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A Review: Experimental Study on the Performance Analysis of a Domestic Refrigeration system with Nano Additives and Proven Alternative Refrigerant

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Abstract: ***Refrigeration may be defined as the process of achieving and maintaining a temperature below that of the surroundings, the aim being to cool some product or space to the required temperature. One of the most important applications of refrigeration has been the preservation of perishable food products by storing them at low temperatures. Refrigeration systems are also used extensively for providing thermal comfort to human beings by means of air conditioning. Nano refrigerants are special type of nano fluids that are synthesized by mixing or dispersing nano particles in refrigerants. They are relatively new with respect to other nano fluids and have broad range of application in refrigeration, air-conditioning systems and other heat transfer devices due to their enhanced heat transfer characteristics. In this paper coefficient of heat transfer of nano refrigerant is investigated based on different volume concentrations of CuO nanoparticles are suspended in R134A + R290 blended refrigerants. Correlations from existing studies have been used to determine thermo- physical properties like thermal conduction, viscosity, density and specific heat of nano-refrigerant. Study has been conducted by theoretical calculations for calculation of total heat transfer co-efficient. Results from the current study shows total heat transfer co-efficient, thermal conductivity increases and specific heat decreases with increase in particle concentration.***
Keywords: Nano particles, vapour refrigeration system, R134a, R290, CuO nano refrigerants, COP, Alternate refrigerants etc.

I. INTRODUCTION

Nano refrigerants are special type of nano fluids that are synthesized by mixing or dispersing nanoparticles in refrigerants. The most widely recognized refrigerant in refrigeration systems is R132a. But, as a result of rapid industrialization the need of new refrigerants which has ability to take more heat from the system has increased. Thus, we require something new that will have the capacity to supplant elective refrigerant with some advanced thermo physical properties like Thermal Conductivity, Specific heat, Viscosity, Density etc. In order to meet the expectations of the Industries, opportunities to increase the heat exchange are given by concentrating attention on the fluid performance. A new technology have been developed, It is combination of nano particles with the refrigerants called as nano refrigerents. The use of nano refrigerants have created a massive boost in the efficiency of the heat exchangers. Refrigeration is additionally made public as a result of the strategy of achieving and maintaining a temperature below that of the surroundings, the aim being too cool some Product or space to the specified temperature. One in every of the foremost very important applications of refrigeration has been the Preservation of spoilable nutrient by storing them at low temperatures. Refrigeration systems are also used extensively for providing thermal comfort to groups of people by implies that of air conditioning. The refrigeration and air conditioning sector in India contains a protracted history from the first years of last century. India is presently producing R134a, R22, R717 and hydrocarbon-based refrigeration and air conditioning units in large quantities. the Utilization of CFC refrigerants in new systems was stopped since the year 2002. The factors that Dictate the adoption of a specific refrigerant apart from its quality for the precise application are its accessibility and worth. The halogenated refrigerants like R12, R22, R134a and natural refrigerant like R717 are promptly on the market at low prices. The compound (HC) and Hydro Fluro Carbon (HFC) mixtures (such as R404a, R407, and R410A) do not appear to be presently ready-made indigenously and therefore ought to be foreign at a stronger worth. this will be on the face of it to possess an impression on the growth in refrigeration and air conditioning sector in India and in addition the total conversion to environmentally friendly alternatives at intervals the near future.

A. Nanofluids

Nanofluids are a suspension of particles between 0 and 100 nm in a base fluid. They have thermophysical properties different to the base fluid due to the addition of metal or metal oxide particles to increase the coefficients of thermal conduction and convection the

main characteristic of Nanofluids is the ability to enhance heat transfer without altering the base fluid Newtonian behaviour with the addition of small concentrations of solid particles. Experimental and numeric tests have been performed in order to better understand the behaviour of these fluids and their characteristics. Studies have focused on thermal conductivity, convective heat transfer coefficient, viscosity, evaporation phenomenon, the influence of particle size and optimal concentration of particles.

Some of the advantages to using Nano-fluids proposed by Choi in are:

1) High specific surface area and therefore greater heat transfer surface between particles and fluid.
2) High stability of the dispersion where the Brownian motion of particles dominates.
3) Reduction of the pumping power in comparison with the base liquid, to achieve an equivalent heat transfer.
4) Reduced clogging particles compared to conventional suspensions, promoting miniaturization of the system.
5) Adjustable properties by varying the concentration of particles. In, the authors describe the challenges faced in studying Nanofluids and its characteristics such as thermal conductivity, the Brownian motion of particles, migration of these and the variation of thermophysical properties with change in temperature.
6) The long-term stability of the dispersion of nanoparticles is a technical challenge to prevent the accumulation and sedimentation of particles. The pressure drop and higher pumping power should also be considered to determine the efficiency of Nanofluids. Other challenges include an increase in viscosity with a greater concentration of particles, low specific heat compared to the base fluid, the prediction of thermal conductivity, high costs and production processes.

B. Nanofluids Application

Heat transfer fluids are the most important part of cooling applications in many industries including transport, energy, manufacturing, and electronics. Nanofluids can be used to improve heat transfer and energy efficiency a variety of thermal system, including the important applications of refrigeration vehicles. Some applications of Nanofluids will discuss below-

1) *Nanofluids for Lubrication Applications:* Solid lubricants useful in situations where conventional lubrication is not enough liquid, such as high temperature and excessive contact pressure, their lubricating properties are due to the layer structure at the molecular level with weak bonding between the layers. Graphite and molybdenum disulfide (MoS2) is the main material used as solid lubricants. Other useful solid lubricants include boron nitride, tungsten disulfide, poly tetra fluoro ethylene (PTFE), etc. to improve the tribological properties of lubricating oils, solid lubricant nanoparticles to disperse. Recent studies have shown that the lubricating oil with additional nanoparticles exhibits improved load carrying capacity, anti-wear and friction reduction property.
2) *Nanofluids for Biomedicine Applications:* Nanofluids have many applications in the biomedical industry. For example, Nanofluids are used to producing effective cooling around the surgical region and thereby enhancing the patient's chance of survival and reducing the risk of organ damage. In a contrasting application to cooling, Nanofluids could be used to produce a higher temperature around tumours to kill cancerous cells without affecting nearby healthy cells.
3) *Nanofluids for Cooling Applications:* Developments in new technologies such as highly integrated microelectronic devices, the engine power output are higher, and the reduction of cutting fluids used continuously increasing heat load, which requires the development of cooling capacity. Thus, there is a need for a new heat transfer fluids and innovative ways to achieve better cooling performance. In general, the conventional heat transfer fluid has the characteristics of poor heat transfer compared to the solid, most solids have thermal conductivities orders of magnitude greater than that of conventional heat transfer fluids. Therefore, the liquid containing suspended solid particles are expected to exhibit a significant increase in thermal conductivity compared with conventional heat transfer fluids. In addition, normal coolant operating temperature can be increased since Nanofluids have obtained a higher boiling point, which is desirable for maintaining single phase coolant flow. The results of Nanofluids research are being applied to the cooling of an automatic transmission with variable operating speeds conducted.
4) *Others Application:* There are unending situations where an increase in the heat transfer effectiveness can be beneficial to be the quality, quantity, and cost of product or process. In many of these situations, Nanofluids are good candidates for accomplishing the enhancement in heat transfer performance. For example, Nanofluids have potential application in buildings where increases in energy efficiency could be realized without increases in energy efficiency without increased pumping power. Such an application would save energy in as heating, ventilating and air conditioning system while providing environmental benefits. In the renewable energy industry, Nanofluids could be employed to enhanced heat transfer from solar collectors to storage tanks and increase the energy density. Nanofluids coolants also have potential application in major process industries, such as materials, chemical, food and drink, oil and gas, paper and printing, and textiles.

II. LITERATURE REVIEW

Wang-1999[1] In this paper thermal conductivities of fluids mixed with Al2O3, Cuonano particles mixed in water, engine oil, and ethylene glycol are measured. Conclusions are made that thermal conductivity of nano particle increases with decreasing the particle size and nano fuid mixture is dependent on the microscopic motion and the particle structure of nano particles. N. Subramani-2011 [2] Conclusions are made that power utilization of the compressor decreases by 25% when the nano lubricant is utilized rather than ordinary oil and the coefficient of performance of the refrigeration system increments by 33% when the nano refrigerant is utilized. N. Subramani-2013 [3] The outcomes shows that refrigeration system with nano lubricant works regularly and securely. It is found that power utilization decreases by 15.4% and the coefficient of performance increments by 20% when TiO2 is utilized in place of SUNISO 3GS. Teshome Bekele Kotu-2013 [4] In this paper test on double pipe heat exchanger with the air refrigeration system was performered. The power use of the HFC134a blended with mineral oil and DPHE system was diminished by 30% and HFC134a blended International Journal of Pure and Applied Mathematics Volume 115 No. 7 2017, 349-354 ISSN: 1311-8080 (printed version); ISSN: 1314-3395 (on-line version) url: http://www.ijpam.eu Special Issue ijpam.eu with mineral oil and alumina nanoparticle was decreased by 26% when compared and normal one. R. Reji Kumar-2013 [5] Conclusions are made that study demonstrates the power utilization of the compressor lessens by 11.5% when the nanolubricant is utilized rather than ordinary oil and coefficient of performance of the refrigeration system likewise increments by 19.6 % when the customary POE oil is replaced with nano refrigerant. T. Coumaressin-2014 [6] Conclusions from the study are made that Cuo nanoparticle with R134a refrigerant can be used as excellent refrigerant to improve the heat transfer characteristics for different concentrations of Cu0 nanoparticle using CFD analysis. Harish Kumar Patel-2014 [7] In this paper thermal conductivity of nano fluids are studied and conclusions are made that nano fluid can be good replacement for conventional base fluid as thermal conductivity of nano fluid changes according to the temperature and volume concentration of the nano particles. Results shown that thermal conductivity increases with increase in temperature and decrease of specific heat of nano fluid is observed. Parvinder Singh-2015 [8] This paper is focusing on mixing of different volume concentration of nano particles with refrigerants and performance characteristics of the system are drawn. The results shows the comparision of actual and theoretical values of performance characteristics of the system while using nanorefrigrants. Rahul.K. Jaiswal-2015 [9] In this paper it is observed that using nano refrigerant instead of pure refrigerant in vapour compression refrigeration cycle increase the performance of system and also observed that the nanoparticle mixed in pure refrigerant enhance the thermal conductivity from 10 to 95 % and heat transfer enhancement factor ranges from 1.4 to 2.5. Asif Faizan- 2016 [10] Coclusions of the study are thermal conductivity, dynamic viscosity increases with increase in volume concentration and Specific heat increases with increase in temperature and density decreases with increase in temperature for nano refrigerant R245fa/Al2O3.

III. OBJECTIVES OF THE PRESENT STUDY

Many investigations have been done to deal with the problem of global warming and ozone layer depletion due to the use of alternative refrigerants in the refrigeration system. Therefore it is felt that detailed investigations on the possibility of adding a new alternative refrigerant and Nano additives to the refrigerant and the comparison between the different concentrations of nano fluids will be analyzed. Our main objective of the present study is to investigate the heat transfer characteristics of the vapour refrigeration system; the refrigerant R134a is taking as a major refrigerant and proven alternative refrigerant R290 with nano fluids is CuO. The properties of heat transfer will be examined by the Different concentration of CuO. Nano additive CuO is taken 0.1%v , 0.2 % v , 0.3% v, 0.4%v and 0.5%v concentration with particle size of 50 nm and (R134a+R290) refrigerant mixture will be investigated by Experimental solution. The system performance with nano particles will be then investigated according to the heat transfer characteristics.

The following steps are taken in present study

1) The most commonly used commercial refrigerant R134a and the proven alternative R290 were blended and the new hybrid refrigerant was prepared and the heat transfer characteristics will be investigated with different volume concentration.
2) The blended percentages of R290 is always in a lower side due to flammable properties that's why we will be taken as 5%, 10% and 15% of it to the R134a.
3) Nano particle size is taken 50 nm and volume percentages are 0.1%v , 0.2 % v , 0.3% v, 0.4%v and 0.5%v to the mixture of R134a+R290 .

A. Why we have chosen R290?

The addition of R290 is supported by the following considerations

1) It has no ODP (Ozone-Depletion Potential) and a very low GWP (Global Warming Potential) .
2) It is non-toxic and has non-toxic products of combustion .
3) Its thermo physical and thermodynamic properties are well known .
4) It has a good compatibility with the materials used in R22, R502 and R 12 systems.
5) In the presence of moisture it does not hydrolyse to form acids.
6) It is a by-product of natural gas and is already widely used as a fuel.
7) Its cost is very low.

In spite of its flammability range (2. I -9.6 vol% in air) R290 is nowadays suggested as a component of refrigerant mixtures. The risk due to flammability may be restricted by avoiding high mass fractions of R290 in the mixture.

IV. PROPOSED METHODOLOGY

A. *Basic Steps To Perform Cfd Analysis*

1) *Pre-processing: CAD Modeling:* Creation of CAD Model by using CAD modeling tools for creating the geometry of the part/assembly of which you want to perform FEA.CAD model may be 2D or 3d.
2) *Meshing:* Meshing is a critical operation in CFD. In this operation, the CAD geometry is discretized into large numbers of small Element and nodes. The arrangement of nodes and element in space in a proper manner is called mesh. The analysis accuracy and duration depends on the mesh size and orientations. With the increase in mesh size (increasing no. of element), the CFD analysis speed decrease but the accuracy increases.
3) *Type of Solver:* Choose the solver for the problem from Pressure Based and density based solver.
4) *Physical model:* Choose the required physical model for the problem i.e. laminar, turbulent, energy, multi-phase, etc.
5) *Material Property:* Choose the Material property of flowing fluid.
6) *Boundary Condition:* Define the desired boundary condition for the problem i.e. temperature, velocity, mass flow rate, heat flux etc.

B. *Solution*

1) *Solution Method:* Choose the Solution method to solve the problem i.e. First order, second order
2) *Solution Initialization:* Initialized the solution to get the initial solution for the problem.
3) *Run Solution:* Run the solution by giving no of iteration for solution to converge.

C. *Post-Processing*

For viewing and interpretation of Result. The result can be viewed in various formats: graph, value, animation etc.

D. *Proposed results*

1) Temperature distribution
2) COP of the system.
3) Pressure distribution
4) Velocity profiles
5) Temperature distribution at different position
6) Heat Transfer Rate
7) Mass fraction of emissions

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