Improvement in Cop of Refrigerator System by Using Nanofluid and Magnetic Field

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IMPROVEMENT IN COP OF REFRIGERATOR SYSTEM BY USING NANOFLUID AND MAGNETIC FIELD

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Abstract— This experimental investigation exemplifies the performance improvement by the effect of application of magnetic field to liquid line and addition of copper Nano particles to the compressor lubricating oil of vapour compression refrigeration system. The main benefit of this experimental investigation is improvement in COP by increasing refrigerating effect and decreasing compressor power input without usage of any external energy. The magnetic field strength was varied by increasing the number of magnetic pairs applied to the liquid line (from outlet of condenser to inlet of expansion valve).

The COP was initially measured without application of magnetic field, and then magnetic field applied to liquid refrigerant was increased by increasing the number of the magnetic pairs from 1 to 5. Similarly The COP was initially measured without addition of copper Nano particles to refrigerant, and then adding copper Nano particles to the refrigerant was increased by increasing the percentage of volumetric addition of copper Nano particles were 0.01%, 0.015%, 0.02%, 0.025% to the refrigerant.

Keywords—Nanofluid , Magnets in refrigeration , COP improving techniques , CuO nanoparticles

1. Introduction

Vapour compression cycle is commonly used refrigeration cycle, first reported in 1748 by Professor Williams Cullen of Glasgow University who produced refrigeration by partial vacuum over ethyl ether. This system was further modified to a hand-operated compressor machine working on ether, by Jacob Perkins. This was further improved by motor driven compressor and in present days commonly used in most of the household refrigerators as well as in large commercial refrigeration systems. Vapour compression refrigeration system is based on vapour compression cycle. Vapour compression refrigeration system is used in domestic refrigeration, food processing and cold storage, industrial refrigeration system, transport refrigeration and electronic cooling etc. So improvement of performance of system is too important for higher refrigerating effect or reduced power consumption for same refrigerating effect. By sub-cooling using heat exchanger at condenser inlet refrigerating effect increases and power consumption or work input decreases. Thus performance of cycle is improved. Along with this waste heat also recovered. The essential quantity of heat recovered is not the amount but it is value.

Numerical study of magnetic fluid flow through a channel has become a very demanding research area for researchers. Over the past few decades, eminent researchers have extensively worked on dynamics of magnetic fluid in the presence of magnetic field. They have made an endeavor to implicate it in the industry, medical technology and bio-engineering. Magnetic fluid or ferro fluid is well known for its wide use in the industry and in the field of medicine, e.g. magnetic drug targeting, ferro fluid sealing, high-gradient magnetic separation, magnetic devices for cell separation, targeted transport of drugs, hyperthermia and reduction of bleeding, cancer treatment, etc. But that magnetic field phenomena was used in refrigeration systems to improve performance with R134a refrigerant and nanorefrigerant (R134a+Cuo) also. The role of formation of recirculating bubble, velocity contour and average stagnation pressure plays an important role in the stage of above applications. Because of various physical attraction forces, refrigerant molecules form densely packed structures which can further organize into clusters.

3. CAD Model

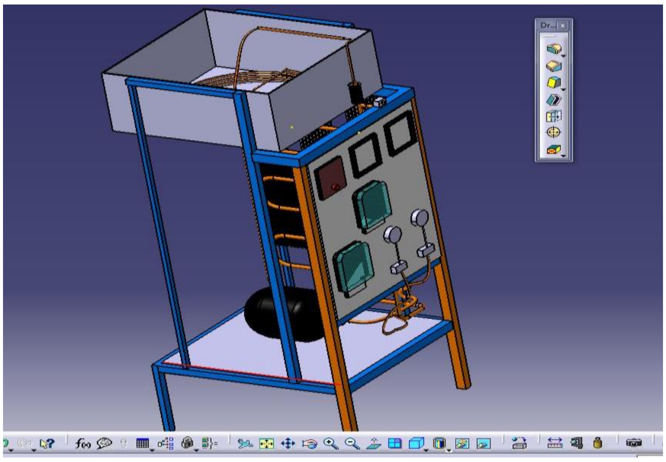


Figure1. CAD Model

The system shown in fig. is space efficient ,affordable and manually operated. This system can be implemented in any commercial building as well as for domestic purpose.

4. Experimental Set-Up and Methodology

The working fluid used was R134a. Drop-in experiments were carried out without any modifications to the experimental apparatus. An experimental setup of a vapour compression refrigeration system was established to investigate the performance of R134a. A schematic diagram of the experimental setup is shown in Fig. 1.

It consists of the main loop. The main loop is composed of a compressor, condenser, low flow glass tube flowmeter, capillary tube valve and evaporator.The compressor is a hermetically sealed reciprocating type of 1/8th TOR capacity. The condenser and evaporator were of both copper single tubes. In the single tube condenser, the refrigerant flows through the innertube while air is outside the tubes. The refrigerant then flows into the evaporator through the capillary tube. The expansion valves are used to control the mass flow rate of the refrigerant into the evaporator coils and also to set the pressure difference. In the single tube evaporator, the refrigerant flow through the inner tube and water is in storage tank outside the tubes. For minimizing the heat loss, the tube is well insulated. Five magnetic pairs with a Gauss level of 450 each were employed in this study and placed in the system on liquid line.

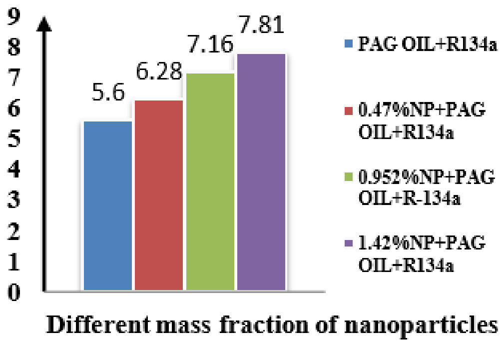
The readings were taken with increasing number of magnetic pairs. Two pressure gauges were placed in the system to note down the compressor inlet and outlet pressure. Temperatures at various points in the system were noted with the help of an six k-type digital thermometer thermocouple sensor. The voltage and the current in the system were measured with the help of calibrated energy meter. six ktype digital thermometer thermocouple sensor 200~1372°c/2501°F s (with an accuracy of ±1.50C and resolution of 0.10C) were used to measure the temperature at different locations in the refrigeration loop (Evaporator inlet and outlet, condenser inlet and outlet, Cooling water and ambient air).Temperatures at various points mentioned in Fig. 3.1 were measured. Power consumed by the compressor was measured by an energy meter. The two calibrated pressure gauges at the compressor inlet and outlet were used to measure the suction and discharge pressure respectively.

Refrigerant is sprayed into the evaporator due to low pressure; it boils rapidly and absorbs heat. The vaporized refrigerant moves back to compressor through the suction line and it compressed to high pressure side as superheated vapour. While through the air cooled condenser it is cooled, gives up heat that absorbed in the evaporator and returns to liquid then flows into liquid receiver ready to repeat the cycle of system. The experimental set up of the VCR system test rig.

5. Result

The temperature is reduced from150c to -130c , -16.30c , -17.40c , -18.50c for the mixture of CuO Nanoparticles and R134a , PAG oil and 0.47% mass fraction of nanoparticles and R134a , PAG oil and 0.952% mass fraction of nanoparticle and R134a , PAG oil and 1.42% mass fraction of nanoparticle an R134a respectively within 9 minutes (540Secs).

5.1 Coefficient Of Performance



6. Conclusion

The COP was initially measured without application of magnetic field, and then magnetic field applied to liquid refrigerant was increased by increasing the number of the magnetic pairs from 1 to 5. The strength of each magnetic pair was 450 gauss. Finally this experimental analysis gives net effect of magnetic field effect and lubrication effect. Only by the impact of magnetic field among all five magnetic pairs, the COP of the system increased up to 40.158% for R134a refrigerant at fourth magnetic pair. And finally by combining these two magnetic effect and lubrication effect, the COP of the system increased up to 24.54% for R134a refrigerant at fourth magnetic pair by the application of magnetic field on liquid line with the 0.025% volumetric addition of copper nano particles to the compressor lubricating oil (PAG46 oil), when compared to simple VCR.

6. References

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