International Journal of Research
Available at https://journals.pen2print.org/index.php/ijr/
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 07
June 2019

Experimental and performance study of Nano refrigerant (R290 + CuO) in vapour compression refrigeration system

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Abstract

system based on Nano refrigerant. The Nano refrigerant is combination of pure hydro-carbon refrigerant and nanoparticles like (R290+CuO). After that the system is run with the help of In this paper , the experimental and performance study of a vapour compression refrigeration Nano refrigerant (Pure refrigerant(R290) + nanoparticles (CuO)) and result is analysed. The results of the experiments indicated that the refrigerator performed better with nanoparticles as compared to pure Hydrocarbon. There is more temperature drop across the condenser for the nanorefrigerant (13.02% – 21.84%) compared to pure R290 hydrocarbon refrigerant. Similarly, a gain in the evaporator temperature (3.28% –5.83%) has been observed. An improvement in COP (5.3% – 14.15%) is also observed during the investigations. A reduction in the power consumption (11.5% - 31.8%) along with faster cooling (from 40 ^oC – 25 ^oC) is also achieved when nanorefrigerant is used. Thus, Cupric oxide (CuO) nanoparticles can be used to improve the performance of a hydrocarbon-based refrigeration system under investigated conditions.

Keywords: CuO nanoparticles, Nano refrigerant hydrocarbon(R290), Coefficient of performance, Power Consumption.

NTRODUCTIONPresently a days interest for the refrigeration and cooling expanded day by day. Industry still as within the homes there would like for the comfort atmosphere for human as well as for man mad product. This can be achieving by the refrigeration and air conditioning. VCR is that the system among all most used for this purpose. In this system, refrigerant is employed because the operating fluid is that the crucial a part of the system. Its operating involves four main processes i.e. compression, condensation, throttling and evaporation. The low pressure and low temperature vapour refrigerant enter into the compressor through inlet valve and discharges to high pressure and high temperature refrigerant. Then it enters into the condenser in which action of refrigerant happens at constant pressure and temperature, wherever it rejects heat to the environment, currently the refrigerant is throttled through accelerator within which refrigerant temperature becomes low and it enters into evaporator through that it absorbs heat and the cycle continues. Hence the vapour compression is considered for refrigeration cycle. A simple vapour compression refrigeration consists of following essential parts:

Compressor: In which the low temperature and pressure vapour refrigerant from the evaporator is drawn into the compressor by suction valve, where it is compressed and high temperature and pressure refrigerant is discharge into the condenser through the discharge valve.

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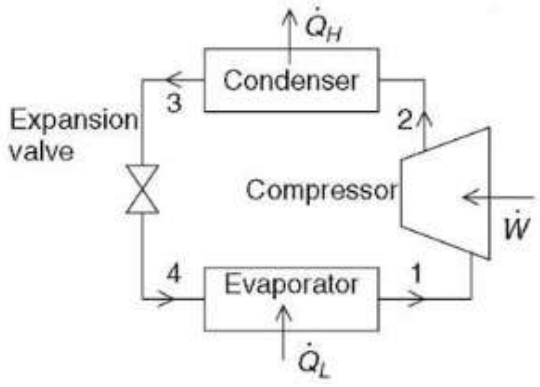
Condenser: In which the high temperature and pressure vapour refrigerant is cooled and condensed by used of normally air and water.

Expansion valve: It is also called the throttle valve. The function of the expansion valve is to allowed the liquid refrigerant under high pressure and temperature passed through the valve after reducing its pressure and temperature.

Evaporator: In which the liquid-vapour refrigerant at low pressure and temperature is evaporated and changed into vapour refrigerant at low pressure and temperature, and discharge into the compressor.

WHAT IS NANO REFRIGERENT?

Nano-refrigerant which is one kind of nanofluids has been introduced as a superior properties refrigerant that increased the heat transfer rate in the refrigeration system. Many types of materials could be used as the nanoparticles to be suspended into the conventional refrigerants.



I. LITERATURE REVIEW

1) D. Sendil Kumar & Dr. R. Elansezhian (2012) investigated on Nano-refrigerant. Nano Al2O3-PAG oil was used as Nano-refrigerant in R134a in VCR system and increased COP upto 3.5

2) M.Abuzar Qureshi (2012) The aim of this project is to comparatively analyze of COP using R134a & R600a Refrigerant in Domestic refrigerator at steady state condition.
In this experimental study Coefficient of performance of R600a was higher range of 40.86%-46.54% than R134a.

3) A.Senthilkumar & R. Praveen (2015) In this paper, CuO - R600a were used as a working fluid of domestic refrigerators. The results indicated that CuO - R600a can work normally and efficiently in refrigerator. Combined with refrigerator using pure R600a as working fluids. 0.1 & 0.5g/L concentrations of CuO - R600a can save 11.83% and 17.88% energy consumption respectively and the freezing velocity of CuO - R600a was more quickly than the pure R600a system.

4) Dr. K.Dilip Kumar (2016) In this work, the Al2O3 nano-oil is proposed as a promising lubricant to enhance the performance of vapour compression refrigerator .The result shows the COP of system were improved by 19.14%

5) Pravesh kumar kushwaha (2016)
Investigations into the performance of Nano-refrigerant (R134a + Al2O3) based refrigeration system. An improvement in COP was also observed during the investigations (1.17% – 9.14%) and reduction in power consumption (4.35% & 14.7%).

6) N Austin (2016) In this paper focuses on the performance comparison and analysis of refrigerants used in domestic compression

refrigeration systems in the premises of steady state.R134a and R600a are the two refrigerants considered for comparison. R600a performance coefficient was found to be in the higher range compared to R134a. It was almost 42.88%-47.56% better than R134a at a constant refrigerant effect of 48W and at a constant evaporating temperature

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7) M.S.Bandgar(2016) The aim of this work is to evaluate the performance of Vapour Compression Refrigeration System using SiO2nano particles mixed with Polyolester (POE) oil / Mineral oil (MO) as Nano lubricant and R-600a as a refrigerant. The result of this paper is the power consumption reduces by 12.02% when POE oil is replaced by a mixture of (MO+ 0.5% Silica). It has been observed that C.O.P. is increased by 11.66% when POE is replaced by a Nano lubricant (mineral oil + 0.5% of SiO2).

8) Balwant Kumar Singh(2017) In the present work, an experimental study is made on the performance of refrigeration system based on (R600a|R290) Nano refrigerant. Here cupric oxide (CuO) nanoparticles of size (20-30) nm has been taken. There is improvement in COP of the system by 3.18%to 11.57 % due to usage of Nano refrigerant. It was observed that energy consumption reduces by 13.5% to 19.7% by using Nano refrigerant of different concentration taken under consideration.

9) J.Melvin Jones(2017) In this paper we choose the nano refrigerant as Tio2, CuO, CNT, Al2O3 and R600a, R134a, R141b are used as a base refrigerants. This paper gives nano refrigerants provided with good results, showing the temperature difference is better, when compared to the mixed refrigerants. The coefficient of performance is one of the important parameters for a refrigerant to obtain good cooling effect.

10) Barathiraja.K, Allen Jeffrey.J (2017) This investigation thermodynamically analyses a vapour compression refrigeration system which compares R134a and R290/R600a refrigerants. In this paper, the experimental analysis of R134a and various ratios of R290/R600a refrigerants have been analysed. The Power consumption of the Hydrocarbon refrigerant R290/R600a has been decreased as compared to the R134a.The coefficient of performance has increases while time increases due to suction of high pressure and temperature increases.

II. EXPERIMENTAL SETUP

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Fig.1 Experimental Setup

Fig.1 shows the experimental setup of vapour compression refrigeration system. It consist of compressor, condenser, expansion device, evaporator, measuring and controlling device. In above figure the experimental setup of pure hydrocarbon refrigerant along with nanoparticle is preformed in vapor compression refrigeration system.

III. EXPERIMENTAL PROCEDURE

In this experiment, the performance of the pure HC refrigerant is compared with the nano refrigerant withinwhich totally different concentrations of CuO nanoparticles are mixed with HC refrigerant in vapour compression refrigeration system.The temperature of the refrigerant at inlet and outlet of each element of the system ought to be measured with thermometer. Similarly, pressure measurement are taken across every component of system with the pressure gauges fitted at the inlet and outlet of the compressor and evaporator. These measurements are necessary to evaluate the performance of the system. The readings of meter and energy meter even be taken to find the power consumption and energy consumption of the system. First of all, the performance is investigated with the pure hydrocarbon refrigerant and then experiment conduct with hydrocarbon + CuO with different concentration of 0.20gm, 0.30gm & 0.40gm.

IV. RESULT AND DISCUSSION

Fig. 2 shows that C.O.P. of pure R290 HC refrigerant is found to be 1.13 whereas C.O.P. of nano refrigerants R290+0.20gm CuO, R290+0.30gm CuO and R290+0.40gm CuO is found to be 1.19, 1.25 and 1.29.It has been observed that C.O.P. of the system increased as increased the concentration of nanoparticles with the pure hydrocarbon.

From fig.3 it has been observed that the power consumption decreases as the nano particles was used with the pure hydrocarbon. As concentration of nano particles increases the power consumption decreases.

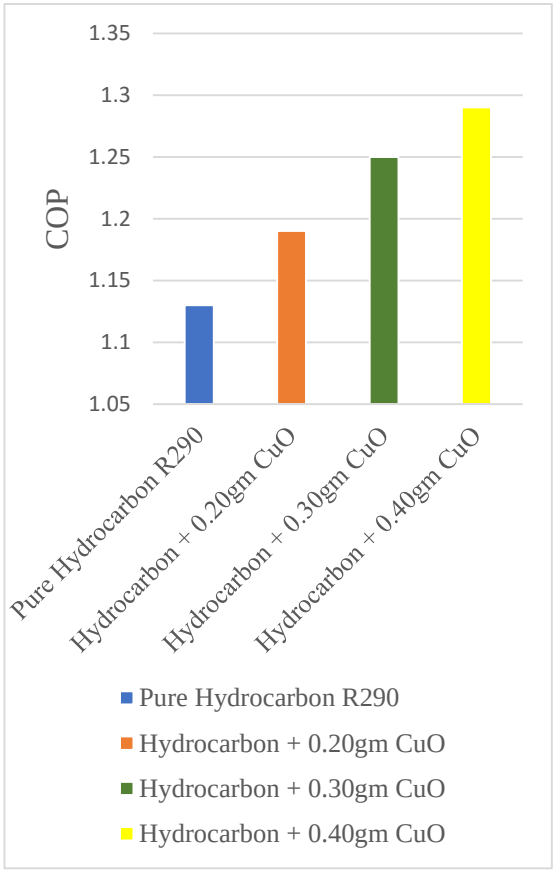

Fig.2 C.O.P. Compression for nano refrigerant

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Refrigerant	C.O.P.	T1 (^{0}C)	T2 (^{0}C)	T3 (^{0}C)	T4 (^{0}C)
Pure R290	1.13	26.52	73.9	48.7	-0.7
R290 + 0.20gm CuO	1.19	27.5	78.3	49.7	-1.1
R290 + 0.30gm CuO	1.25	26.5	76.50	48.2	-1.8
R290 + 0.40gm CuO	1.29	26.40	75	45.90	-2.60

Table.1 : C.O.P., pressure and temperature for R290 refrigerant and nano refrigerants

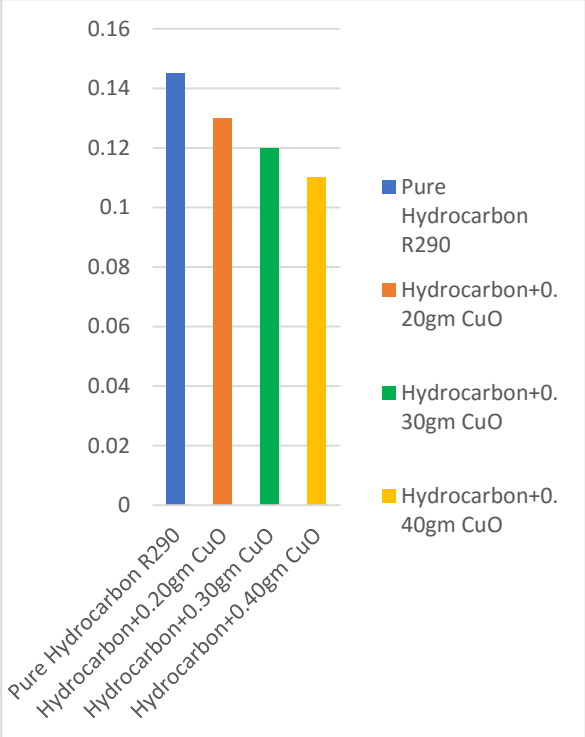

Fig. 3 Power consumption by pure R290 HC refrigerant and nanorefrigerants

V. CONCLUSION

In this paper, the application of nanoparticles in a refrigerator has been studied that increase in heat transfer caused by the suspension of nanoparticles in the working fuid.

There are the following points to be investigated.

1. The experimental studies indicated that refrigeration system doesn't suffer with nano refrigerant and works normal like any conventional refrigeration system.
2. It was initiate that accumulation of CuO nanoparticles to the refrigerant results in enhancement in the thermo physical properties and heat transfer properties of the refrigeration system
3. The C.O.P. of the system increased by (3.684% – 21.05%) with use of hydrocarbon with nanoparticles.
4. A reduction in the power consumption (11.5% to 31.8%) along with temperature drop (from 40^{o}C – 25^{o}C) is also achieved when nano refrigerants are used.

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