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Comparison of COP of R134a with Hydrocarbons by using VCR cycle.

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Abstract - This paper is concerned with the future use of hydro carbons and their blends used in the refrigeration and air conditioning system. The refrigeration and air conditioning industry is currently evaluating alternates refrigerant for different CFC refrigerants and HFC refrigerant used in domestic and industry RAC system. A Vapour compression refrigeration cycle is used for performance comparison of the basic natural hydro carbon blends used in internationally with R134a (HFC) as a base refrigerant. In this project two different refrigerants R-600a and a blend of R290 and R600a in proportion of (50:50) is used as alternatives of R134a refrigerant in VCR cycle and (analyze /investigate) the thermal properties and acceptable pressure and temperature ranges. The refrigerant used as the replacement of R134a mentioned above have very low global warming potential and zero ozone depletion potential these refrigerants are evaluated individually and performance parameters are compared such as : COP, cooling capacity energy efficiency ratio, SEER, power consumption.

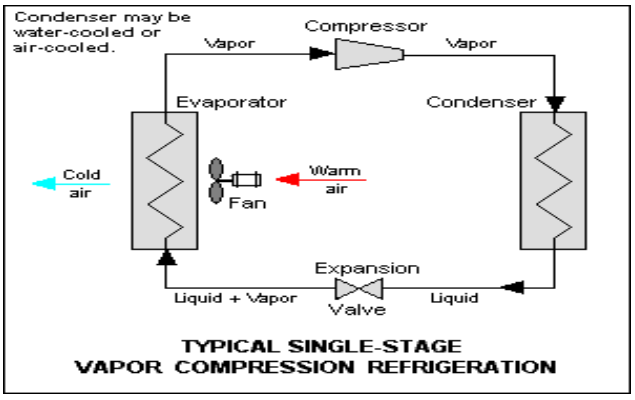
Key Words: COP, ODP, GWP, HC, HFC and VCR.

1. INTRODUCTION

Mechanical refrigerators and air conditioners came into practice from the year of 1920 and have achieved phenomenal progress in the field of refrigeration since then. At present RAC system are used in household industrials and for domestic purposes. Making use of natural ice from the mountains/glaciers for refrigeration was seen in past decades, but now in present 20th century different systems are available in the market for the production of artificial ice. Different parameters available in the system which can control wastage of food are used in concepts of cold chain storage temperature, humidity, air motion and chill room condition are parameter controlled. Montreal protocol: in the year of 1974, the refrigerants like R-11, R-12 where used in the industry at a very high rate, after analysis and investigation it came into notice that ODP of there refrigerants are high. Hence after discussion in 1987, a petition was passed by representatives of many countries in Montreal Canada: The phase out periods of these CFC'S was planned in accordance. These CFC'S than were replaced by HCFC'S which hard lesser impact than the CFC. Many country put ban on use of these refrigerants and which would lead to lesser effect on environment.

1.1 Vapour compression refrigeration system

It is most widely used system in the field of RAC for both domestic and industrial application. In this system the refrigerant passed in system is first compressed in the compressor which led to increase in pressure and temperature of the system, this high pressure and high temperature gas is than passed over the condenser where the phase change occurs of the refrigerant from gaseous to liquid state, pressure at this stage remains constant hence this liquid phase of refrigerant is pumped using and then pass over the capillary to the evaporating coils where evaporation process takes place and liquid form of refrigerant change into vapour form.



TYPICAL SINGLE-STAGE VAPOR COMPRESSION REFRIGERATION

1.2 Selection of refrigerant

According to the new trend of using geotropic mixture blend in the refrigeration system. in this experimental analysis to natural refrigerant R600a and blend R290 and R600a is used as an alternate refrigerant of R134a in VCR test rig. The natural refrigerants are allotted to hydrocarbon series, there refrigerants are highly inflammable and explosive, but also has advantage that has zero ozone depletion potential and almost zero global warming potential. It is expected that these refrigerants will not only have low ODP and GWP but will also enhance the performance of the system.

1.3 Classification of refrigerants

The refrigerants are classified into two groups:-

Primary refrigerant: The refrigerants which are used as working medium in a refrigeration system are known as primary refrigerants.

Secondary refrigerant: The refrigerants which are used for absorbing heat from the refrigerated space, and are than transformed to primary refrigerant in the condenser are known as secondary refrigerants.

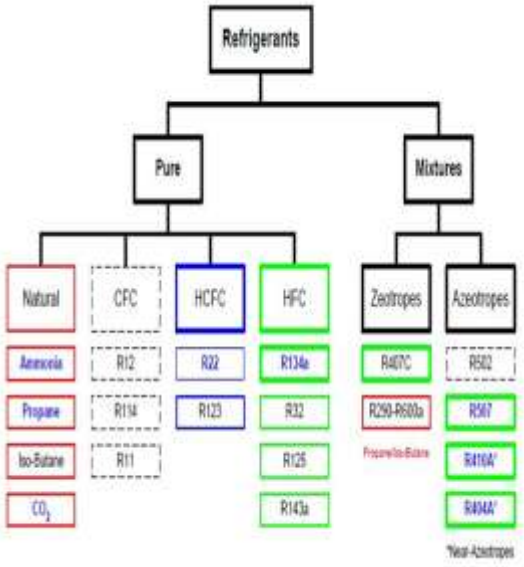


Fig -1: classification of refrigerants.

2. TEST PROCEDURE

During the performance on the trainer circuit the steady state condition was achieved by running the circuit ideally after which check for stability was performed by checking the fluctuations in the pressure gauges the performance is carried out at different loads of (12) kg of water in evaporator setup where the water inside the container was maintained at 40 degree Celsius to detect performance of vapour compression cycle test rig circuit. The procedure is repeated for different refrigerants R600a, R290+600a, for R134a.

2.1 System specification

Description of test apparatus: The trainer circuit consist of a base stand made up of M-S square tubes. The setup consist of a compressor with the capacity 1/3 ton, for compression of refrigerant. Condenser is the trainer forced air cooled type of which fan and motor setup is provided and standard size of specification is 11"*10"*3 rows. Expansion devices used in the setup is capillary tube with dimension (bore * length) = 0.050"*5'.Pt100 temp, sensor with a range of -15 to 400degree Celsius is used. Load tank is made of stainless steel with inbuilt coil and heater. Drier and the rotameter are the components which are used for moisture control and measurement of flow rate in litres per hour.

2.2 Result and Analysis

A)Calculation procedure:-

COP Carnot cycle = $\frac{T1}{T2-T1}$

T1 = saturation temperature at suction pressure of compressor.

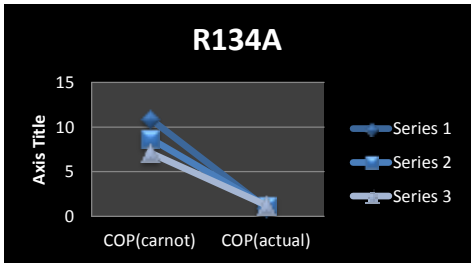
T2 = saturation temperature at discharge pressure of compressor.

COP actual = $\frac{\text{heat supplied by heater}}{\text{energy consumedby compressor}}$

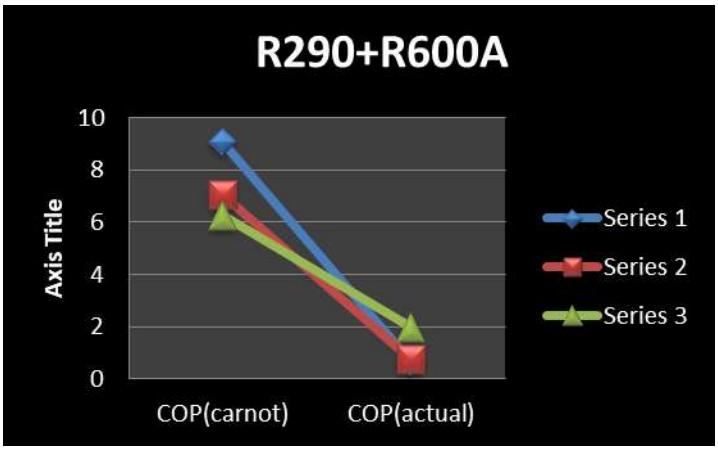
B) Result and discussion:-

The performances were carried out for the analysis of different thermal parameters for the domestic vapour compression refrigeration cycle and its components. By using various refrigerants and blends COP (Carnot) and COP(actual) of the blends are analyzed.

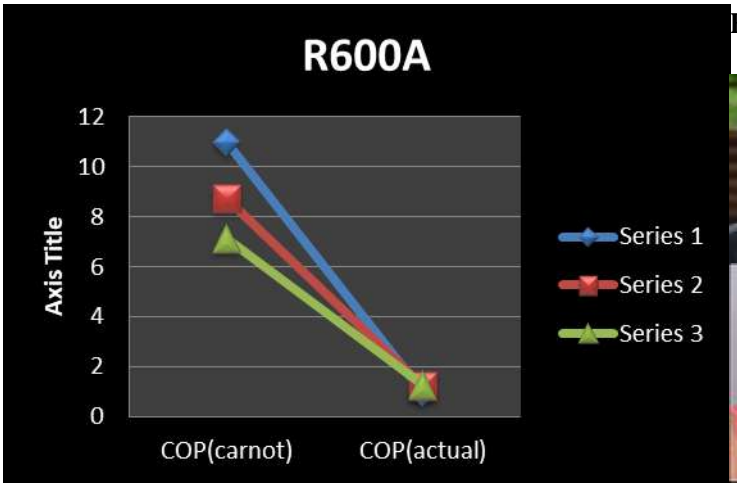
COP comparison of R134a



COP comparison of R290+ R600a



COP comparison of R600a



3. CONCLUSIONS

An experimental study has been carried out to analyze the thermal performance characteristics of the different components in the system b using different refrigerants.

- The determination of the thermal properties is compared at full load of 12litre, and it was analyzed that at all loads temperature of evaporator remains low for R600a and R290+R600a.
- Experimental analysis also revealed that the mass of gas required during charging of R600a and R290+R600a is less compared to R134a, which leads to reduction in charge.
- Due to low ODP and GWP values these hydrocarbons and its blends are eco-friendly and may get replaced in near future.

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