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# Performance Enhancement of Vapour Compression Refrigeration System by Using Nanofluid

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**ABSTRACT:** In today's world refrigeration systems play a vital role to fulfill the human needs and a continuous research is being carried out by many researchers in order to improve the performance of these systems. Here, a attempt has been made to improve the performance of the system. Our, present study on experimental investigations into the performance of nanorefrigerant (R134a + CuO) based refrigeration system. Cooling is one of the most important technical challenges faced by many diverse industries, including transportation and manufacturing.

**KEYWORDS:** VCRS, refrigerants, nanoparticles, COP, CuO etc.

### I. INTRODUCTION

In cooling and heating applications, thermo-physical properties of matter play a great role. It has been observed that the performance of any system mainly depends on the thermal conductivity, viscosity, specific heat and density of gases and liquids which are used in system. Conventional fluids have poor heat transfer capacity and low thermal conductivity which limits its performance.. Due to this, there is always a need to develop effective & efficient fluids capable to deal with high heat transfer rate. Small solid additives usually in micrometer are good option to enhance the thermal properties of fluids, but it has been found that these small solid additives poses number of problems like particle sedimentation, particle clogging, large pressure drop in the system. Investigations show that use of nanoparticles in conventional fluids is a good option and it also reduces the number of other problems because at nanometer the material behaves like colloidal solutions. Modern nanotechnology offers us many routes to prepare nanometer sized particles.

Recently some studies have been reported on nanoparticles in refrigeration systems because of its capability to improve heat transfer characteristics, hence efficiency enhancement. Investigated the effect of copper oxide based nano-

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lubricant on the COP of the system and freezing capacity of the system. The experimental set up was build as per Indian standards. There was increase in the COP of the system.

## II. RELATED WORK

- [1] Guo-liang Ding This paper determines the CFD simulation of vapour compression refrigeration system. The different modules of refrigeration system were designed to investigation and the simulation process. The further calculations of the refrigeration characteristics were summarized in detail.
- [2] Hao Peng et al. Refrigeration characteristics were examined by the nano-refrigerant using the nano particles of Cu, Al, Al<sub>2</sub>O<sub>3</sub> and CuO. The nano-particles were used with a average diameter of 20 nm. The R113 and R141b were the refrigerants which were mixed with the nano particles to perform the research work and to get the desire solution. RB68EP was the lubricating oil used in this experiment. The result was the comparison of nano-refrigerant with different concentration of nano particles which depicts that the pool boiling of nano-refrigerant increase by decrease of nanoparticle density.
- [3] V Timofeeva et al. The nano-refrigerants are the new concept in field of refrigeration and air conditioning system and the affect of nano-particles is beneficial to us in terms of increasing thermo-physical properties of the refrigeration and air-conditioning system. The nano-particles were added to refrigerants with the different particle size and mole fraction so that the comparison can be made and the best combination can the depict for the sake of healthy environment.
- [4] R. Kumar et al. There are some common refrigerants are used like R12, R22, R600, R600a and 134a. These were not as efficient as to decrease the power consumption. This was the reason behind the development of nano-refrigerant so that the power consumption can be reduced. In this paper, aluminium oxide nano refrigerant is used with the lubricant to reduce the power consumption.

## III. METHODOLOGY

1. Firstly we will lookout for whole setup & then we will solve compressor problem & other problems.
2. Now for the complete vapour compression cycle we have to add the filter between condenser & expansion valve so filter will work as filtration unit & the nanofluid will not pass ahead the condenser.
3. The fabricated experimental setup was filled with N<sub>2</sub> gas at a pressure of 5 bar to 7 bar and this pressure is maintained for 45 minutes. Thus the system was ensured for no leakages.
4. After solving all the leakage problem we will mix the refrigerant ( R134a ) & copper oxide (CuO).
5. When it mix properly together it should be recharging carefully in vapour compression cycle.
6. As we know by changing atmospheric temperature coefficient of performance also changes.
7. So we have to take reading for 3 different days at 3 different atmospheric temperature.
8. So now we will got the reading for R134a + CuO at 3 different atmospheric temperature. We got 3 different COP , so we will select maximum COP between those 3 readings.
9. Recovery of the refrigerant involves the removal of refrigerant from system & placing that refrigerant into container.
10. Technician need to open or dispose of air conditioning & refrigeration equipment then these recovery process is conducted.
11. So now we have to make the recharging of the system in which fresh refrigerant R134a is added in existing refrigeration or air conditioning system without nanofluids.

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12. So again we have to take reading for 3 different days at 3 different atmospheric temperature.
13. So now we will get the reading for R134a without nanofluid at 3 different atmospheric temperature. We got 3 different COP, so we will select maximum COP between those 3 readings.
14. Compare results with & without nanofluids,

### IV. EXPERIMENTAL RESULTS

The refrigeration test rig works on vapour compression cycle. The refrigeration is accomplished by continuously circulating, evaporating & condensing fixed supply of refrigerant in a closed system. Evaporation occurs at low temperature & low pressure to an area of high temperature. The compressor pumps the low pressure refrigerant from the evaporator, increases its pressure & discharges the high pressure gas to the condenser. In the condenser, the refrigerant rejects its heat to the surrounding by passing air over it. In the condenser at pressure, the refrigerant loses its latent heat & liquefies. Then the refrigerant passes through the drier filter where any residual moisture or foreign particles present are plugged, the flow of refrigerant into the evaporator is controlled by an expansion device where the compressor draws the cold vapour & the cycle repeats.



FIG NO 1 : Experimental Setup

Fig.1 shows the actual setup for vapor compression domestic refrigerator in which R134a refrigerant is used as working fluid along with the nanoparticles. The process of refrigeration occurs in a system which encompasses of a

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compressor, a condenser, expansion device and an evaporator. The VCRS system consists of four main components which are compressor, condenser, expansion device and evaporator. Compressor is used to compress the low temperature and pressure refrigerant from the evaporator to high temperature and pressure. After compression the high temperature and pressure refrigerant is discharged into the condenser through the delivery or discharge valve. The Condenser consists of coils of pipe in which the high temperature and pressure refrigerant is cooled and condensed. The refrigerant, which passing through the condenser, gives up its latent heat to the surrounding condensing medium which is normally air or water. The condensed liquid refrigerant from the condenser is stored in the vessel known as receiver from where it is supplied to evaporator through the expansion valve (i.e. capillary) or refrigerant control valve. The function of the expansion valve is to allow the liquid refrigerant under high temperature and pressure to pass at a controlled rate after reducing its temperature and pressure. Some of the liquid refrigerant evaporates as it passes through the expansion valve, but the greater portion is vaporized in the evaporator at low temperature and pressure.

Next it travels to the evaporator. An Evaporator consists of coils of pipes in which the liquid-vapour refrigerant at low temperature and pressure is evaporated and changed into vapor refrigerant at low pressure and temperature. In evaporating, the liquid vapor refrigerant absorbs its latent heat of vaporization from the medium (water) which is to be cooled. The performance of the water cooler system is to be evaluated by using experimental methods which is carried out by using the specially developed test rig. The test rig can be modified and upgraded if required. The work explains some of the technical modification and evaluation of the refrigeration system under varying load condition. The refrigeration system used to test the concept has a low pressure with single hermetically sealed compressor.

## V. CALCULATIONS

( COP ) theoretical =  $\frac{h_1 - h_4}{h_2 - h_1}$

$h_1$  = Enthalpy at evaporator outlet temperature.

$h_2$  = Enthalpy at condenser inlet temperature.

$h_3 = h_4$  = Enthalpy at condenser outlet temperature.

Standard values & formulae:

1 bar : 14.5 psi

Observation table:

Readings taken with pure refrigerant R134a-

Temperature				pressure		COP
(T1)	(T2)	(T3)	(T4)	P1 (psi)	P2 (psi)	
18	73	50	1	10	208	7.3
18	60	49	3	19	222	7.4
18	70	45	1	19	222	7.5

T1=18

T2=70

T3=45

T4=1

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Suction Pressure = 19 psi = 1.310 bar  
Discharge Pressure = 222 psi = 15.31 bar

From p-h chart for R134a we got the enthalpies as

H1 = 415 H2 = 435

H3 = H4 = 265

$$\text{COP} = \frac{H1 - H4}{H2 - H1}$$

$$= \frac{415 - 265}{435 - 415}$$

$$\text{COP} = \frac{415 - 265}{435 - 415} = 7.5$$

2) Readings taken pure R134a + CuO

Refrigeration temperature				Refrigerant pressure		COP
Aft evap (T1)	Aft Comp (T2)	Aft Cond (T3)	Aft Exp (T4)	Suc P1 (psi)	Dis P2 (psi)	
18	53	38	-7	20	140	11.5
22	52	38	-16	21	140	11.6
18	56	37	-7	16	140	11.71

T1 = 18

T2 = 56

T3 = 37

T4 = -7

Suction pressure = 16 psi = 1.48 bar

Discharge pressure = 140 = 9.62 bar

From p-h chart of R134a we got the enthalpies as

H1 = 416 H2 = 430

H3 = H4 = 252

$$\text{COP} = \frac{H1 - H4}{H2 - H1}$$

$$= \frac{416 - 252}{430 - 416}$$

$$= \frac{416 - 252}{430 - 416}$$

$$\text{COP} = 11.71$$

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## VI. EXPERIMENTAL RESULTS

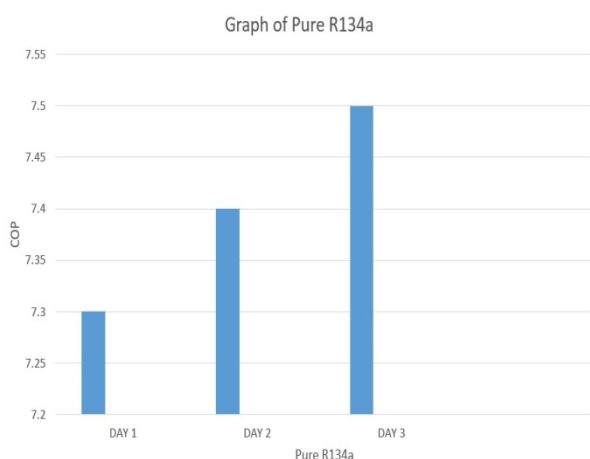


FIG 2 : Pure R134a

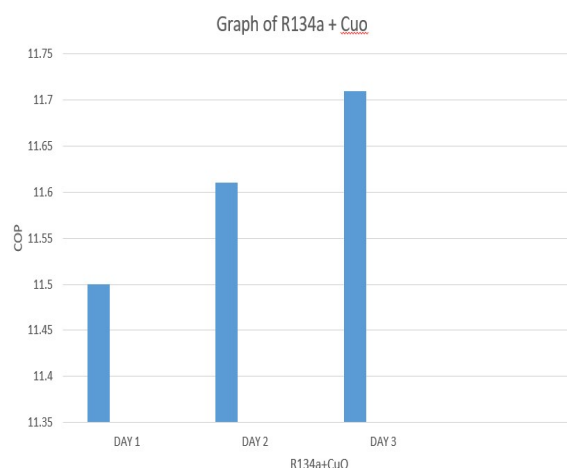


FIG 3 : R134a + CuO

Fig 2 shows the performance of pure R134a without adding nanofluid CuO, We have taken the reading at 3 different days at oarticular time span.as we see that at day 1 the COP of pure R134a has been 7.3. At day 2 ew get the COP as 7.4. At third day we get the coefficient of performance as 7.5 So from this above reading we have taken the maximum reading. We get the maximum reading at day 3 as 7.5.

Fig 3 shows the performance of R134a + CuO. In this we have added the nanofluid copper oxide (CuO). Also in this case we have taken 3 reading at 3 different days. At day 1 we got ther COP as 11.5. At day 2 we got the COP as 11.61.

At third day we got the COP as 11.71 So from above reading we have taken the maximum reading. So at day 3 we got the maximum COP as 11.71.

## VII.CONCLUSION

1. The COP of refrigeration system with nanoparticles as we can see it is more than COP of refrigeration system without nanoparticles.
2. It was found that addition of CuO nanoparticles to the refrigerant results in improvement in the thermo physical properties and heat transfer characteristics of the refrigeration system.
3. The COP of refrigeration system with nanoparticles is increased by 4-5 %.
4. In refrigeration system, it is found that mixing of CuO nanoparticle with pure R134a works normally.

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