Performance Analysis of Thermodynamic Properties of VCC using Nanorefrigerant

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Abstract- In today's world refrigeration system plays a vital role to fulfill the human needs and a continuous research is being carried out by many research in order to improve the performance of the system ,here , scientist such attempt has been made to improve the performance of the system . Researchers are trying to use new generation heat transfer fluids in this field. The nanofluid $Al_2o_3$are a new class of fluid which promise to significantly enhance thermal, rheological properties of fluid.

Keywords- Nanofluid (Al_2o_3), vapour compression cycle, Coefficient of performance, Heat transfer, Reynolds number.

1. INTRODUCTION

Heat transfers are used in many industrial area. Natural convective heat transfer by nanofluid is nothing but exchange of thermal energy and heat between the physical systems by nanofluids. Convective heat transfer is the transfer of heat by movement of fluids. Nanofluids, a name conceived by Dr. Choi, in Argonne national laboratory, describe a fluid consisting of solid Nanoparticles with size less than 100 nm. Suspended on it with solid volume fractions typically less than 4 %.

Recent development of nanotechnology brings out a new heat transfer coolant called "Nanofluids". This fluids exhibit's larger thermal properties than conventional refrigerants. The conventional refrigerant have major role in global warming and depletion of ozone layer. Therefore, there is need to improve the performance of vapour compression refrigeration system with the help of suitable refrigerant. Nanoparticles are able to coagulate easily with period elapsed for its high energy surface. The aggregation of nanoparticles is a reason for sedimentation of decreases the thermal conductivity of nanofluids. There are several ways which includes addition of surfactant, Ph. Control and increase the ultrasonic type and vibration means evaluate the stability of nanofluid ultra sonication is a common wave to brake up agglomerates and promote dispersion of nanoparticles into base fluids to gate more stable nanofluids stability of Al_2o_3 – R 134 nanofluid by using SDBS are the dispersant followed by ultra-sonication 16-20 hours.

2. Experimental Work

The fig 1 depicts a typical, single stage vapour compression system. All such systems have four components: compressor, condenser, thermal expansion valve (throttle valve) and an evaporator. Circulating refrigerant enters the compressor in the thermodynamic state known as saturated vapour and is compressed to higher pressure, resulting in a higher temperature as well. The hot, compressed vapour is then in the thermodynamic state known as a superheated vapour and it is at a temperature and pressure at which it can be condensed with air cooled. The hot vapour is routed through a condenser where it is cooled and condensed into a liquid by flowing through a coil or tubes with the cool air flowing across the coils or tubes. This is where the circulating refrigerant rejects heat from the system and the rejected heat is carried away by the air. The condensed liquid refrigerant, in the thermodynamic state known as a saturated liquid, is next routed through an expansion valve where it undergoes an abrupt reduction in pressure. That pressure reduction results in the adiabatic flash evaporation of a part of the liquid refrigerant. The auto refrigeration effect of the adiabatic flash evaporation lowers the temperature of the liquid and the vapour refrigerant mixture to where it is colder than the temperature of the enclosed space to be refrigerated. The cold mixture is then routed through the coil or tubes in the evaporator. A fan circulates the warm air in the enclosed space across the coil or tubes carrying the cold refrigerant liquid and vapour mixture. That warm air evaporates the liquid part of the cold refrigerant mixture. At the same time, the circulating air is cooled and the lowers the temperature of the enclosed space to the desired temperature.

The evaporator is where the circulating refrigerant absorbs and removes heat which is subsequently rejected in the condenser and transferred elsewhere by the air is used in the condenser. To complete the refrigeration cycle, the refrigerant vapour from the evaporator as again a saturated vapour and is routed back into the compressor.

3. Results

DENSITY

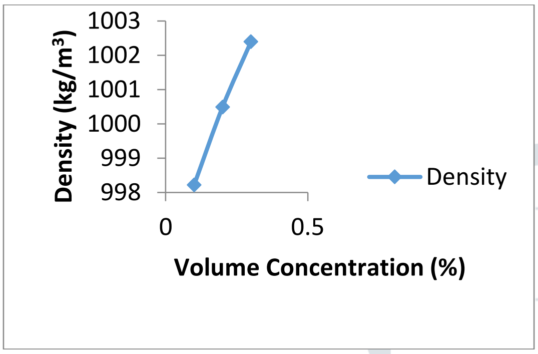

FIG 1.

The change in density with respect to refrigerant's temperature has been shown in fig.1 for R-134 and Al_2o_3 /R-134a nanorefrigerant was used to calculate the density of nanorefrigerent. The density of Al2o3/ R-134a nanorefrigerant and R-134a refrigerant are moderately increased with the volume concentration. It is found that, Al_2o_3 /R-134a nanorefrigerant exhibits approximately 11% higher density compared to R-134a refrigerant at the same temperature.

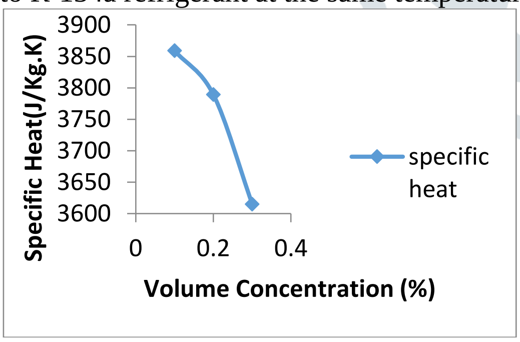

FIG 2.

SPECIFIC HEAT

The specific heat of both Al_2o_3 /R-134a nanorefrigerant and R-134a refrigerant linearly decreases with volumeconcentration from 0.1-0.3 as shown in fig. The specific heat of nanorefrigerant was calculated for a particular volume fraction, analysis showed that the minimum specific heat belonged to the Nano refrigerant. This decreased due to the lower specific heat of added particles. Moreover, higher specific heat of the base fluid is the reason why the specific heat of the mixture exceeds that of the nanoparticles. Specific heat capacity of R-134a refrigerant is 2.4% higher compared to both Al_2o_3 /R-134a nanorefrigerant.

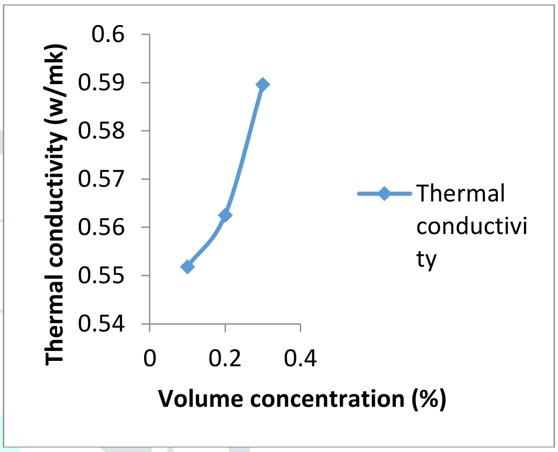

FIG 3.

THERMAL CONDUCTIVITY

Above fig. Shows the variation of thermal conductivity of nanorefrigerant and refrigerant with volume concentration ranging from 0.1-0.3. It can be seen that the thermal conductivity Al_2o_3 /R-134a nanorefrigerant was linearly increased with increasing volume concentration. As the thermal conductivity of Al_2o_3 nanoparticle is higher than the base fluid therefore, the thermal conductivity of the nanorefrigerant was found to be higher than the pure refrigerant.

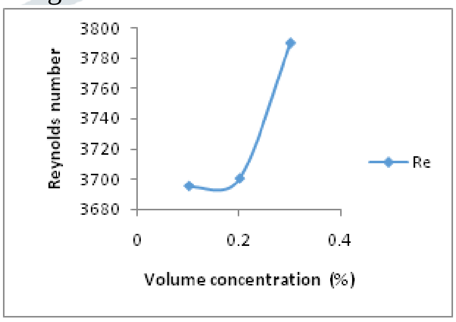

FIG 4.

REYNOLDS NUMBER

Fig shows the variation of Reynolds number of refrigerant and nanorefrigerant with the volume concentration ranging from 0.1-0.3. It can be seen that, Reynolds number of Al_2o_3 /R-134a nanorefrigerant was linearly increased with increasing volume concentration. As the Reynolds number of Al_2o_3 nanoparticle is higher than the base fluid therefore, the Reynolds number of the nanorefrigerant was found to be higher than pure refrigerant.

4. Conclusion

From above the result and discussion it is concluded that, addition of Al_2O_3 nanoparticles in the base refrigerant will leads to improve in the overall performance of vapour compression refrigeration system than that of pure base refrigerant .As per change in volume concentration specific heat reduces and Reynolds number, density, thermal conductivity increases.

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