EXPERIMENTAL ANALYSIS ON VCR SYSTEM USING ALTERNATIVE REFRIGERANTS (R600A) BY ADDING NANO PARTICLES (Cuo) WITH DIFFUSER AND NOZZLE

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***Abstract**: Now a days refrigeration systems have shown many applications in both industrial and domestic Sectors. The majority of domestic refrigerators works on vapour compression refrigeration system. Vapour compression refrigeration system uses expansion valve to reduce the pressure of liquid refrigerant and delivers to the evaporator. The process of throttling is isenthalpic, which means that the kinetic energy produced during the pressure reduction is dissipated and eventually wasted. Nozzle is placed at the inlet of evaporator to increase the flow of refrigerant. Diffuser is placed at the outlet of compressor which provides additional compression to the refrigerant and reduces mechanical work for the compressor. The leakages of widely used hydrofluorocarbon refrigerants from refrigerator shows severe impact on the environment like global warming, ozone depletion, etc. In order to overcome this problem a mixture of nano particles with R600A is used in this experiment. By adding Nano particles it can increase cooling capacity of the system and reduces compressor work.*

Keywords - passive devices (diffuser & nozzle), R600a refrigerant. Cuo nano particles

I. INTRODUCTION

Most of the domestic sector refrigerators work on vapour compression refrigeration system. The leakages of refrigerants from refrigerator show a severe impact on the environment like global warming, ozone depletion, etc. In order to overcome these problems, the HC Mixture of R600a is used. This refrigerant has zero ODP and negligible GWP (0-3). HC Mixture is an Eco-Friendly Refrigerant which is available at Low Cost can be used as an alternative to HFCs like R-134a. For a refrigeration system, the coefficient of performance can be enhanced either by the reduction of compressor input work or by increasing the refrigeration effect. Compressor input work can be reduced with the installation of the diffuser at the inlet of the condenser section. The diffuser converts the kinetic energy of a vapour refrigerant leaving compressor into pressure energy, which leads to a reduction of work input to the compressor. Apart from this, the diffuser also reduces the vibrations that are occurred at the heat rejection section (condenser) due to refrigerant's high velocity at the compressor outlet. Also, a nozzle is installed at the heat absorption section (evaporator) inlet to convert pressure energy into kinetic energy, with the installation of nozzle further expansion takes place leads to enhancement of refrigeration effect

II. EXPERIMENTAL SETUP & METHODOLOGY

In the present study the refrigerant selected is R600a. Isobutane (R600a) is more widely adopted in domestic refrigerator because of its better environmental and energy performances. A new refrigerator test system was built up according to the requirement of this study. R600a is used as refrigerant in 175L capacity refrigerator. Also a diffuser is attached at condenser inlet to convert kinetic energy available at condenser inlet to pressure energy which gives additional compression and nozzle is attached at inlet of evaporator to converts pressure energy into kinetic energy which provides increasing of flow. Copper oxide (Cuo) Nano particles is added to the lubricant to reduce compressor work and to increase cooling capacity of system

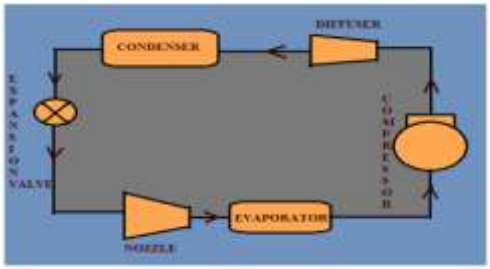


Fig 1: Proposed Refrigeration system

Fig 2a: Nozzle

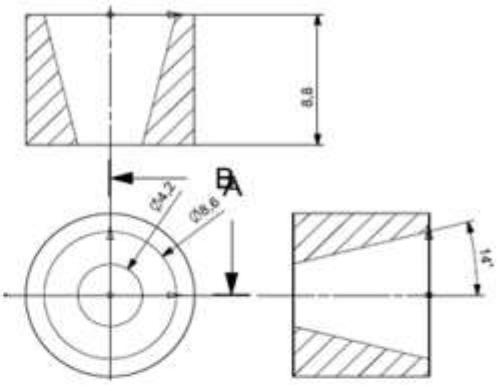


Fig 2b: Proposed Nozzle

Fig 3a: Diffuser

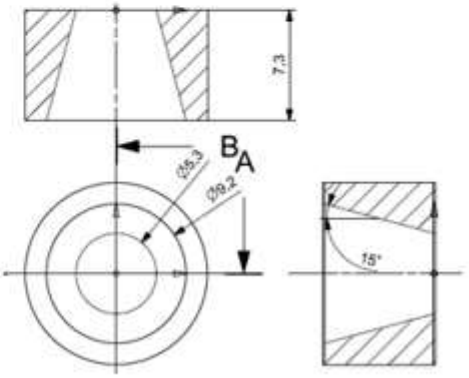


Fig 3b: Proposed Diffuser

All dimensions are in mm

III. REFRIGERANT AND EXPERIMENTAL PROCEDURE

HC (Hydrocarbon) mixture can be used as an alternative refrigerant to HFC refrigerants as there is no fluorine element. A hydrocarbon (HC) includes naturally occurring substances like isobutane and propane. In many ways, Hydrocarbons has better properties like better efficiency, transport, energy Efficiency, heat transfer properties, and environmentally sound but the major concern is HC's are flammable in nature. About 35% of refrigerators in northern Europe are based on hydrocarbons.

First R134a compressor is fixed and then nitrogen gas is filled in the compressor and then leak detection test (soap bubble test) conducted and conformed that there are no leakages in the system. Then vacuum is created and then R134a refrigerant charged into the compressor. Temperature and pressure readings are noted by using thermocouples and pressure gauges respectively at required places for normal cycle. Then R600a compressor is fixed and then nitrogen gas is filled in the compressor and then leak detection test (soap bubble test) conducted and conformed that there are no leakages in the system.5.Then vacuum is created and then R600a refrigerant charged into the compressor.

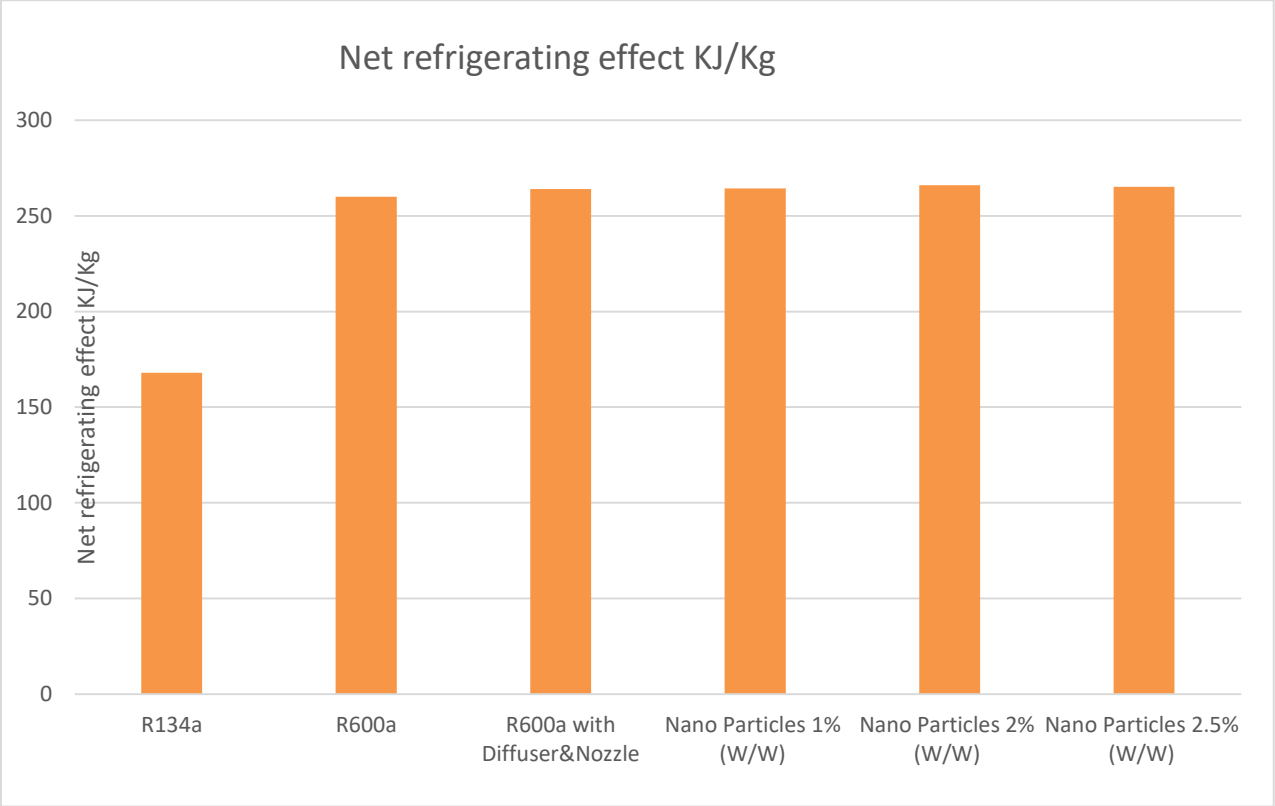
Temperature and pressure readings are noted by using thermocouples and pressure gauges respectively at required places for normal cycle. Then diffuser valves and nozzle valves are opened and Temperature and pressure readings are noted by using thermocouples and pressure gauges. Then nano lubricant is prepared with the concentration of 1%w/w, 2%w/w, 2.5%w/w and Temperature and pressure readings are noted by using thermocouples and pressure gauges. .

IV. PERFORMANCE PARAMETER CALCULATION:

Net Refrigeration Effect (NRE) =h1-h4 kj/kg
Work of compression (Wc) = h2-h1 kj/kg
Diffuser work (Wd) = hd-h2 kj/kg
Reduction in Compressor Work (W) = Wc-Wd kj/kg
Coefficient of Performance (COP) = NRE / W
The values of enthalpies h1,h2 ,hd,h3,h4 are taking from p-h chart

V. RESULTS AND DISCUSSION:

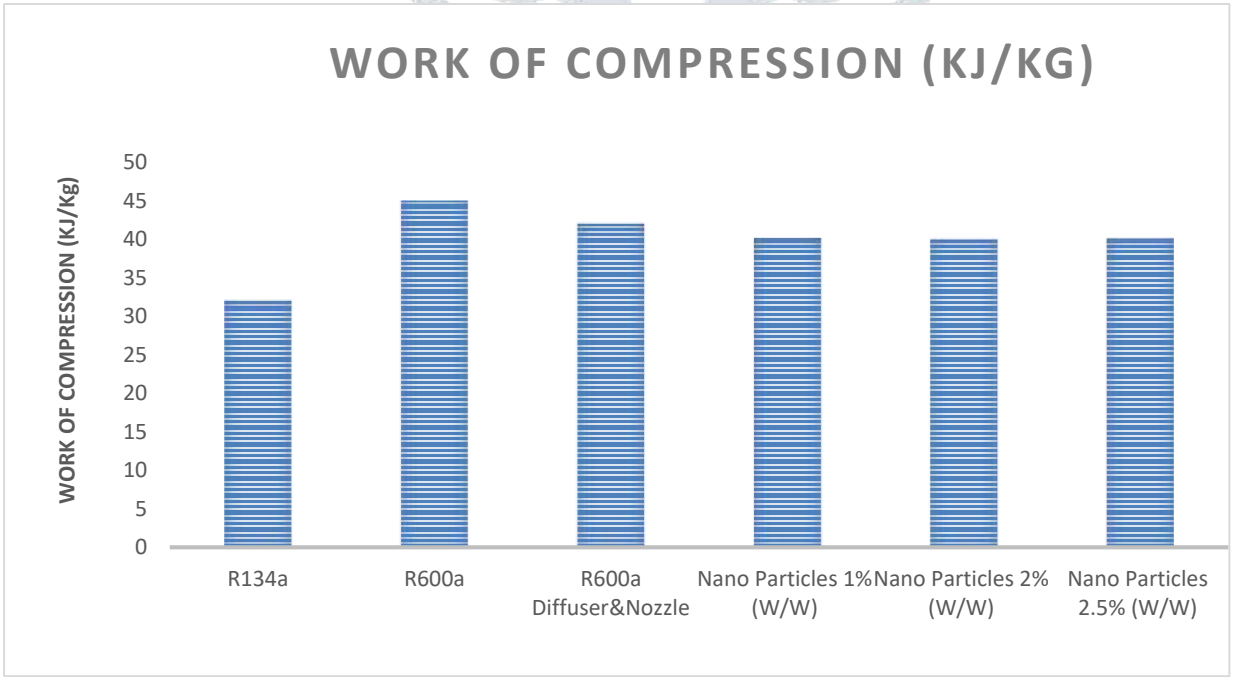
Comparison of Refrigeration Effect



Graph.5.1. Comparison of Net Refrigeration Effect

The above graph shows that the refrigeration effect for R-600a using diffuser and nozzle with 2%(W/W) of nano particles is more when compared with normal cycle use of diffuser and nozzle, The refrigeration effect is more because of the nozzle at the inlet of evaporator it increases the flow of refrigerant into the evaporator this causes the increasing of the cooling capacity and reduces cooling time of evaporator and cabin of the refrigerator and by nano particles increases the cooling capacity of refrigerator. Therefore refrigeration effect for R600a using diffuser and nozzle with 2% (W/W) concentration of nano particles is more when compared with all the remaining cases.

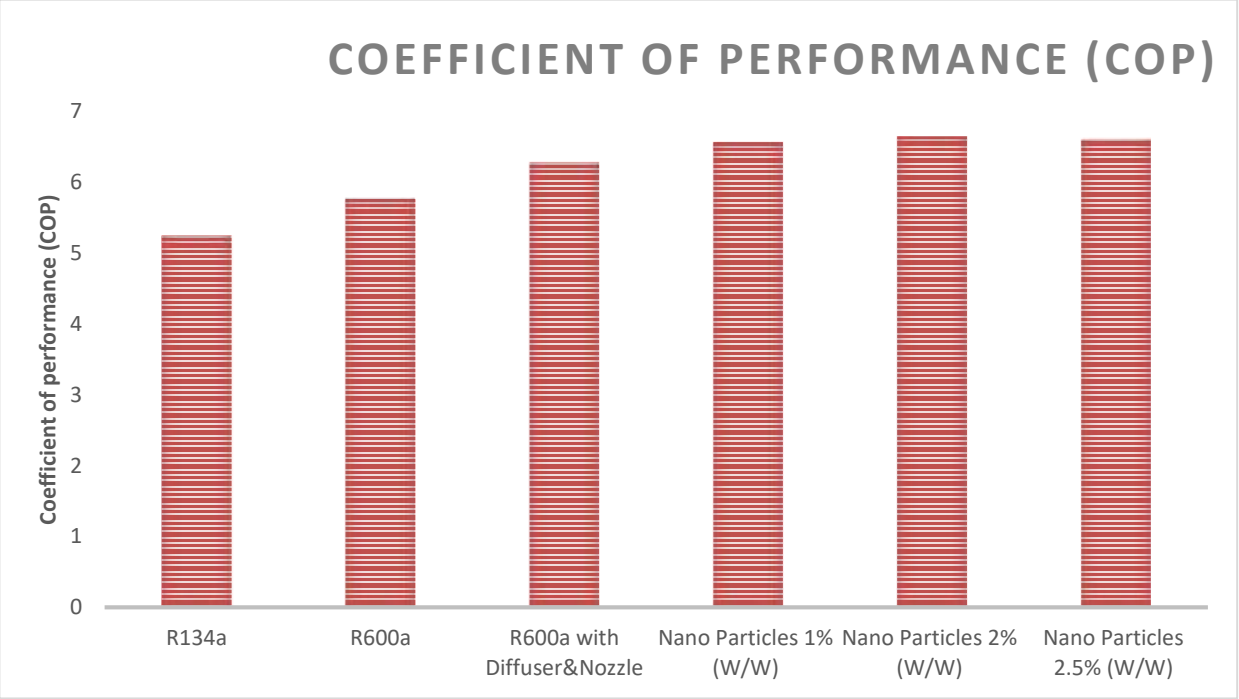
Comparison of Compressor Work



Graph.5.2. Comparison of Work of Compression

The above graph shows that compressor work required for ton of refrigeration is less in the case of R600a with diffuser and nozzle with 2%(W/W) concentration of nano particles when compared with R600a normal cycle. The diffuser reduces the compressor work for the same refrigeration effect by converting all the kinetic energy available at compressor outlet to pressure energy and nozzle increases the refrigeration effect by increasing the flow in evaporator and nano particles. Therefore the compressor work required for ton of refrigeration is less for the diffuser with nozzle with 2% (W/W) concentration of nano partices when compared with R600a refrigerant in all the remaining cases.

Comparison of COP



Graph.5.3. Comparison of COP

The above figure shows that the coefficient of performance for R-600a using both diffuser and nozzle with 2%(W/W) of nano particles is higher performance of than the all the cycles. In all these cases R600a with diffuser and nozzle with 2% concentration of nano particles is optimum value. The percentage increase of COP with nozzle and diffuser to the R600a normal cycle is 8.83%. The percentage increase of COP for diffuser and nozzle with 2%(W/W) concentration of nano particles when compared to the R600a normal cycle is 13.23%.

CONCLUSIONS

An experimental analysis is performed on Vapour Compression Refrigeration System with R600a used as refrigerant and the system is run for all cases. Those are normal cycle, diffuser and nozzle and mixture of nanolubricant with concentration of 1%(W/W),2%(W/W),2.5%(W/W) In all these cases the performance parameters like Refrigeration effect, Compressor work, COP are investigated and evaluated. Based on the results the following conclusions are drawn:

The compressor work saved due to nozzle and diffuser to the normal cycle is 6.66%. The compressor work saved due to diffuser and nozzle with 2%(W/W) concentration of nano particles cycle when compared with R600a normal cycle is 11.11%.

The refrigeration effect for R-600a using diffuser and nozzle with 2%(W/W) concentration of nano particles is more than that of all the remaining five cases. The refrigeration effect is 2.25% increased when compared with normal cycle.

The percentage increase of COP with nozzle and diffuser to the normal cycle is 8.83%. The percentage increase of COP for diffuser and nozzle with 2% (W/W) concentration of nano particles when compared to the normal cycle is 13.23%.

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