EFFECT OF NANOREFRIGERANT ON PERFORMANCE OF VCR SYSTEM: A REVIEW

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ABSTRACT

Refrigeration is the process of removal of heat from a space it is where it is unwanted and transferring the same to the surrounding environment. This is produced by evaporation of liquid refrigerant in VCR system. The coefficient of performance (cop) of VCR system is depends on the refrigeration effect and work required the rate of heat transfer or by reducing the compressor work. Recently it is found that the use of nanotechnology in the refrigeration system can increase the performance of system. In this technique the nanoparticles are added in to the base fluid which is refrigerant or compressor oil (lubricating oil). It also has been found that nanorefrigerant have much higher and strongly temperature dependent thermal conductivity than conventional refrigerant and it improve the thermo-physical properties. This can be considered as one of the key parameter of enhanced performance for refrigeration system. For this project will first find all the available nanoparticles and we will also find their all properties and cost. After collecting all these data we will select one of the most suitable nanoparticles and mix them at proper concentration. This project is performed in order to check and clarify the effect of nanorefrigerant properties on heat transfer compared to pure refrigerant in refrigeration system.

Keyword: - *Nanorefrigerant, Performance, Heat transfer rate, Power consumption, COP*

1. INTRODUCTION

Refrigeration is process of removal of heat from space where it is unwanted and transferring the same heat to the surrounding atmosphere where it make little or no difference. This refrigeration is produced by evaporation of a liquid which is known as refrigerant. The refrigerant is a heat carrying substance which absorbs latent heat from space to be cooled and rejects that heat to outside system generally in atmosphere.

Refrigeration system maintains cold environment in selected space relative to surrounding. The selected space is maintained at temperature lower then surrounding atmosphere temperature. In order to maintain this, a mechanical device called refrigerator is used which extracts heat from space and reject it into surrounding atmosphere. For this purpose of conveying heat from lower temperature space to higher temperature surrounding, refrigeration system requires external energy.

The major problems with refrigeration systems are higher amount of power consumption, lower freezing speed, lower rate of heat transfer and the main problem is, it cause the environmental problems like ozone layer depleting (ODP) and global warming potential (GWP). The refrigerants used in refrigerators and air conditioners do not easily decompose when they reach to atmosphere following emission. Thus they are responsible to earth's green house effect, which resulting in change in climate or atmosphere around the world and effects to the ecosystem. So it is need for developing thermal systems which are energy efficient as well as they are natural friendly.

The environmental problems can be reduced by proper selection of refrigerant in refrigeration system. Another problem of power consumption or freezing speed and heat transfer rate is solved by using of new modern type of fluid called nanofluids. The use of nanofluid will increases the rate of heat transfer and also it reduces the power consumption. Hence these increases in heat transfer and lower consumption of power results in increase of performance of system.

Nanofluid is mixture of liquid and solid which consist of nanoparticles as solid and base fluid as liquid as water or oil. Ultrafine sizes of nanoparticles (1nm to 100nm) are suspended in a base fluid in proper mass or volume fraction and then this fluid is stabilized with ultrasonic stabilizer. Suspension of nanoparticles results in change of properties of fluid as thermal conductivity, boiling point, viscosity and specific heat etc. They have higher thermal conductivity and also lower friction losses. Therefore application of nanofluid in refrigeration system gives better result than conventional refrigerant.

The compressor of system consumes larger amount of electric power. It can be reduced by suspending nanoparticles in lubrication oil of compressor. It involves nanoparticles additives or nanofilm coating. The bearing, cam and piston of a compressor during operation depended on a film of lubricating oil which separates their surfaces and thus it reduces the friction. Thus reduction in friction results in reduction in power.

The freezing speed of system is also slow. It is due to refrigerant is in fluid form. Fluid has lower thermal conductivity compare to solids. By suspending nanoparticles in working fluid results in improved thermal conductivity of fluid and hence improvement in freezing speed. This is one of the most important key parameter for improving the performance of system.

In VCR system the nanoparticles can be added to lubricant of compressor. When the refrigerant is circulated through the compressor, it carries traces of lubricant plus nanoparticles mixture called nanolubricant so that all parts of system have nanolubricant and refrigerant mixture.

2. LITERATURE SUMMERY

Many researchers have investigated and studied on VCR system with nanorefrigerant and also nanolubricant on performance of VCR system. Some of those literatures are as discussed below:

2.1 Kumar, Sridhar, & Narasimha, 2013

[1] Conducted experimental study on performance of VCR system with Al_2O_3 nanoparticles, mineral oil as lubricant and R600a as refrigerant in the domestic refrigerator. The experimental setup for this purpose was build based on the national standards of India. The nanoparticles are added in to refrigerant which results in increasing of thermal conductivity and heat transfer property of the refrigerant. The mass fraction of nanoparticles in lubricant is 0.06%. The heat transfer characteristics were estimated numerically. This study indicates that when mineral oil and Al_2O_3 nanoparticles were used then the power consumption of compressor is decreases by 11.5% and the freezing capacity is also higher. The coefficient of performance of the system also increases by 19.6% when POE oil changed with mixture of nanoparticles mineral oil.

2.2 Kotu & Kumar, 2013

[2] Investigated the performance of the domestic refrigerant with mineral oil and R134a system was compared with mineral oil, nanorefrigerant and R134a, mineral oil and double pipe heat exchanger (DPHE) experimentally. The aluminum oxide with average size up to 50nm and mass fraction in lubricant was 0.06%. These nanoparticles were added in to compressor oil or lubricant. The result shows that the use of mineral oil, nanorefrigerant and R134a, mineral oil and DPHE works normally and safely. The power consumption of R134a, Mineral oil and DPHE system was decreased by 30% and also power consumption was reduced 26% when R134a, mineral oil and Al_2O_3 nanoparticles were used. The performance of R134a, Mineral oil and DPHE system increased by 10% and increased by 6% when R134a, mineral oil and Al_2O_3 nanoparticles were used.

2.3 Coumaressin & Palaniradja, 2014

[3] Conducted performance analysis of a refrigeration system using nanofluid by CFD (Computational Fluid Dynamics) heat transfer analysis using the FLUENT software. The nanoparticles used for this was CuO (copper Oxide) with mass fraction of 0.05% to 1% and size range from 10nm to 70nm. The result shows that CuO nanoparticles used with R134a refrigerant would improve the heat transfer characteristics in refrigeration system. A model is designed and the basic theoretical heat transfer analysis of refrigeration system has been done. CFD heat

transfer for design test section has been successfully performed FLUENT software. The result shows that, the heat transfer coefficient of evaporator increase with the use of CuO nanoparticles.

2.4 Kumar & Elansezhian, 2012

[4] Studied on experimental work of nanorefrigerant. An experimental test rig of VCR system was designed and fabricated in which R134a as refrigerant and PAG oil as lubricant was used Al_2O_3 nanoparticles were used. The nanoparticles were mixed with PAG (Poly Alkylene Glycol) lubricating oil. The concentration of nanoparticles in lubricant was 0.2% of volume. The result shows that system with R134a and PAG oil with Al_2O_3 nanoparticles as works normally and safely. The performance of system with nanorefrigerant was better than pure lubricant with R134a as working fluid with 10.32% less energy consumption and improvement in coefficient in performance up to 3.5. The uses of nanorefrigerant also reduce the length capillary tube.

2.5 Subramani & Prakash, 2011

[5] Conducted experiment studies on a VCR system it the use of nanorefrigerant. They sate that the nanoparticles added in to the refrigerant result in enhanced thermo-physical properties and heat transfer rate of refrigerant. This results in improved performance VCR system. The refrigerant used for this purpose was R134a. Stable nanolubricant was prepared for the experimental study. For experimental study there was three cases considered. The compressor filled with (1) pure POE oil, (2) mineral oil (3) mineral oil with Al_2O_3 nanoparticles and the mass fraction of nanoparticles in lubricant was 0.06%. It is found if mineral oil with Al_2O_3 nanoparticles used in system then system works normally and gives best result. The power consumption reduced by 25% and the freezing capacity is also higher with mineral oil and alumina nanoparticles. The improvement in COP of system was 33% when nanorefrigerant was used.

2.6 Abdel-Hadi, Taher, Mohamed Torki, & Hamad, 2011

[6] Conducted heat transfer analysis of VCR system by using nanorefrigerant as CuO R134a. In this the effect of evaporating heat transfer coefficient is studied experimentally. For this purpose experimental test rig is designed and constructed. The test section consists of a horizontal tube in tube type heat exchanger which is made from copper. The hot water is passing through the surrounding the copper inner tube and the refrigerant are evaporated inside the copper tube The nano particles used for this purpose were size ranged from 15nm to 70nm and concentration range from 0.05% of 1%. The result indicated that heat transfer coefficient increased up to 0.55% of nanoparticles concentration after that it decreases. The result also indicated that the heat transfer coefficient given best performance with 25mm size of nanoparticles.

2.7 Fadhilah, Marhamad, & Izzat, 2014

[7] Studied the effect of suspended CuO nanoparticles in to R134a hic is investigated by mathematical modeling. The investigation includes heat transfer rate, thermal conductivity and also dynamic viscosity of nanorefrigerant in a tube of evaporator. The result shows that thermo physical properties were increased. The nanoparticles concentration was ranged from 1% to 5%.

3. SUMMARY TABLE

Table -1: Summary from literature review

Researcher	Refrigerant	Nanoparticles	Lubricant	Mass/ volume fraction	Result
Reji Kumar et al	R600a	Al_2O_3	Mineral oil	0.06%	Freezing capacity increased, Power consumption reduced by 11.5% and COP increased by 19.6%.
Kotu & Kumar	R134a	Al_2O_3	Mineral oil	0.06%	Installing DPHE gives best result, Power consumption of HFC 134a/Mineral oil/Al_2O_3 system reduced by 26% & COP increased by 6%.
Coumaressin & Palaniradja	R134a	CuO	-	0.05% - 1%	Heat transfer coefficient increased up to 0.55% of concentration & then it decreases.
Kumar & Elansezhian	R134a	Al_2O_3	Mineral oil	0.2% of volume	Power consumption reduced by 10.32% & COP increased up to 3.5.
Subramani & Prakash	R134a	Al_2O_3	Mineral oil	0.06%	Freezing capacity is higher, Power consumption reduced by 25% & COP increased by 33%.
Abdel-Hedi et al.	R134a	CuO	-	0.05% - 1%	Heat transfer coefficient is higher at 0.55% of concentration gives best performance with 25nm particles size.
Fadhilah et al.	R134a	CuO	-	1% - 5%	Power consumption reduced & thermo-physical properties were increased.

4. CONCLUSIONS

- V**apour compression refrigeration system with nanorefrigerant/nanolubricant works normally.**
- **Energy consumed by compressor in VCR system is lower compared to simple VCR system.**
- **Coefficient of performance and freezing speed of system increased with use of nanorefrigerant/ nanolubricant.**
- **Installing double pipe heat exchanger in VCR system also increase the performance of system.**
- **Use of nanorefrigerant in VCR system reduces the length of capillary tube and hence cost of capillary tube reduces.**

5. REFERENCES

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