PERFORMANCE STUDY OF VCR SYSTEM USING ZrO_2 NANO LUBRICANT WITH DIFFERENT BASE LUBRICANTS

[1]D.Dasthagiri, [2]Dr.K.Kalyani Radha
[1]PG Research scholar, Refrigeration and Air Conditioning, JNTU College of Engineering, Ananatapuramu, India.
[2]Assistant professor, Mechanical Engineering, JNTU College of Engineering, Ananatapuramu.

Abstract: The nano technology utilized in lubrication by nano particles could be a quickly developing scientific space and one that has been watched paying attention for the past twenty years. Once the nano particles area unit additional to oil then it's known as as nano fluid or nano lubricating substance. the current analysis paper basis on the utilization of nano additive lubricating oils in vapour compression cooling system because of their thermo physical properties like thermal physical phenomenon, viscosity, and constant friction that area unit to boost the COP and dependability of cold system. Since the thermal physical phenomenon of zirconium dioxide is over the thermal physical phenomenon of ancient lubricating oils, once the ZrO2 nano particles area unit mixed with ancient lubricating oils that area unit polyester oil and oil the thermal physical phenomenon of nano lubricating substance is improved. Although hydro flouro carbon (HFC) refrigerant R134a doesn't eat the layer however area unit still active greenhouse gases. Now-a-days most of the makers' area unit step by step turning over their refrigerators ranges to include R600a, no hurt full to the atmosphere than R134a. During this paper, researches have done on the appliance of nano lubricating substance created of ZrO2 nano particles mixed with the oil at one.0% weight concentration in R600a tape machine system. And conjointly to match the performance of tape machine system with the required one.0% weight concentration of ZrO2 with oil and polyester oil.

Key words: Nano lubricant, COP, ZrO_2 nano particles, Mineral oil, Polyester oil.

1. INTRODUCTION

Nano fluids is employed in big selection of engineering significance thanks to their improved thermo physical properties. Materials usually select as nano particles area unit with chemicals stable metals (e.g. Gold, copper, zinc, silver, platinum), oxides of metals (e.g. Alumina, zirconia, silica, titania), ceramic oxides (e.g. Al2O3, CuO), carbides of metals (e.g. SiC),nitrides of metals (e.g. AlN, SiN), carbon primarily based normal forms (e.g. Diamond, graphite, carbon nano tubes, carbon). COP of the VCR system may be improved by increasing the thermal physical phenomenon of the operating fluid. Ordinarily used heat transfer fluids love water, glycol, polyester oil and oil have comparatively low thermal physical phenomenon of the solid metal oxides. High thermal physical phenomenon of solid metal oxides is wont to increase the thermal physical phenomenon of a fluid by adding little solid particles thereto fluid. Nano fluids having properly dispersed nano particle possess the following advantages.

- High specific surface area and therefore more heat transfer surface among particles and fluids.
- High dispersion stability with superior Brownian motion of particles.
- Reduced pumping power as differentiated to pure liquid to achieve equality heat transfer intensification.
- Reduced particle clogging as compared to conventional slurries, thus promoting system is better.
- Variable properties, including thermal conductivity and surface wettability, by varying particle concentrations to suit different applications.

Generally, the vapor compression cooling system consists of a condenser, associate growth valve, associate evaporator, and a mechanical device. The vapor compression cooling system consists of 4 processes as such below. (1-2) compressing refrigerant in hermitically sealed compressor isentropically,

(2-3) condensation at constant pressure in the condenser,

(3-4) isenthalpic expansion of refrigerant in the expansion valve,

(4-1) evaporation at constant pressure in evaporator.

Here,

h_1 is the enthalpy at compressor inlet in kJ/kg,

h_2 is the enthalpy at compressor outlet in kJ/kg,

h_3 is the enthalpy at the condenser exit in kJ/kg,

h_4 is the enthalpy at the inlet of evaporator in kJ/kg

And, $h_3=h_4$, since the process (3-4) is an isenthalpic

Net refrigeration effect (NRE) = $h_1 - h_4$ (or) $h1 - h_3$ in kJ/kg

Mass flow rate of working fluid (m_f) =210/NRE in kJ/min

Compressor work (W_c) = $h_2 – h_1$ in kJ/kg

Heat equivalent for compressor work per TR (Q_e) = m_f (h2 – h_1) in kJ/min

Power of compressor (P_c) = Q_e/60 in kW

Coefficient of performance (COP) = (h1 –h_4) / (h2 –h_1) or NRE / W_C

Heat rejected by the condenser (Q_r) = $h_2 – h_3$ in kJ/kg

II. Research Method

Firstly choose the VCR system of a hundred seventy five L capability. Separate the mechanical device from VCR system once cutting suction and discharge lines. And take away grease already gift in it. Fill the writer oil into the mechanical device with acceptable amount. Fix the pressure gauges at entry of mechanical device, exit of mechanical device and exit of condenser. Reinstate the mechanical device in its place and fasten it tightly. Join the suction and discharge as within the past with facilitate of gas attachment. N gas is charged into the VCR system up to a hundred and fifty psi for the flush out of dirt particles and foreign traces. Soap-bubble take a look at is performed to notice the run gift at the welded portion of copper tubes. Air present within the system is removed by the vacuuming sealed system method. When vacuuming, charge the mechanical device with R600a by exploitation manifolds, hoses, access fittings and fast couplers. Fix the thermocouples at the entry and exit of the elements like at the mechanical device water, mechanical device outlet, and exit of condenser and within the evaporator.

2.1. Preparation of ZrO_2 nano lubricant

ZrO_2 nano particles which are presently using in the experiment are made by sol-gel method.

Fig2.1.1. ZrO2 nano particles

Fig.2.1.2.Ultrasonication

ZrO2 nano stuff is ready by ballroom dance technique. Within the start, needed amount of ZrO2 nano particles area unit supplemental in ancient oil to fulfill the required 1 Chronicles wt. concentration. Once the direct admixture it's unbroken within the vibratory machine. At the frequency of twenty rate vibratory machine, disperse the nano particle uniformly within the oil. This helpful method of nano fluid is thought as ultra-sonication. Ultra-sonication method is shown in Fig2.1.2. The refrigeration system experiment was carried out with

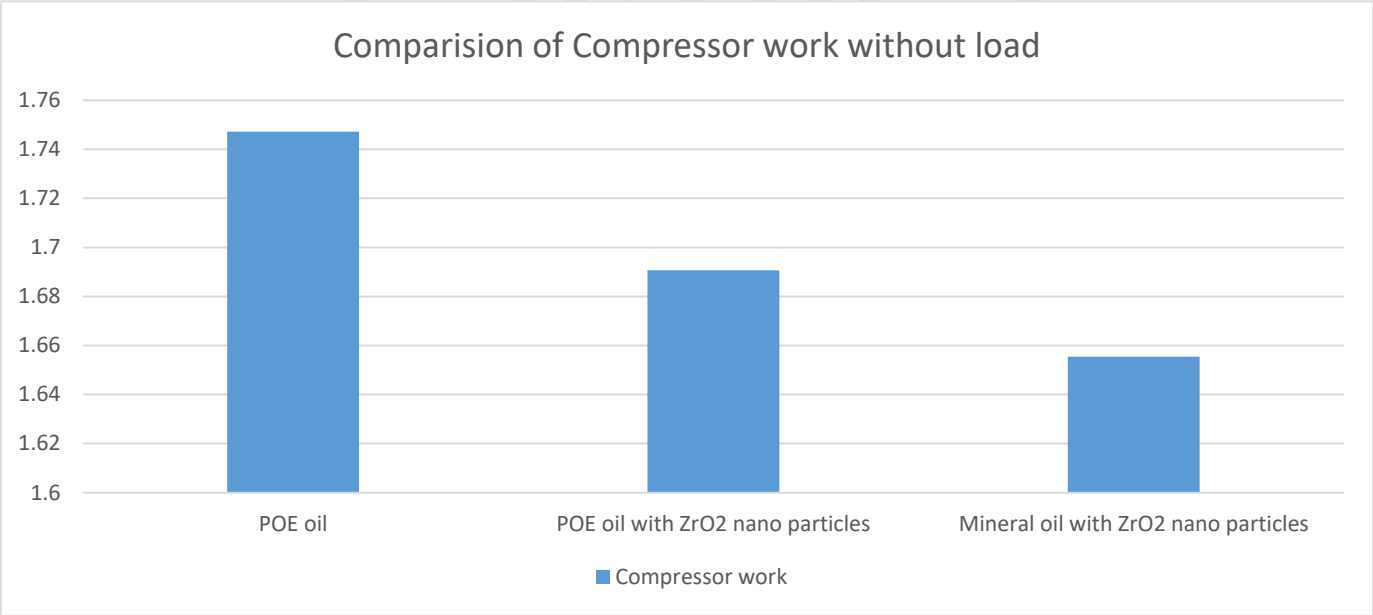
1. Normal VCR system with R600a as refrigerant and POE oil as lubricating.
2. VCR System with R600a as refrigerant and ZrO_2 nano lubricant where base fluid is POE oil.
3. VCR system with R600a as refrigerant and ZrO_2 nano lubricant where base fluid is mineral oil.

Experiments are tired all cases and also the values of pressures and temperatures are tabulated and calculations are done.

III. RESULTS AND DISCUSSION

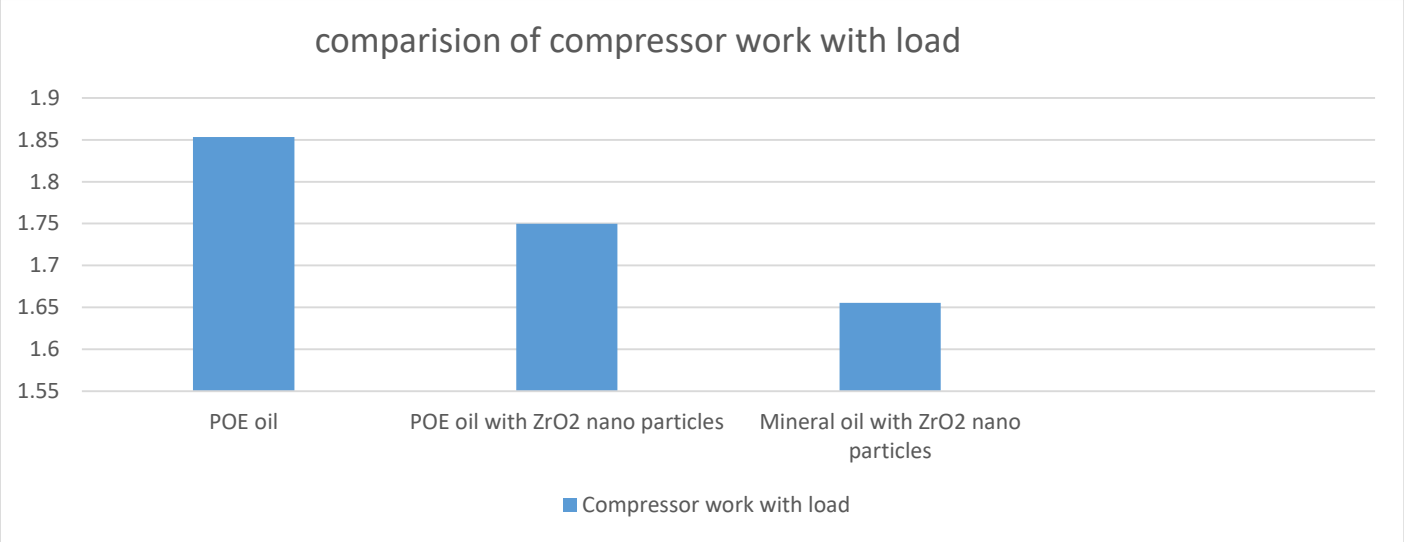
Experiments are done on the 175 L capacity VCR system. Since ZrO2 nano particles have more thermal conductivity than traditional lubricants like POE oil, mineral oil and ethylene glycol, when they mix with lubricants, the nano fluid exhibits improved thermo physical properties. Here 1% wt. concentration of ZrO2 nano lubricant is using as it has low coefficient friction.

4.1. Comparison of compressor work at without load condition



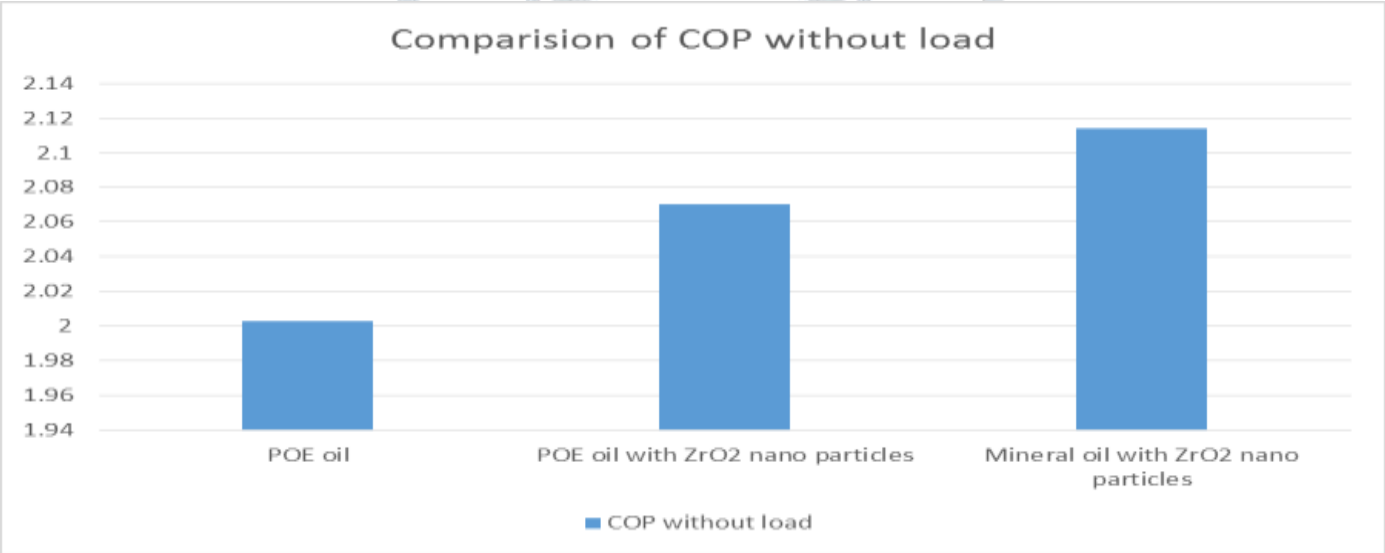
From the experiments, compressor work for VCR system having POE oil as lubricant is 1.74716 kW, compressor work for VCR system having 1.0% wt concentration ZrO2 nano lubricant with POE oil as base fluid is 1.6907, and compressor work for VCR system having 1.0% wt concentration ZrO2 nano lubricant with mineral oil as base fluid is 1.6554. The decrease in compressor work is due to increase in viscosity of nano lubricant due to the addition of nano particles.

4.2. Comparison of compressor work at with load condition



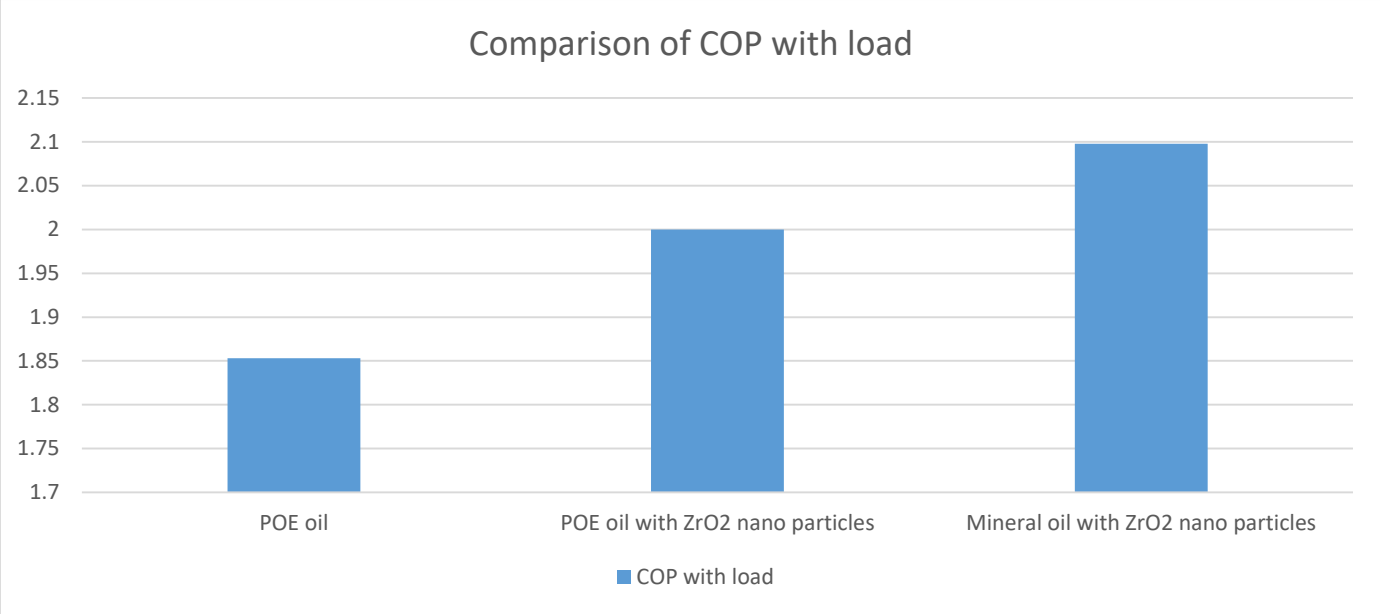
From the experimental work, compressor work for VCR system having POE oil as lubricant is 1.85324 kW, compressor work for VCR system having 1.0% wt concentration ZrO2 nano lubricant with POE oil as base fluid is 1.7498, and compressor work for VCR system having 1.0% wt concentration ZrO2 nano lubricant with mineral oil as base fluid is 1.6692. The decrease in compressor work is due to increase in viscosity of nano lubricant due to the addition of nano particles.

4.3. Comparison of COP at without load condition



COP of VCR system with traditional POE oil is 2.0030, COP of VCR system when 1.0 % wt concentration ZrO_2 nanoparticles are mixed with POE oil is 2.07 and COP of VCR system when 1.0% wt concentration ZrO_2 nano particles are mixed with mineral oil is 2.1142. Percentage increase in COP of VCR system with ZrO2 nano lubricant with POE oil as base fluid is 3.345%. Percentage increase in COP of VCR system with ZrO_2 nano lubricant with mineral oil as base fluid is 5.55%. As the decrease in compressor work, that implies increase in COP takes place.

4.4. Comparison of COP at with load condition



The COP of VCR system with traditional POE oil is 1.85324, COP of VCR system when 1.0 % wt concentration ZrO2 nanoparticles are mixed with POE oil is 2.00 and COP of VCR system when 1.0% wt concentration ZrO2 nano particles are mixed with mineral oil is 2.0977.Percentage increase in COP of VCR system with ZrO2 nano lubricant with POE oil as base fluid is 7.919%. Percentage increase in COP of VCR system with ZrO2 nano lubricant with Mineral oil as base fluid is 13.19%. Increase in the COP value is due to the decrease in compressor work.

IV.CONCLUSION

The performance improvement of the refrigeration cycle by applying a nanoparticle is mainly due to heat transfer enhancement in heat exchangers and reduction of power consumption of the compressor by improvement of lubrication. These effects are included in the theoretical analysis as well. It was observed that 1.0% ZrO_2 nano lubricant with mineral oil as base fluid is better choice over the 1.0% ZrO_2 nano lubricant with POE oil as the base fluid.

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