PERFORMANCE ANALYSIS OF VCR SYSTEM PLACING DIFFUSER AT THE CONDENSER INLET USING SIO_2 NANO PARTICLE MIXED WITH POE OIL

[1]GATTU RAJESH, [2]Prof.K.PRAHLADARAO
[1]M.Tech , Mechanical Engineering, JNTUA College of Engineering Ananthapuramu, A.P, India
[2]Professor, Mechanical Engineering, JNTUA College of Engineering Ananthapuramu, A.P, India

Abstract: ***Normal domestic refrigerators have very low heat transfer rates because of free convection on condenser. However these rates can be increased by using forced convection techniques. As an alternative, nano particles are used in this work. Because, nano fluids are considered a promising choice for several heat transfer applications. With the increasing awareness for energy saving and efficiency improvement in various thermal systems, including refrigeration systems, there is a growing interest in the refrigerant-based nano fluids owing to their superior thermo-physical properties. Nano refrigerants are a class of nano fluid, which consist of suspended nano particles in a base refrigerant. 0.5% W/w of SiO_2 nano particles are mixed with POE oil and used as lubricant in compressor of refrigerator which uses r-134a as a refrigerant.***
In this project work, a diffuser is also added at the inlet of condenser. The purpose of diffuser is to increase the pressure energy so that there is availability of much amount of time for heat transfer. Experiments are conducted to analyse the performance.

Key words- R134a, SiO_2 Nano particles, POE oil, Diffuser

I INTRODUCTION

Nano particles are particles having size between 1 and 100 nanometres (nm) with a surrounding interfacial layer. Nano fluids are relatively new class of fluids having nano particles suspended with a base fluid. In this project work SiO_2 nano particles are suspended in the base fluid of POE oil. Silicon dioxide, also known as silica, is an oxide of silicon with the chemical formula SiO_2. Mostly it is found in nature as quartz. These nano particles are generally metal oxides which increase heat transfer coefficients allowing for more heat transfer out of the coolant. Since refrigeration involves heat transfer exchange with the environment, scientists are using these nano particles in refrigeration. Nano particles have very high surface area to volume ratio which provides a driving force for the diffusion to occur, particularly at elevated temperatures. The nano particles are in the form of solid, so they have more heat transfer rate than the normal refrigerants. The normal refrigeration cycle has problems like high compressor work requirement, vibrations in condenser (due to the high velocity of refrigerant after compression). Hence the diffuser is added at the inlet of condenser to avoid the vibration problem. The purpose of diffuser is to increase the pressure energy so that there is availability of much amount of time for heat transfer and for smoother flow of the refrigerant in the condenser.

II LITERATURE REVIEW

Pawel et al.[1] Conducted studies on nanofluid and found that the performance of the system was increased. In this work there is the significant increase in the thermal conductivity of nano fluid compared to the base fluid. They also found that addition of nanoparticles results in significant increase in the critical heat flux. S heng-shan Bi et al. [2] Conducted an experimental study on the performance of a domestic refrigerator using TiO_2-R600a nano refrigerant as working fluid. They showed that the TiO_2-R600a system worked normally and efficiently in the refrigerator and an energy saving of 9.6%. They showed that the freezing velocity of nano refrigerating system was more than that with pure R600a system.

Bi et al.[3] Conducted studies on a domestic refrigerator using nano refrigerants. In their studies R134a was used the refrigerant, and a mixture of mineral oil TiO_2 was used as the lubricant. They found that the refrigeration system with the nano refrigerant worked normally and efficiently and the energy consumption reduces by 21.2%. When compared with R134a/POE oil system.They have also found that there is remarkable reduction in the power consumption and significant improvement in freezing capacity. Jwo et al. [4] Conducted studies on a refrigeration system replacing R-134a refrigerant and polyester lubricant with a hydrocarbon refrigerant and mineral lubricant. The mineral lubricant included added Al_2O_3 nano particles to improve the lubrication and heat-transfer performance. The power consumption was reduced by about 2.4%, and the coefficient of performance was increased by 4.4% for R-134a and 0.1 wt. % Al2O3 nano particles.

R.Reji et al. [5] Performed heat transfer enhancement of domestic refrigerator using R600a/mineral oil/nano-Al2O3 as working fluid. It was founded that the freezing capacity was higher and the power consumption reduces by 11.5 % when POE oil was replaced by a mixture of mineral oil and Aluminium oxide nanoparticles. Thus using Aluminium oxide nanolubricant in refrigeration system was feasible and the coefficient of performance of the refrigeration system also increases by 19.6 % when the conventional POE oil is replaced with nanorefrigerant.

In this work R134a refrigerant and SiO_2 nanoparticles are selected. R134a is also known as norflurane, which is a haloalkane refrigerant with thermodynamic properties similar to R-12 (dichlorodifluoromethane) but with insignificant ozone depletion potential and a somewhat lower global warming potential. 0.5% W/w and 10nm-20nm size of SiO_2 Nano particles are mixed with POE oil and this nano fluid is used as lubricant in the domestic refrigerator having a capacity of 165L. A diffuser is also added at the inlet of condenser. The purpose of diffuser is to increase the pressure energy so that there is availability of much amount of time for heat transfer. The freeze capacity test was conducted to compare the performance of the refrigerator with and without nano refrigerant so as to provide the basic data for the application of the nanoparticles in the refrigeration system.

III EXPERIMENTAL SETUP

The main components of the system are compressor, condenser, capillary tube expansion valve. The diffuser is placed after compressor as shown in figure 2. The diffuser is made with copper and it is having dimensions as shown in figure 5. The main objective of diffuser is to convert kinetic energy into pressure energy. In the proposed layout of the tested refrigeration system, the diffuser is placed in between compressor and condenser in order to reduce compressor work which enhances the vapour compression system efficiency.

Fig 1: Experimental refrigerator

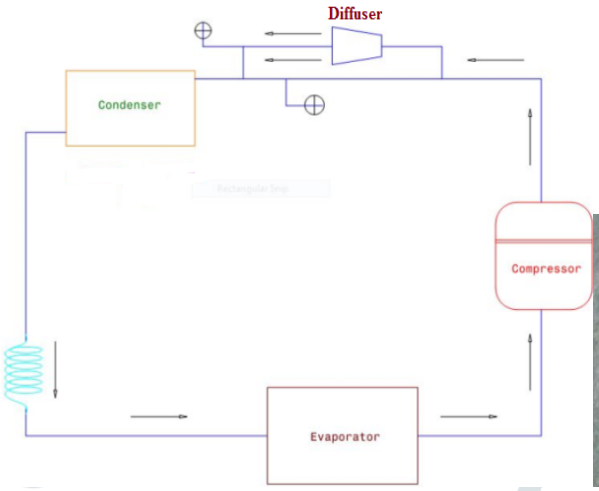

Fig 2: Line Diagram for experimental refrigerator

Fig 3: Diffuser

Fig 4: Diffuser connection

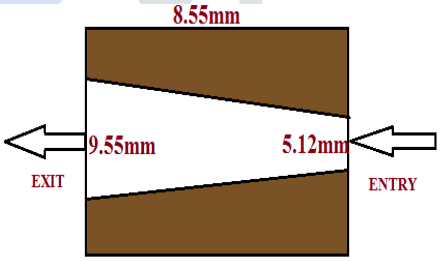

Fig 5: Line Diagram of Diffuser

A) Nano fluid preparation:

SiO_2 nano fluid is prepared by adding weighted amount of SiO_2 particles to the lubricant in the compressor of the domestic refrigerator. The concentration of the SiO_2 in the POE oil is 0.5% W/w. To get the uniform mixing of the particles in the POE oil, the mixture is placed on the ultrasonic vibrator. The commonly used lubricating oil in the system is POE oil. This oil is selected owing to its superior quality. Ultrasonic vibration is used to stabilize the dispersion of the nano particles.

Fig 6 SiO_2 Powder Before Mixing With Oil

Fig 7 Ultrasonic Vibrator

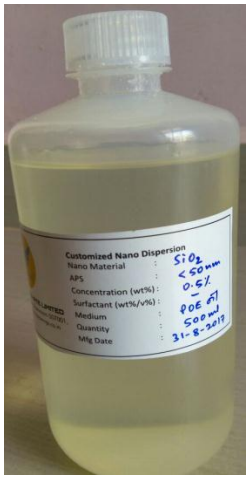

Fig 8 After Mixing

IV RESULTS AND DISCUSSION

A) Time Vs. Evaporator Temperature:

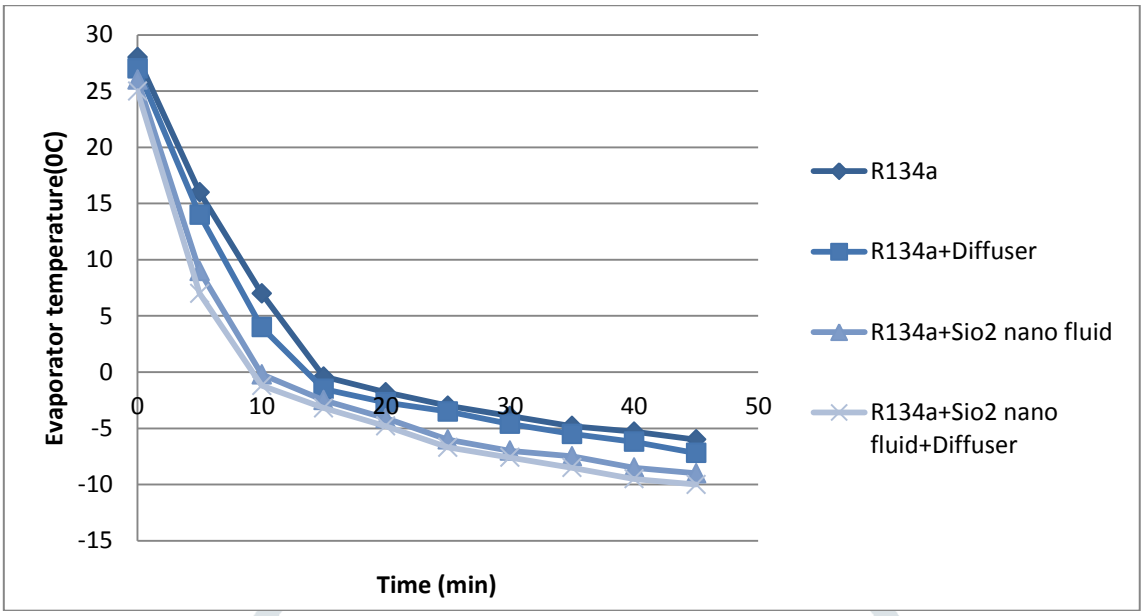

Fig 9: Time Vs. Evaporator Temperature

Above graph shows the variation of evaporator temperature with respect to time.As the temperature of evaporator decreases the time required is increases in all the cases of experiment. .The time required for getting -7^{o}C is less in SiO_2+POE oil when compared with normal R134a cycle.From the graph we can say that the system with R134a+SiO_2 nano fluid+Diffuser configuration is best for getting the very low temperature in very less time

B) Comparison of Compressor Work Required per Ton of Refrigeration:

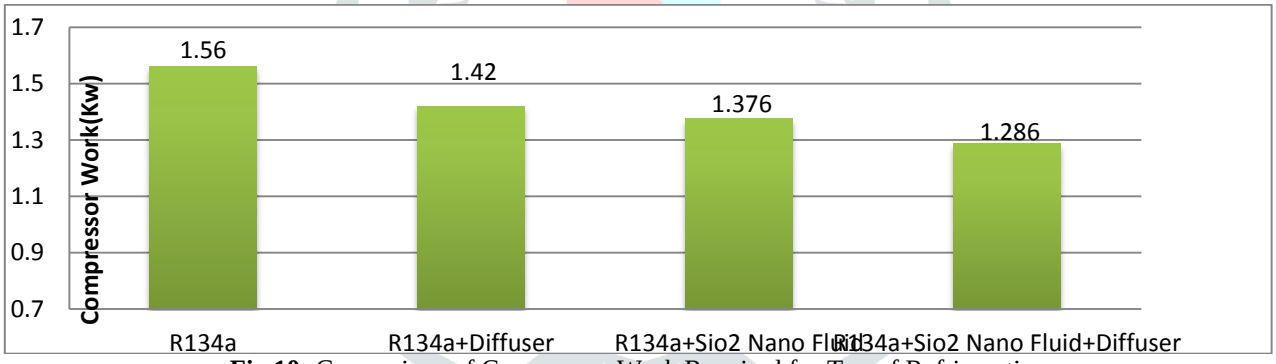

Fig 10: Comparison of Compressor Work Required for Ton of Refrigeration

The figure 10shows that compressor work required per ton of refrigeration is less in the case of R134a with SiO_2+POE oil along with diffuser at condenser inlet when compared with R134a normal cycle. When diffuser is placed after the compressor it converts the kinetic energy into pressure energy and increases the heat transfer from the condenser. Hence the work of compression is reduced by 8.97 % when compared to the normal R134 cycle. When SiO_2 nano fluid is operated its work compression is reduced by11.79% when compared to the normal cycle. It is because of the thermodynamic properties of the nano particles. When system is operated with R134a+SiO_2 Nano Fluid+Diffuser configuration, it's work of compression is reduced by 17.56% when compared to the normal cycle.

C) Comparison of Refrigeration Effect throughout the Experiment:

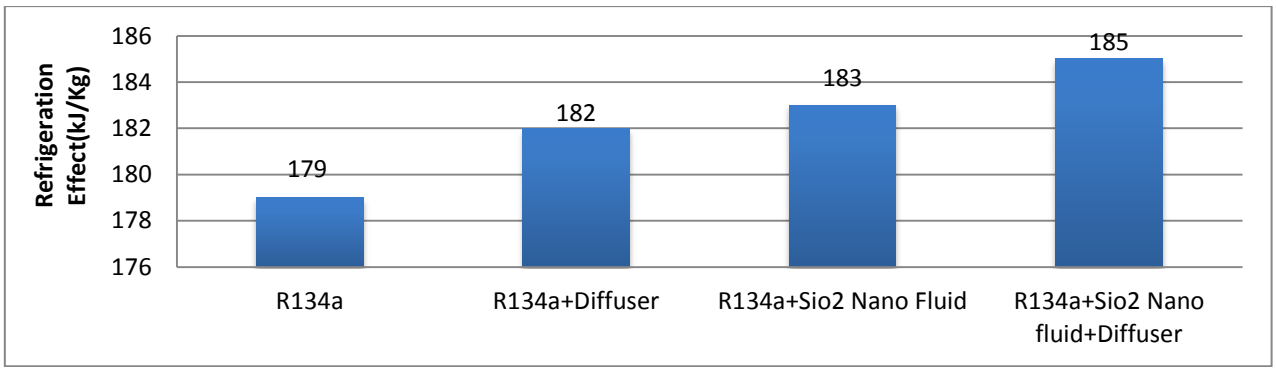

Fig 11: Comparison of Refrigeration Effect throughout the Experiment

The figure 11 shows Comparison of Refrigeration Effect. It shows that the refrigerating effect is very high for the system with SiO2 nanofluid and diffuser configuration when compared to the normal cycle. Due to action of the nanofluid and diffuser, the system goes to sub cooling region at the condenser outlet.

D) Comparison of COP throughout the Experiment:

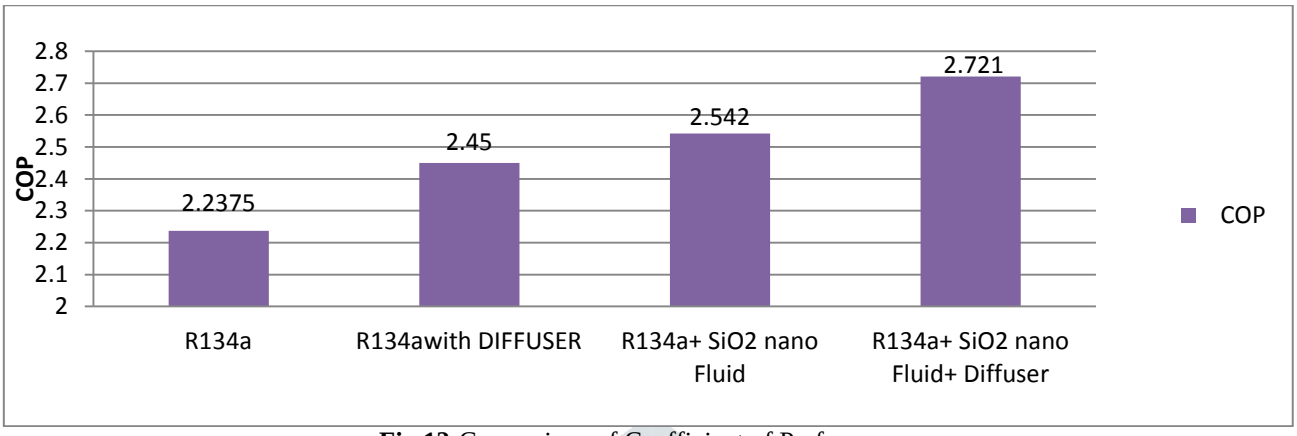

Fig 12: Comparison of Coefficient of Performance

The figure 12 shows the cop for the various configurations of the refrigeration system. . Due to the reduction in compressor work and increase in refrigeration effect, the coefficient of performance is more with R134a+ SiO2 nano Fluid+ Diffuser configuration. The percentage increase of COP with diffuser at condenser inlet to the normal cycle is 9.49%. The percentage increase of COP for SiO2 nanofluid along with diffuser at condenser inlet when compared to the normal cycle is 21.6%.

V CONCLUSIONS

Performance analysis is conducted on Vapour Compression Refrigeration System with R134a as a refrigerant. Tthe system is analysed for four cases. Those are normal cycle, diffuser at condenser inlet cycle, SiO2 nano particles+POE oil cycle and SiO2 nano particles+POE oil along with diffuser at condenser inlet.The system is analysed for performance parameters like Refrigeration effect, Compressor work and COP and they are investigated.

In the case of R134a with SiO2 nano particles+POE oil along with diffuser at condenser inlet cycle, the refrigeration effect is increased by 3.35%, it's work of compression is reduced by 17.56% and the overall coefficient of performance is increased by 21.6% when compared with normal cycle. Hence it can be concluded that the cycle with SiO2 nano particles+POE oil along with diffuser at condenser inlet has better performance and take less time for the same freezing capacity when compared with normal cycle.

REFERENCES

[1] Pawel K. P., Jeffrey A.E. and David G.C., 2005. Nanofluids for thermal transport. Materials Today, pp. 36-44.

[2] S heng-shan Bi et al. Application of nanoparticles in domestic refrigerators. Applied Thermal Engineering 28 (2007) 1834– 1843.

[3] Bi S., Shi L. and Zhang L., 2007. Performance study of a domestic refrigerator using R134a/mineral oil/nano-TiO2 as working fluid. ICR07-B2-346.

[4] Jwo 2009. Effect of nano lubricant on the performance of Hydrocarbon refrigerant system. J. Vac. Sci. Techno. B, Vol.27, No. 3, pp. 1473-1477.

[5] R.RejiK. Sridhar,M.Narasimha"Heat transfer enhancement in domestic refrigerator using R600a/mineral oil/nano-Al_2O_3 as working fluid", International Journal of Computational Engineering Research 2013, Vol.3, Issue:04, Pp. 43-50.

[6] www.wikipedia.org