RESEARCH ARTICLE

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Nano Fluids used in VCRS: A Review

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ABSTRACT

This study highlights the utilization of nano-particle fluids as the refrigerants in the conventional vapour compression based thermal systems due to their super improvement in thermo-physical properties together with heat transfer capacity to enhance performance of the system described by its COP and reliability of refrigeration system. Further, demanding situations of performance enhancement of system the usage of nano additive refrigerants had been presented. Lubricant oil is described as the important part inside the complete refrigeration system, typically for the operation characteristic of the compressor. Presently, a collection of research goes on inside the area of the nanoparticles like metals, carbon nanotubes or carbides and many more. Nano-lubricants are somewhat different form of nano-fluids that can be types of nanoparticles, lubricants are identified as typical agents in the fields of refrigeration. This paper is representing the utility of nanoparticles balanced in lubricating oils of refrigerating structures. The purpose of this research is to look at and locate what kind of lubricant oil works higher with nanoparticles in refrigeration. From the assessment of literature, it's been found that nanoparticles blended with mineral oil offer improved performance than polyester oil.

Keywords: Lubricant, Nanofluids, Refrigerant, and VCRs.

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INTRODUCTION

For any equipment applied as a system to achieve cooling its performance is best understand by the value of its COP which in turn is defined as fraction of heat energy extracted from the given space and energy in the form of work required to achieve that effectively there are 2 different ways to increase the COP value of the particular equipment, first can be achieved by gaining reduction in supply of work to the compressor and next by employing an arrangement to have effectively high heat transfer rate at the side of evaporate heat exchanger [1]. Lots of experts have invested their time in the field to achieve above two mentioned conditions to improve the performance of the system and have reached the point to introduce new advancement in the field of research using the nanoparticles employed to refrigerants and lubricants in compressor as well which are abbreviated as nano refrigerants and nano lubricants respectively. Which results in increasing the performance of system because of increasing of heat transfer rate at the fluid interaction [2]. For any systems employed for cooling of space lubricating oil is important matter of concern as it reduces the wear in the heart of system which is compressor [3]. The oil also acts in numerous critical roles as sealing, lowering the noise [4], nanoparticles

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as additives are also taken into consideration to enhance the lubrication properties of the oil for the compressor [5]. These days, exceptional varieties of nano-oils have attracted observation as it can contribute to reduce the irreversible processes such as the friction and wear in the compressor, which, in turn, improves the performance of the compressors, Employment of nano-oils fully appreciate the compressor performance [6]. This study specializes in representing the work supply decrement using the nano-lubricant. Nano particle with best thermal conductivity property is suspended in base fluid such as refrigerates and oils to develop the special class of fluids known as nano fluids [7] [8]. Cooling devices like the fridge and AC employed in specific location consumes larger quantity of electric energy, many researchers have been involved in the processes of developing models and system with dominant heat transfer rate to improve performance of the systems, nanoparticles are either doped inside the refrigerant or lubricant [9].

The subsequent are the characteristics of particles: -

1. As the surface area of particles increases there is increase in heat transfer rate.
2. It is under observation that clogging seems to be reduced.
3. Compressor consumption of electricity is reduced compared to the base fluid to acquire an equal contribution.
4. Dispersion balance is high [10].

Nanoparticles are composed of metal which may include copper, nickel, aluminum, and oxides like aluminum oxide, titanium oxide, copper oxide, and silicon oxide, employed to wide range of fluids such as water, propylene glycol, ethylene glycol, engine oil, and refrigerants [11]. Nano fluids are basically manufactured using to distinct approaches single step and double step approach in single step approach there is simultaneous preparation and addition of nano particles in the fluid and in second approach this are two different steps [12].

Mixture of nano particles and fluids are must to be stable with no exchange of any chemical reaction or any sort of dispersion [13]. Nano-fluids have wide range of application right from refrigerator to the bio medical [14]. The Under fig indicates a unique sort of nanoparticles with duration scale and associated examples [15].

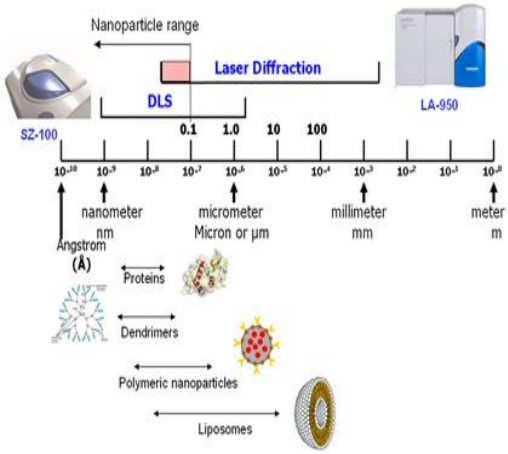

Figure :1 Particle Size [8]

THERMAL CONDUCTIVITY OF NANOFLUID

Governing term to exchange the heat energy for any matter is the thermal conductivity. It takes an important function inside the thermal machine. If the conductivity has an increment, then the coefficient of transfer of heat also has an increment [16]. Numerous researchers have done experiments and have a look at the usage of Al_2O_3 nanoparticles and R134a refrigerant machine as a base fluid [14]. Thermal conductivity turned into property of interest by incorporating a analyzer for the temperature range of 10^0C -40 ^{0}C [17].It is confirmed that thermal conductivity complements using 4.6%, and 2 .5% for 1.0, 2.0 Weight % Al_2O_3 at 40^{0}C and nanofluids show increased end form for excessive temperatures [18]. Mahabulul et. al. has performed an experimental evaluation on glide evaporation inside horizontally kept smooth pipe the use of Al_2O_3/R134a nano-refrigerant, temperature varying from the temperature of 300 K to temperature of 325 K [19]. Thermal conductivity was found out to and analyzed it's incremental at 20% of the most volume attention and occasional at 500^{0}C temperature and 0.4% ^{0}C quantity attention [20]. Nanofluids have better thermal conductivity in comparison to base fluids [21] [22].

VISCOSITY OF NANOFLUIDS

Volume proportion and temperature impacts the property of viscosity of nano-fluids it turned into organized the usage of TiO_2 nano particle and measured the viscosity it's been discovered that viscosity of concentrated fluid will increase with the aid of including nanoparticles [23]. Viscosity of any discrete fluid turned into predicted via the use of redwood viscometer [24]. Experimental examines are conducted on Al_2O_3/R141b nano refrigerant,

measurement of the viscosity of nano fluid is carried out by employing using lvdv series viscometer [25]. O. A. Alawi mentioned that addition of nanoparticles. Viscosity elaborated extended while experimenting the boiling of fluid inside a tube [26]. It is pronounced that the viscosity of paraffin dominant Fe_3O_4r fluid the usage of instrument thermometer [27]. Viscosity of Al_2O_3/R141b nano-refrigerant became anticipated by employing brinkman version and observed that including nanoparticle on quantity resulted in wise rise of viscosity and decreasing the temperature [28].

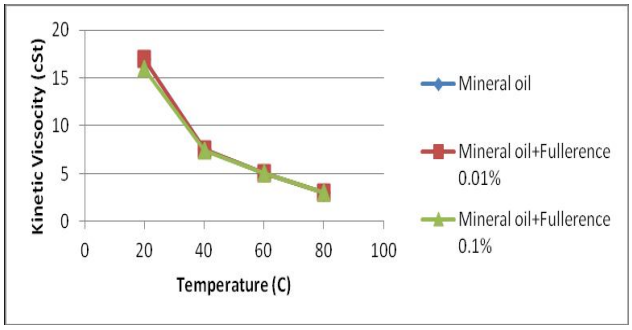

Figure 2: Friction Co-efficient vs Load [15]

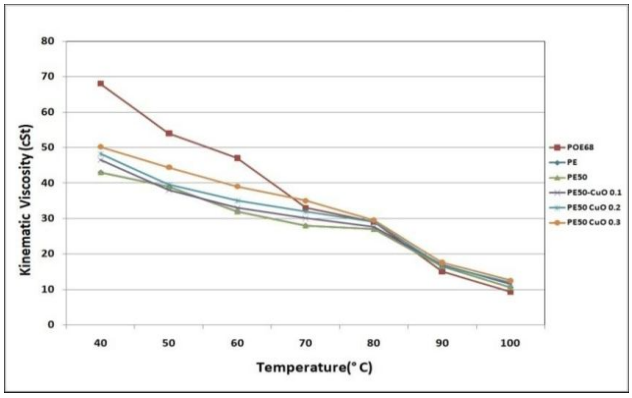

Figure 3: Viscocity vs Temperature[15]

HEAT TRANSFER PERFORMANCE

Nano fluids acts as an agent that results in changing the basic characteristics of any related fluids and are the dominant super imposing factor to appreciate the heat transfer physics. Refrigeration machine that was experimented was holding a different type of heat exchanger using concentric tubes and CuO as a nano particle and base fluid as R134a and resulted in good increment in the co-efficient of heat transfer [29]. The heat transfer estimation was also anticipated via the usage of computational fluid dynamic ideas using fluent software programs. Heat transfer coefficient showed that there is valuable increment as good as 0.55% of the decreases for all values [30]. As a result of increase in the convective heat transfer coefficient upto 0.55% after which it start decreasing [31] & [32]. The heat transfer coefficient will increase until the length of particle are reached to the 25 nm length for maximum values of heat flux [33]. H. peng et.al. executed an work to evaluate the numerous concentrations of CuO nanoparticle and resulted in increase of the required property of CuO nanoparticle. Mahabulul et al. implemented the time to evaluate the heat transfer coefficient for combination of Al_2O_3/ R134a inside a plane tube and resulted in increasing the volume concentration of particle [34],[35].The experimental evaluation was carried out with utilizing R113/VG68 and carbon nano tubes extraordinary mixtures of refrigerant and nano particle resulted in enhancement of pool boiling can attain up to 61% whilst [37], [36].

ENERGY PERFORMANCE

D. Colorado performed the check to determine the functioning of any cooling system the using the of nano substance and observed that 3-GS and Al_2O_3 nanoparticles, COP progressed with the aid of 35% with the aid of 33% and cooling potential also will increase while as kept side by side with pure POE oil. Power enhancement issue became 1.5 pronounced that 10.34% of electricity recovery become with oil and nano Al_2O_3 turned into system. The widest COP of 5 was received for length of the capillary tube is 5.03 m [38]. Overall equipment quality check was performed the usage of 3 sorts of nano lubricants, which might be TiO_2 nanoparticles, Al_2O_3 nano matters and CuO particle with 3GS as base fluid [39], [40]. Moreover, the performance of home fridge using R134a and nano refrigerant was elaborated, increases freezing ability of the system while in comparison 30% increase was observed as compared to the system using Al_2O_3[41]. A. Patta Nayak charged into investigation of R600A/Poe oil device in regular cooling system and found out that the poe oil, saves the energy consumption by 11%, they concluded that it took nearly 42 minutes to reduce evaporator temperature from 280 to 50 ^{0}C for the fluid Oil [42]. Performance check was carried out on a sealed compressor the use of TiO_2 nanoparticles and mineral oil determined that electricity consumption turned into decreased approximately 10% to 9.33% and COP progressed by way of 16.08% [43].

Table-1: Concentration of Various Nano Particles

Researcher	Refrigerant	Nano Particle	Lubricant	Nano Particle
Bi et al.	HFC134	TiO_2–Al_2O_3	POE	0.06%–0.1%
Subramani et al.	R134a	TiO_2	Mineral oil	300g
Kumar et. al.	Rs- 143a	TiO_2	Mineral oil	400g
Elanse zhian	R134a	CuO - R13a	0.55%	0.55% to 1.5%
H. Hussein,	R13A	TiO_2	0.20%	0.1% to 20%
O.A. Alawi, et al.	R1225	TiO_4	0.50%	0.25%

CONCLUSION

There was extensive work made on nano refrigerants and nano lubricants by plenty researchers tried to demonstrate the increase of performance of regular refrigeration system by incorporating the nano particle either in refrigerants or in lubricants. From the study it is concluded that nano fluids have more thermal conductivity state than the simple fluids. With increase of nano particles based on volume there would be additional increase in the thermal conductivity of the nano fluid. Some of the factors governing the thermal conductivity of fluids are temperature, particle length and dispersion. Growing of nano particles consequences of increased viscosity. There was a behavior of the parabolic nature found out at some references. The geometry of the material of nanoparticles influenced the overall performance of refrigerator. Particles with better size precipitated a few issues like sedimentation, erosion, fouling. The work required to drive the compressor can be reduced by using Nanoparticles as much as a certain limit after which elevated. Nano lubricant are whittling solution for many commercial systems as they effectively reduce the work consumption by compressor. The research at the lubricant utilizing nano particle is summarized in this study. It is observed that nano particle combined with mineral oil offers higher effects than Poe Oil.

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