system. Domestic refrigerator system is transferred heat from low temperature to high temperature reservoir by using vapour compression system. Conventional refrigeration system consumes more electric power and low coefficient of performance. Hence to overcome the above problem we are going to use water cooled condenser instead of air cooled condenser and R134 is replace by R600a refrigerant, So power consumption is reduced and increased coefficient of performance. R600a refrigerant is low ODP, Low GWP.**

**Keywords: - water cooled condenser, R600, COP, ODP, GWP**

### I. INTRODUCTION

Household refrigerator is a common household appliance that consists of a thermally insulated compartment and which works to transfers heat from the inside compartment to its external environment so that inside in thermally insulated compartment is cooled to a temperature below the normally at room temperature. 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. Tetrafluoroethane (HFC134a) refrigerant is now widely used in most of the domestic refrigerators.[1] Refrigeration is the process of rejecting heat from the Enclosed space for providing cooling purpose in the enclosed space. In the industrialized nations and affluent regions in the developing world. The refrigeration mostly used to store food stuff at low temperature, thus the prevent from more damage action of any bacteria as well as yeast, fungus and mold. Many perishable products can be cooled or frozen, permitting them to store for months and even year also and main advantage is to without loss in nutrition or taste of

change in appearance. Air-conditioning, the use of refrigeration for comfort cooling, has also become widespread in more developed nations. If a liquid is rapidly vaporized, it expands quickly. The rising molecules of vapor abruptly increase their kinetic energy. Much of this increase is drawn from the immediate surroundings of the vapor, which are therefore cooled. Thus, if water is placed in shallow trays during the cool tropical nights, its rapid evaporation can cause ice to form in the trays, even if the air does not fall below freezing temperatures. By controlling the conditions of evaporation, it is possible to form even large blocks of ice in this manner.[2]

### II. PROBLEM STATEMENT

Nowadays, energy crises is big problem in India in addition conventional refrigeration system consumes more electrical power and low coefficient of performance, so we need some research to reduce energy consumption as well as increased coefficient of performance.[3]

### III. METHODOLOGY

In these project find out the EER of domestic refrigerator by using water cooling and air cooling and find out which method better, also used R600a refrigerant and compare the performance with the refrigerant R134. Due to these test find out better performance of the refrigerator to overcome the energy consumption and increases the EER.[1]

### IV. LITERATURE REVIEW

Er. Rahul Patel & Er. Ramji Tripathi, (June 2015), During performance analysis it is observed that when condenser is of air cooled then compressor work increase and work on about 220-250 psi but when we have use water cooled condenser then compressor work on about 110-120. The theoretical COP of the refrigerator is about 90% more in case of water cooled condenser. In case of air cooled

condenser it slightly decrease compare to water cooled condenser.[4]

M. Abuzar Qureshi & Shikha Bhatt, (December 2014), Coefficient of performance of R600a was higher range of 40.86%-46.54% than R134a at Constance refrigerant effect 45W and Constance evaporating temperature. Coefficient of performance of R600a was higher range of 83.33% than R134a at Constance refrigerant effect 30W and Constance evaporating temperature. The discharge temperature of compressor is decreased with 10% by using R600a compressor energy consumption refrigerator gradually decrease with 3% of compared to normal R134a domestic compressor refrigerator.[5]

## V. MAIN COMPONENT OF REFRIGERATION SYSTEM

- Hermetically sealed compressor:-** A hermetic or sealed compressor is one in which both compressor and motor are confined in a single outer welded steel shell. The motor and compressor are directly coupled on the same shaft, with the motor inside the refrigeration circuit. Thus the need for a shaft seal with the consequent refrigerant leakage problem was eliminated.[6]
- Wire and tube type condenser:-** In this type of condenser is used for small capacity refrigeration system. It is either plate surface type or finned type in these type condenser tube is attached to the plate and plate mounted back side of the refrigerator and plate is act as fin.[6]
- Capillary tube:-** Capillary tube is copper tube of small inner diameter and of variable length which depends upon type of application. It has simple in construction and no moving part. Inner diameter of capillary tube varies from 0.5mm to 2.25mm and length of tube varies from 0.5m to 5m.[6]
- Plate and tube type evaporator:-** It is usually made up of copper or aluminium and it is embed in the plate so it is look like flat surface. Externally it is look like single plate type but inside there are several metal tube and through which the refrigerant is to be flow.[6]

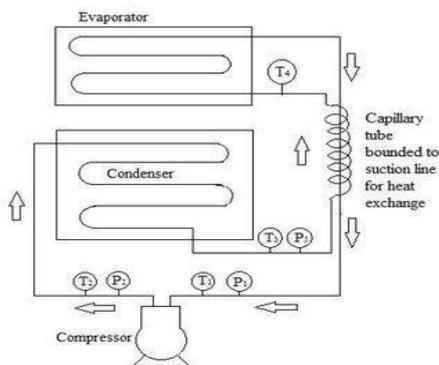


Fig. 1, Layout of Refrigeration system [6]

## VI. EXPERIMENTAL SETUP

The experiment is conducted sequentially as per given in manual. The RTD temperature sensor which can be located at various sections in refrigerator. This RTD can be measure the temperature at certain particular point such as vapour compression cycle. The temperature is measure at various point is time increases of object that stable reading on temperature indicator. Backside of the test rig panel is connected to pressure gauge at suction side and discharge side of compressor to measure to calculate the pressure at vacuum and discharge point. The data can be recorded as various time intervals that load can be provided in domestic refrigerator by using the heater.[3]

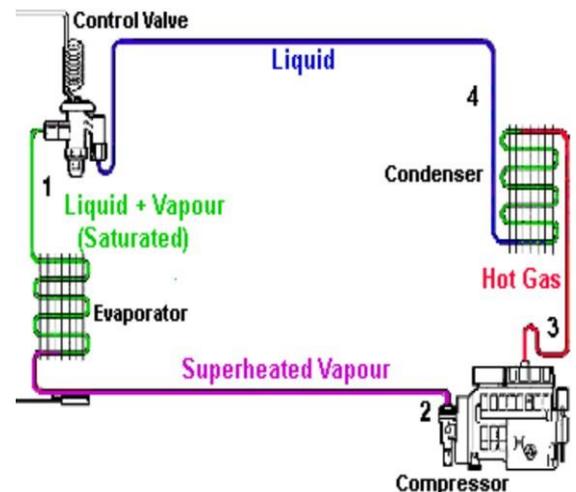


Fig. 2, Measuring location of the test refrigerator [7]

## VII. CAD MODELLING

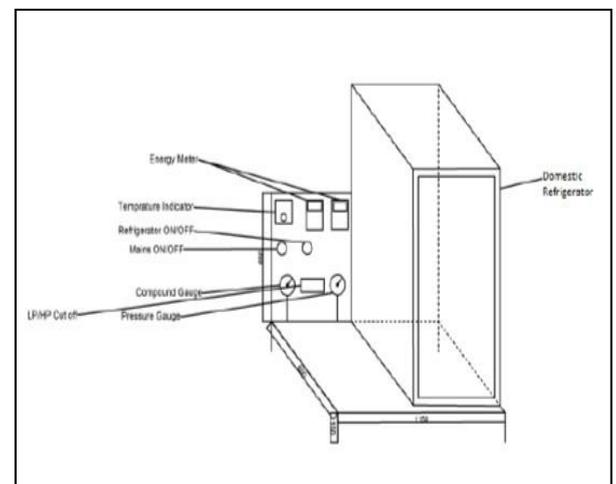


Fig.3, 3D cad model of test rig on domestic refrigerator

## VIII. REFRIGERANT SELECTION

In refrigeration and air conditioning systems selection of an appropriate working fluid is one of the most significant steps for a particular application. Low global warming potential has been inserted to the long list of desirable criteria of refrigerant's selection.

- Environmental impact and safety aspects
- Zero ODP and Low GWP Refrigerant[6]

**Table No.1, Properties Of R600 & R134a Refrigerant [5]**

refrigerant	R600a	R134a
Chemical formula	C4H10	CH3CH2F
Critical temp °C	135	101
Molecular W in kg/k mole	58.1	102
Normal Boil point	-11.6	-26.5
Pressure at -25 °C in bar (absolute)	0.58	1.07
Liquid density kg/lit	0.60	1.37
Vapour density kg/m <sup>3</sup>	1.3	4.4

#### Advantages of R600Refrigerant

1. Zero ozone depletion potential.
2. Good compatibility with components.
3. It is suitable for high and medium temperature application.[8]

#### a. Advantages of Water cooled condenser

1. Heat rejection is very fast.
2. Cop of the system is increases.[9]

#### b. The refrigerant which are to be used

1. R134a (TETRAFLUROETHANE): The long term replacement for R12 is R134a because of having favorable characteristics such as zero ODP, non – flammability. ODP of R134a is zero, but it has relatively high global warming potential.[9]
  
2. R600a (ISOBUTANE): R134a is replace by R600a is one of the best refrigerant it has zero ozone depletion and negligible global warming potential.[10]

### IX. CONCLUSION

From the literature review we found that water cooled condenser is consume low energy as well as high COP than the air cooled condenser and also by replacing the refrigerant from R134a to R600a, thus the refrigerator increases COP and constant refrigerating effect or low GWP.

### X. NOMENCLATURE

COP – Coefficient of Performance  
 ODP – Ozone Depletion Potential  
 GWP – Global Warming Potential  
 EER - Energy Efficiency Ratio

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