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Expermental Investigation Of Sio_2 And Ceo_2 Hybrid Nanolubricants In R600a Vapour Compression Referigeration System

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Abstract: *To conserve less energy in vapour compression refrigeration system is the main problem and many researches has been performed to overcome the issue.To enhance coefficient of performance of the system and to reduce compression work dispersion of nanoparticles in the lubrication plays the vital role and lead to a better alternative and produce remarkable change .In this study sio_2 and ceo_2 nano lubrications used as a alternative for lubricating oil in vapour compression refrigeration system.These nanoparticles at concentrations of 0.5g/l and 0.5g/l and refrigerants.These silicon oxide and cerium oxide nanoparticles will result in improved coefficient of performance and refrigeration effect.Experiment is performed with 0.5g/l of sio2/0.5g/l of ceo2 hybrid lubricants in R600 a refrigeration system.*
Keywords: *vapour compression refrigeration system,coefficient of performance,nano particles,nano lubricants,*

1.INTRODUCTION

Refrigeration is defined as the process of cooling of bodies or fluids to temperatures lower than those available in the surrounding at a particular time and place it should be kept in mind that refrigeration is not same as “cooling” ,even both the terms imply a decrease in temperature.in general,cooling is a heat transfer process down a temperature gradient;it can be a natural,spontaneous process,as it requires expenditure of energy (or availability).thus cooling of a hot cup of coffee is a spontaneous cooling process (not refrigerant process),while converting a glass of water from room temperature to say,a block of ice ,is a refrigeration process (non - spontaneous).all refrigeration process involve cooling ,but all cooling process need not involve refrigeration .refrigeration is a much more difficult process than heating,this is in accordance with the second law of thermodynamics.

1.1. Methods Of Refrigeration

The Vapour Compression Refrigeration System (VCRS) is the most common type of refrigeration system used in refrigerators, air conditioners, and industrial cooling applications. It works on the principle of extracting heat from a low-temperature space and releasing it to a high-temperature space using a circulating refrigerant.

Basic Components of a VCRS

1. **Compressor**

Compresses low-pressure vapour refrigerant into high-pressure, high-temperature vapour. Increases the pressure and temperature of the refrigerant.

2. **Condenser**

Heat exchanger where high-pressure vapour releases heat to the surroundings.Vapour condenses into high-pressure liquid.

3. **Expansion Valve / Throttle Valve**

Reduces the pressure and temperature of the refrigerant. Liquid becomes a low-pressure, low- temperature mixture.

4. **Evaporator**

Heat exchanger where the refrigerant absorbs heat from the refrigerated space. Refrigerant evaporates into vapour.
Cycle Overview (Ideal Vapour Compression Cycle): Compression (1 - 2):
Low-pressure vapour is compressed to high pressure.
Condensation (2 - 3):
Vapour condenses at constant pressure and temperature.
Expansion (3 - 4):

Liquid is throttled to lower pressure and temperature.
Evaporation (4 -1):
Refrigerant absorbs heat and evaporates, cooling the desired space.

Working Fluid: Refrigerant

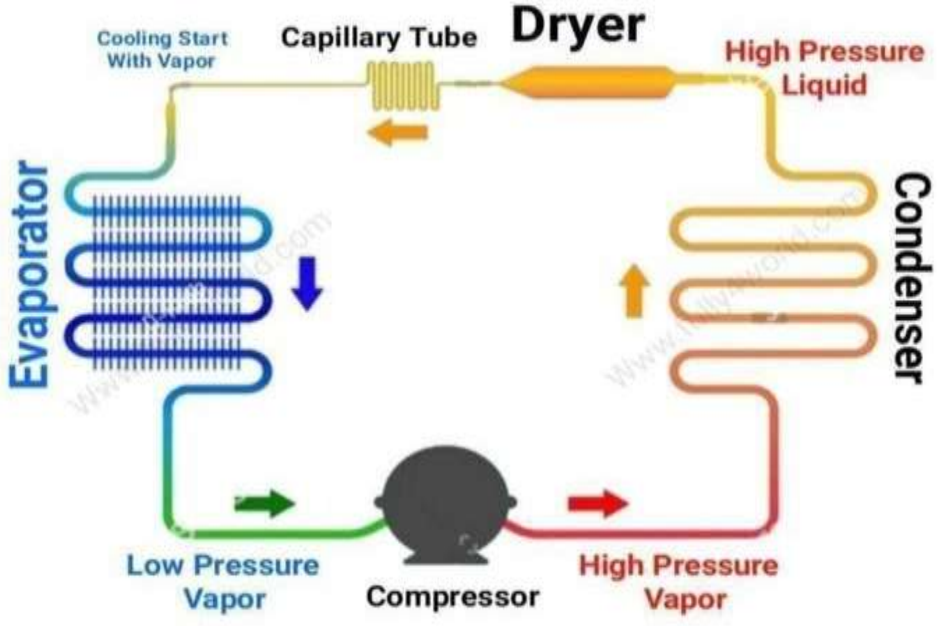


Figure 1.1

2.LITRATURE REVIEW

Bolaji and Huan (2013) compared R-600a with R-134a in domestic refrigerators. They found that R-600a provided better energy efficiency and lower compressor work, largely due to its favorable thermophysical properties such as lower viscosity and high latent heat.

Fatouh and El Kafafy (2006) conducted performance tests on R-600a and mixtures with other hydrocarbons. They concluded that R-600a offered similar or better performance than R-134a, with improved coefficient of performance (COP) and reduced power consumption.

Tashtoush et al. (2007) reported that R-600a exhibits lower discharge temperatures compared to conventional refrigerants, enhancing compressor life.
Cerium oxide (CeO_2) nanoparticles are gaining attention as additives in lubricants due to their unique properties such as high oxygen storage capacity, redox activity, and excellent thermal stability. When dispersed in base oils, CeO_2 nanoparticles improve the tribological behavior of lubricants, making them suitable for various industrial and automotive applications.

Ali et al. (2016) observed that CeO_2 nanoparticles in engine oil significantly reduced the coefficient of friction and wear scar diameter under boundary lubrication conditions.
Rao et al. (2017) demonstrated that CeO_2 nanoparticle additives in synthetic lubricants lowered friction by up to 40% and reduced wear volume due to the formation of a protective tribofilm.

Wu et al. (2018) emphasized the importance of surface modification (e.g., oleic acid treatment) of CeO_2 nanoparticles to improve their dispersion stability in mineral and synthetic oils.
Agglomeration can hinder the effectiveness of nanolubricants, so surfactants or functional coatings are often used.
Jatti and Singh (2015) found that CeO_2-enhanced lubricants improved the oxidative stability of engine oils, delaying oil degradation at high temperatures.

3. EXPERIMENTAL PROCEDURE

3.1 Pressure gauges:

a) Suction pressure gauges:this is joined in the suction line i.e.,before the compressor by means of gas welding.It is used for measuring the pressure of vapour refrigerant before entering the compressor .Its range is from 0 bars to 220bars.

b) Discharge pressure gauge :this is joined in the discharge line i.e,after the compressor by means of gas welding . It is used for measuring the pressure of the vapour refrigerant after leaving the compressor .Its range is from 0 to 500 bars.

3.2 charging of nanaoparticles into domestic refrigerator

1. Flushing of compressor is carried out then nanoparticles are evenly mixed into the refrigerator.
2. Nanoparticles of 0.5 g of silicon oxide is taken,these nanoparticles are mixed with the lubricating oil .
3. Mixed oil is shaken well and see that the mixture is evenly mixed.
4. Evenly mixed oil is taken in the bottel and is placed with the pipe
5. When the system is on suction of lubricating oil is carried out ,the mixture of silicon oxide and lubricating oil is injected into the system (domestic refrigerator).
6. Nanoparticles of 0.5 g of cerium oxide is taken ,these nanoparticles are mixed with the lubricating oil.
7. Mixed oil is shaken well and see that the mixture is evenly mixed.
8. Put on the system suction of the cerium oxide is carried out ,the mixture of cerium oxide and lubricating oil is injected into the system (domestic refrigerator)
9. 9.Compressor is made to run, values are noted down ,reading are noted regularly.

3.3 Charging of refrigerant R600a into domestic refrigerator

The following procedure is adopted for the experimental setup of domestic refrigerator.Domestic refrigrator selected is originally manufactured to work with r600a .

1. After installing pressure gauge and temperature indicators to the domestic refrigerator ,flushing of the system is done by pressurized nitrogen gas.
2. Charging of the refrigerant r 600a in refrigrator is done by the following procedure;

The schematic line diagram for charging is shown in the figure.it is necessary to remove the air from the refrigeration unit before charging .first the valve V2 is closed and pressure gauge p2,vaccum gauge v are fitted as shown in the figure .the value V5is also closed and values V 1 andV3 are opened ,the motor is started.thus the air from the condensor,recevier and evaporator sucked through the value V1 and it is discharged into the atmosphere through the value V6 after into the compressor.the vaccume gauge V indicates sufficiently low vacuum when most of the air is removed from the system.the vaccume reading should be 74 and 75cm of Hg.if the vaccume is retained for the above an hour it may be concluded that the system is free from air.after removing the air the compressor is stopped and the valves V1 and V6 are closed and valves V5,V2 and V7 of the refrigerant cylinder are opened and then the compressor is started. Whenever sufficient quantity of refrigerant is taken in to system which will be noted on the spring balance as shown in the figure,the compressor is stopped. The valves V7 and V5 are closed and valves V1 is opened the refrigerant cylinder is disconnected from the system .the pressure guages fitted are used to note the pressure during charging the system.

After charging the system ,leakages tests are carried out with the help of soap solution . a thick soap solution is used near the joints and if bubbles are formed it indicates leakages.Refrigerator is switched on and it is run for 2 hours and after attaining steady state condition ,readings are noted from pressure gauge and temperature indicators.The performance of the existing is investigated ,with the help of temperature and pressure gauge readingsThe refrigerant r600a is discharged out it is flushed with pressurized nitrogen gas.

Figure 3.1

4.RESULT AND DISSCUSION

An experimental investigation has been carried out with the systematically recorded data by operating vapour compression refrigeration system(vcrs) first with r600a refrigerant and later with nanolubricants of ceo_2 and sio_2.temperature readings at five different location and pressure at two points(before and after the compressor) The cooling capacity of the refrigerant with lubricating oil is shown below in graphs .The cooling capacity of the pure refrigerant with lubricating oil is shown,the cooling capacity of refrigerant with sio_2 has been found to its highest . A graph is drawn with cooling capacity on one side and nano lubricants on other side.

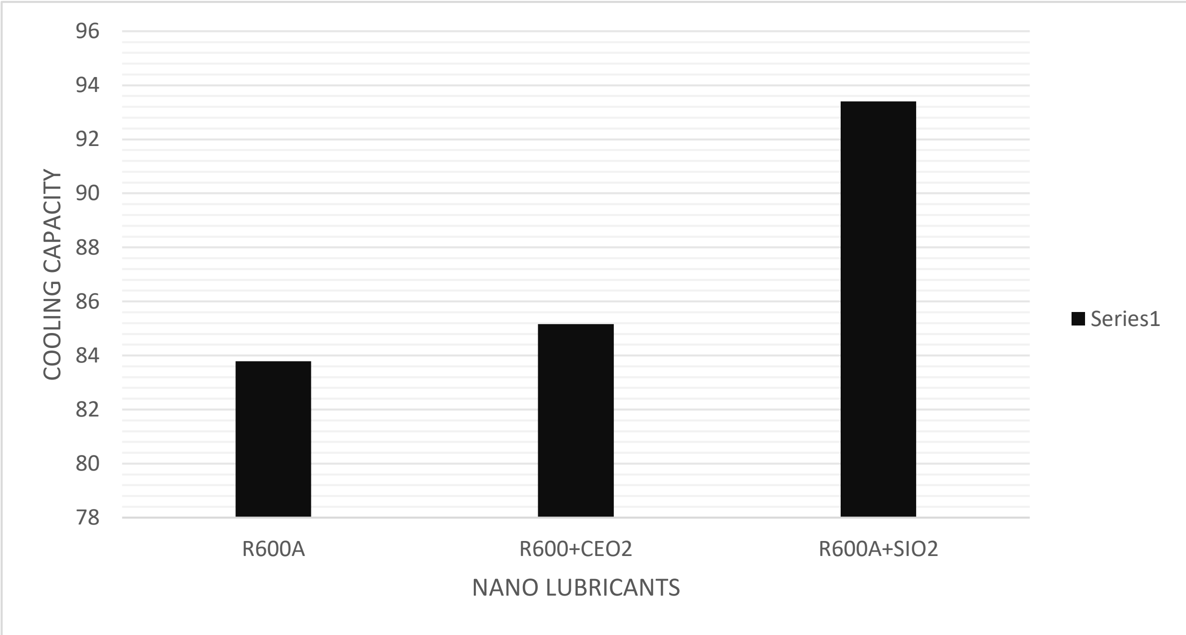
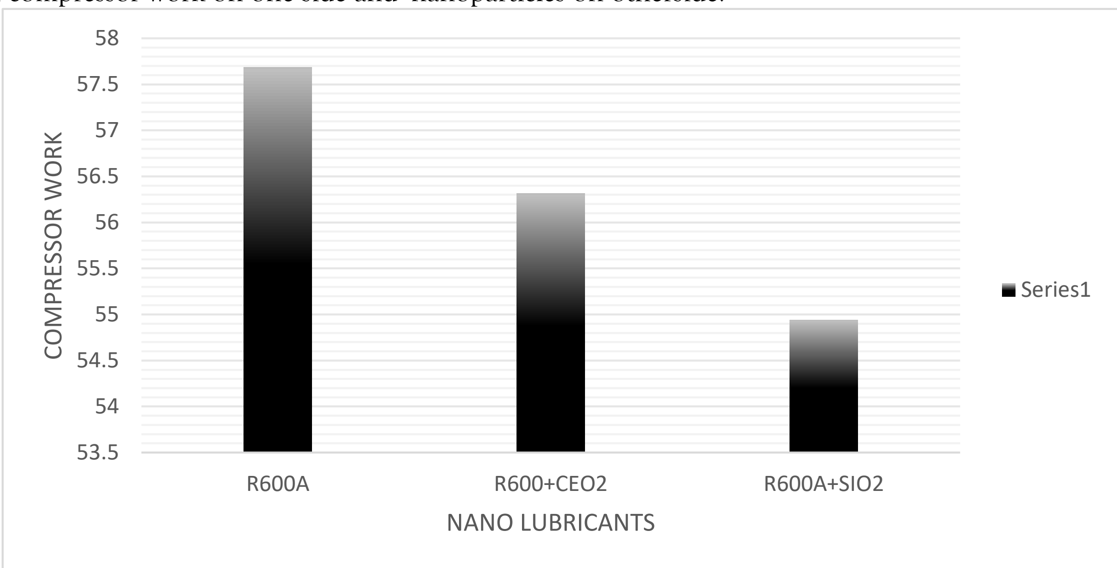


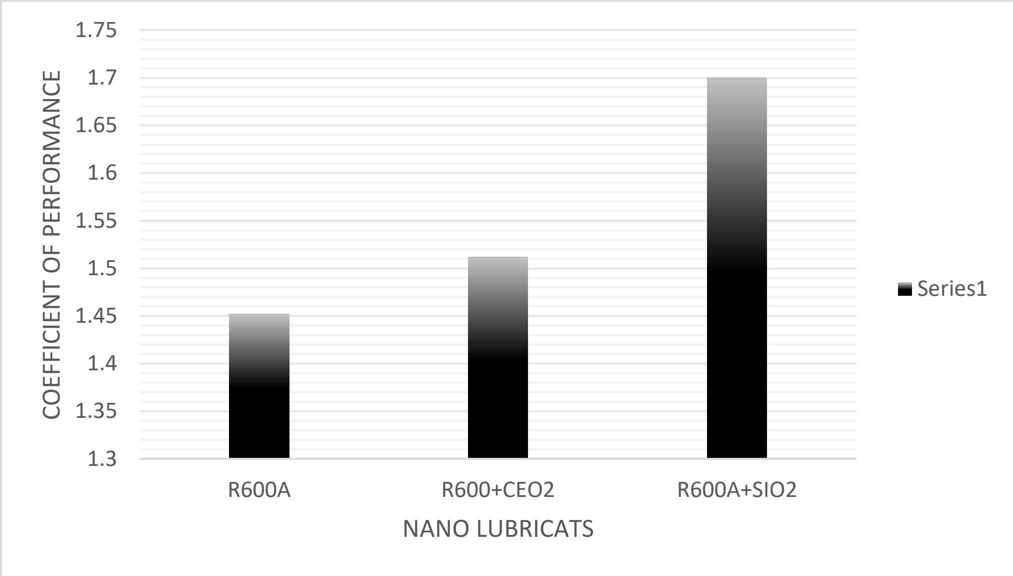
Fig 4.1

Variation of compressor work with r600a refrigerant with different load conditions are shown in graph.the compressor work has been highest for the R600A . the compressor work has been lowest for SIO_2. a graph is drawn on compressor work on one side and nanoparticles on otherside.



GRAPH 4.2

A graph has been plotted coefficient of performance on one side and nanoparticles concentration on other side.The coefficient of performance of nanolubricants with r600a refrigerant is highest of the sio_2.



Graph 4.3

CONCLUSIONS

The following conclusions are obtained from the present experimental procedure carried out. The coefficient of performance of (cop) of vapour compression refrigeration system (vcrs) is being highest for silicon oxide(sio_2). Compressor work of vapour compression refrigeration system (vcrs) has been lowest for siliconoxide(sio_2) and highest for R600a plain lubricants. Cooling capacity has been highest for the silicon oxide (Sio_2).

The cooling capacity of R600a with ceo_2 is 0.53 % higher than R600a, the cooling capacity of R600a with sio_2 is 3.14 % increase than the R600a with ceo_2. For the compressor work of R600a with ceo_2 is 0.97 % decreased than the R600a. And the compressor work of R600a with sio_2 is 0.97 % decreased than the R600a+ceo2. The coefficient of performance of R600a with ceo_2 is 3.819 % increased then R600a, and the coefficient of performance of R600a with sio_2 is 15.14 % increased than R600a with ceo_2. Finally coefficient of performance of R600a with sio_2 is 18.96 % increased than R600a.

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