# Experimental analysis of the Performance of GWP Halogenated Alkene Refrigerants and their Blends with Domestic Refrigerants to Enhance the Performance of Refrigeration System

Vishal Satankar [1], Manish Bharti [2]

*ME Scholar[1], Prof. [2]*
*Department of Mechanical Engineering[1,2]*
*RNTU Bhopal, India*

**Abstract**

*work an experimental investigation is made for look at the performance of home refrigeration system which acts on (Hydrocarbon+ CuO) Nano refrigerants. To behavior the experiment all required setup is evolved in line with norms of country wide standards of India, and carried out to feature beneath differing situations. After deliberations &dialogue it turned into decided to apply hydrocarbon as principal refrigerant which is exchange desire for R1132a, R1141, R1150, R134a,due to its GWP & ODP dangers, due to extra time in carrier R1132a, R1141, R1150 refrigerant can be used as replacement of R134a for this reason of getting analogous thermo-bodily homes and eco-friendly nature. But, it turned into visible that its capability of warmth switch is bounded and it expend greater electricity at some stage in the refrigeration cycle. Also use of a particular refrigerant impacts the temperature over the device condenser and the evaporator and the time duration to acquire a specific temperature in evaporator or freezing capacity. In consideration of improvement in its overall performance an experimental research work was performed by the use of Nano refrigerant in area of the conventional refrigerant. Nanoparticles are installed collectively with refrigerant R600aimprovement of charge of warmth transfer and for the lessening of electricity usage and in the end an enrichment into the overall performance of the device. Cupric oxide (CuO) nanoparticles having size (20-30nm) were put into movement in this refrigeration unit with 3 variation concentrations (zero.15, 0.25 and zero.35)gm of respective nanoparticles. Here records is believed for a volume go with the flow charge of 3.5LPH and for the 2 warmth flux in evaporator supplied at 25–260C and 35–360C. It became additionally carry to notice that including cupric oxide (CuO) nanoparticles to the base refrigerant advances the thermo-physical houses And heat switch behavior of refrigeration device. Also fall in temperature greater over the condenser for the Nano refrigerant (14.42% – 20.05%) in evaluation to pure R290/R600a hydrocarbon refrigerant. In the same way, upward thrust of evaporator*
*temperature (2.85% –5.48%) has been perceived. An increment in COP (3.18% – 11.57%) is viewed at some stage in the estimation .It was won for the duration of 25–26 C evaporator temperature load conditions. Alike advancements also are zero seen while refrigerator is running at 35–36 C temperature of evaporator. A decrement of the 00 intake of strength (13.5% - 19.7%) together with faster cooling (from 40 C – 25 C) is obtained when check was performed with the aid of using Nano refrigerant. The experimental analysis demonstrates that the homely refrigerating unit works normally functioned by way of Nano refrigerants. Hence, for making improvements to the overall performance of hydrocarbon based refrigeration machine cupric oxide (CuO) nanoparticles may be exercised without amendment in existing structures.*

## 1). INTRODUCTION

Refrigeration systems talk to the different physical components that make up the full refrigeration unit. The special tiers in the refrigeration cycle are exceeded thru in the ones physical structures. These structures encompass an evaporator, a condenser, a compressor and an expansion valve. The evaporator is the space that wishes to be cooled thru the refrigerant; the compressor compresses the refrigerant from the low pressure of the evaporator to the strain at the condenser. The warmth received via the refrigerant is rejected on the condenser and the excessive strain refrigerant is improved into the low pressure evaporator by means of the expansion valve. This is a completely preferred illustration of the severa gadgets in a refrigeration device. The refrigeration systems range in step with the reason and the shape of refrigerant used. They are the method thru which we are capable of absolutely carry out the refrigeration manner.

Refrigeration structures take a look at with the distinct physical components that make up the entire refrigeration unit. The first-rate ranges inside the refrigeration cycle are long gone thru in those physical structures. These structures consist of an evaporator, a condenser, a compressor and an expansion valve. The evaporator is the distance that needs to be cooled by the refrigerant; the compressor compresses the refrigerant rom the low stress of the evaporator to the stress on the condenser. The warmth acquired with the useful resource of the refrigerant is rejected on the condenser and the high strain refrigerant is prolonged into the low strain evaporator by way of the growth valve. This is a completely fashionable instance of the numerous gadgets in a refrigeration gadget. The refrigeration systems range regular with the cause and the kind of refrigerant used.

## 2). Refrigerants

The going for walks agent in a refrigerating device that absorbs contains or releases heatfrom the area to be cooled or refrigerated may be termed as a refrigerant. This warmth switch commonly takes vicinity via a phase exchange of the refrigerant. "Refrigerant is the fluid used for heat switch in a refrigerating system that absorbs heat throughout evaporation from the place of low temperature and strain, and releases warm temperature during condensation at a place of higher temperature and pressure

## 3). LITERATURE REVIEW

**Fatouh M. Et al. (2006)** become made an research on circle of relatives fridge via placing R134awith the hydrocarbon refrigerant over a large place of evaporator temperature (-35 to – 100C) and condenser temperature (40 to 600C) with a couple of ratio of propane in propane/butane/isobutene aggregate of refrigerant. The take a look at indicates that hydrocarbon refrigerant with 60% propane mass percent is simplest and it amends the C.O.P. Over the usage of R134a and moreover decreases strain drop through 11.1% as related to R134a.

**Som chai Wong wises et al. (2005)** Checked the accomplishment of car-purpose air conditioners by using using exchange of HFC-134a box with hydrocarbon refrigerant. They did have a look at on four in assessment to percentage of hydrocarbon series and got that the aggregate propane/butane/isobutene (50%/40%/10%) is the most appropriate collection to trade HFC-134a and having satisfactory fulfillment concerning C.O.P., the sphere ability and art work enter to compressor.

**SomchaiWongwises et al. (2004)** worked at the stance of hydrocarbon refrigerant in exchange of HFC134a subject in a committed field system. Hydrocarbons taken are profane, beaten and isobutene. For taken into consideration device they carried out energy ingesting test (ECT) approach wherein refrigerator section temperature has been look at out at durations of one min for twenty-four hours after that strength consumption is calculated in KWh. In addition to this, they evaluated the compressor paintings and referred to temperature and pressure at wonderful factors. This approach emerge as selected with 3 outstanding refrigerant blends. That is 3 hydrocarbon combinations, hydrocarbon aggregate and hydrocarbon and HFC134a combination. Here a majority of these experiments were finished at 250C atmospheric temperature. After evaluation all three commixture refrigerant with HFC134a refrigerant experimentally the outputs well-knownshows that power consumption reduced thru 0.Sixty nine% as correlated to HFC134a and final effects furthermore famous that propane 60% and butane 40% mixture is the maximum appropriate possibility of HFC134a.

**Hammad M.A. Et al. (1998) t**ested the effectiveness of family refrigerator via taking 4 ratios of propane, butane and isobutene to update R12 refrigerant. Altered proportions of hydrocarbons are 75% propane 19.1% butane five.Nine% isobutene, 50% propane 38.Three% butane eleven.7% isobutene and 25% propane fifty seven.Five% butane 17.Five% a hundred% propane isobutene. The C.O.P And cooling load were calculated on the idea of respective ratios and evaluation of outputs end up finished with R12. The commentary appears that propane one hundred% gives maximum C.O.P. However 50% propane aggregate is the greatest in preference to R12 on the base of COP.

**Jwo Ching Song et al. (2009)** Examined the functioning of home refrigerators with the resource of R-290/R- 600a hydrocarbon refrigerant in vicinity of R134a. In this take a look at they has taken 50% of every of R-290 and R-600a with variant in mass and calculated the consequences in assessment to R134a. They concluded that the R-290/R-600a hydrocarbon refrigerant with 90g mass has greater standard overall performance in comparison to 150g R-134a that is decreased to 40%. It is likewise seen that alternate in fridge temperature is likewise improved with quicker cooling fee in evaluation to R-134a and good deal in power consumption with the aid of four.4%.

**Rasti M. Et al. (2012)** has completed an test on alternative of R134arefrigerant with the R436A (a mixture of fifty six% R290 and 40 4% R600a) in a 238L domestic motive refrigerator. They charged version portions of R436a refrigerant and

measured energy consumption and temperature at exceptional part of the tool. The many graphs were drawn to evaluate the outcomes of R436 with the R134a. It become placed that there has been reduction in charged quantity thru forty eight% with admire to R134a and the evaporator temperature is likewise decreases by way of the use of 330C. Also energy consumption is minimized by manner of using thirteen.6% and Energy Efficiency Index is extended from E to D.

**Joudi et al. (2014)** Investigated the operating of cut up air conditioners with the aid of using the use of 4 each other refrigerants to R22. They has taken break up air conditioner structures of capability 1TR and 2TR in which they evaluated C.O.P., energy intake and condenser heat rejection. Here the compartment air is managed at constant temperature but the atmospheric situation have emerge as modified. After test it turn out to be decided that refrigerant R410 has most electricity consumption and cooling functionality conjointly it moreover has maximum warmth removal from condenser. R290 has the greater COP in contrast to at least one more refrigerants and it's additionally a right choice over R22 on the equal time as R407 has a greatest compression ratio**.**

**Rasti Mehdi et al. (2013)** studied the effect of hydrocarbon refrigerants rather than R134a refrigerant in family fridge. This take a look at turned into made for character investigation via the usage of forms of compressor one is HFC compressor and a few different is HC compressor within the refrigerator. They decided that during evaluation to 105g R134a charged in fridge the R436a and R600a charged 60g and 55g whilst the usage of HFC compressor advanced result is acquired that electricity usage was reduced by using 14% and seven%. On the alternative hand because of use of HC kind compressor the charged quantity of R436a and R600a is to 50g simplest and the consumption of electricity come to be dwindled through 14.6% and 18.7%.

**BiShengshan et al. (2011)** studied the overall performance of home refrigerator via the usage of TiO2- R600a Nano refrigerant with concentrations of nanoparticles. They maximized the efficacy of fridge at 0.1 and zero.Five g/L concentrations of TiO2-R600a and observed that at zero.1 g/L interest the strength intake minimized via 5.Sixty four% and at zero.Five g/L cognizance it reduced via nine.60%. Moreover, the freezing capability of TiO2-R600a is likewise greater as associated with R600a herbal refrigerant**.**

**Subramani N et al. (2011)** research cited that the operation of refrigeration gadget with Nano refrigerant is everyday and affords advanced results. It changed into concluded that the freezing potential enhances and the power consumption curtails via 25% whilst POE oil is took over by way of a combination of mineral oil and alumina nanoparticles. Result also discovered that improvement difficulty in the evaporator is 1.Fifty three even as Nano refrigerants have been taken in location of natural refrigerant.

**Kumar S.D et al. (2012)** Has finished the test on Nano refrigerant through making use of Al2O3- PAGoil in R134a vapor strain refrigeration framework. The framework running turn out to be studied at the ground of power usage test and prevent limit take a look at. It become seen that Al2O3Nano refrigerant acts normally and securely within the refrigeration device. It have come to be examined that functioning of refrigeration device turn out to be finer than herbal lubricant with R134a going for walks fluid, a ten.32% lesser power come to be implemented even as 0.2% amount of the awareness taken inside the gadget. In addition warmth transfer coefficient raiseswith the recognition of nanoparticle Al2O3. Thus, education Al2O3Nano refrigerant in refrigeration device improves the general overall performance of the device.

**Mahbubul I.M. Et al. (2015)** Investigated the thermo-physical houses and their impact on COP. 5% quantity of Al2O3 nanoparticles are blended at temperature of 283-308 K. The outcomes display that the first-class and at ease conductivity of Nano refrigerant Al2O3 advances on enlarging temperature i.E. Eight.12% to 20-8.Fifty eight% for 208K to 308K. The density and viscosity of Nano refrigerant moreover expanded by means of the use of way of thirteen.Sixty eight% and eleven% for the equal temperature increment. The alteration in thermal conductivity, density and viscosity moreover complements the COP thru 15%, 3.2% and 2.6%.

**Mahbubul I.M et al. (2012)** analyzed the volumetric and temperature reaction over viscosity of R123-TiO2Nano refrigerants for 5ºC to 20ºC temperatures up to two % amount congregation of nanoparticles. Moreover impact of stress fall with the increase in viscosity has additionally been studied. Based on the studies it modified into found that viscosity of Nano refrigerant enhances in order to growth of nanoparticle amount concentrations and decreases with the gain in temperature and moreover pressure fall will increase drastically with the amassment of amount concentrations. For this cause it's some distance directed to apply little concentration of nanoparticles for additonal regular ordinary performance.

**BiShengshan et al. (2007)** have investigated with R134a as refrigerant and a combination of mineral oil and TiO2 for lubrication purpose in a domestic refrigeration machine. It changed into proven that the refrigeration gadget with the

above mixture acts on the entire and simply and also the energy usage decreases by using 21.2% as equated with R134a/POE oil tool.

**Kumar R.R et al. (2013)** Have experimented the importance of Al2O3based Nano-lubricant on the COP and freezing ability of the gadget. In this laboratory setup R12, R22, R600, R600a and R134a have been used as a refrigerant. The typical overall performance of the machine lean at the thermo-physical characteristic of the refrigerant and so the adjacent of nanoparticles to the refrigerant outcomes in enrichment within the thermo- physical homes. Even even though there was improvement in the common standard overall performance of the tool. The experimental evaluation demonstrates that the refrigeration framework with Nano refrigerant works commonly and efficaciously at equal taking walks circumstance. The COP of the system improves through way of 19.6 % and it modified into additionally placed that freezing functionality will increase and power intake reduce thru 11.Five % as regarding to polyester**.**

**Jwo C.S et al. (2009)** had taken mineral oil with Al2O3 nanoparticles to growth the lubrication and heat-transfer houses. This take a look at display off that R134a + 0.1 wt % Al2O3 nanoparticles have been highest best for better ordinary overall performance and outcomes in bargain of power consumption about 2.4%. COP became raised with the useful resource of 4.4%.

**Peng H et al. (2011)** Studied the impact of refrigerant-primarily based totally Nano fluids charter and heating mode at the motion of nanoparticles at some stage in pool boiling. The nanoparticles involveCu (everyday measurements of 20, 50 and 80 nm), Al and Al2O3 (regular distances during of 20 nm), and CuO (regular estimated of forty nm) and the refrigerants comprise R113, R141b and n- pentane. The mass a part of ointment RB68EP is from 0 to ten wt%, the warmth motion is from (10 to 100) kW/m2 and the starting off fluid-diploma height became from 1.3 to 3.Four cm. The outcomes decided out that a migration percent of nanoparticles over the pool boiling of refrigerant-based totally completely Nano fluid rises with the lessening of nanoparticle density, nanoparticles diploma, dynamic thickness of refrigerant, mass a part of lubricant or heat transition; while complements with the expansion of fluid diploma thickness of refrigerant or establishing liquid-diploma top.

**Hafez E.A et al. (2011)** have takenCuO-R134a within the vapor strain framework and evaporating warmth transfer coefficient changed into experimentally evaluated. Readings had been taken for decent transition ran from 10 to forty kW/m2, tilizing CuO nanoparticles of period 15 to 70 nm with numerous concentrations (zero, 0.1, zero.2, 0.Three, zero.4, zero.5, zero.55, zero.6, 0.Eight and 1%). There is set 0.Fifty 5% boom in warmness switch coefficient below analyzed interest range and after that reduces for ultimate values of heat flux. However the heat switch coefficient rises up to particle length of 25mm then it lessen with the boost in particle length.

**Mahbubul I.M. Et al. (2013)** studied the volumetric consequences on thermal conductivity, density and viscosity of Nano refrigerant Al2O3-R141b. The analyses had been finished for wonderful temperature degrees. The exploratory outcomes show off that warmth conductivity increments with the quantity fixations and temperature. The viscosity and density additionally will increase with the quantity awareness but lower with the growth in temperature. Therefore an maximum suitable volume attention can enhance the performance of the machine**.**

**Tashtoush B et al. (2001)** Investigated the impact of changing of R12 with the combination refrigerant of propane/butane/R134a in home refrigeration device. The research had been performed in a internet site of evaporator load from 100W to 350W. The fridge with this blended refrigerant can feature frequently and without problems without any trade in mineral oil and condenser. The test displaying that COP of blends refrigerant at 100W evaporator load is five.Four% decrease and 0.Eight% lesser at 350W evaporator load. But the volumetric performance of mixed refrigerant is greater than R12 and combined refrigerant can even increase the lubrication property and miscibility of lubricant.

**Mohanraj M. (2013)** studied the power consummation of family fridge through converting R134a refrigerant with the R430a. The experimentation were made for 3 altered condensing temperature forty, 50 and 600C, the evaporator temperature additionally stages from -300C to 00C. They decided that COP of the fridge with R430a is extra than R134a by way of the usage of 2.6%, four.3 % and 7.Five% at condensing temperatures of 40, 50 and 600C. The strength consumption come to be also decreased with the aid of the usage of manner of 1–7.7%, 1.2–eight.2%, and multiple.Five–9.Eight% at condensation temperatures forty, 50 and 600C. Even although it is also take a look at that discharge temperature of compressor is in reality more with R430a refrigerant which disturb the compressor interest**.**

**A.Senthikumar, R.Praveen (2015)** experimentally investigated reliability and average performance of nano refrigerant (CuO –R600a) inside the home fridge.The results display that combination of (CuO- R600a) works within the normal manner. It is likewise discovered that cooling capacity of refrigerator is extended by using 10-20% & power intake reduced with the aid of way of 11.Eighty three to 17.88% respectively.

**Lingnan Lin (2016)** experimentally inquired the impacts of vital molecule measure, crucial molecule recognition and temperature on molecule conglomeration behavior in Nano refrigerant-oil mixture. The nanoparticles, refrigerant and greasing up oil for assessments were TiO2, R141b, and ATMOS NM56 respectively.

## 4). EXPERIMENTAL SETUP AND METHODOLOGY

### 4.1 Experimental Setup

In this portion a entire explanation of the factors utilized in experimentation of a circle of relatives refrigerator along with their walking is furnished. Here, we moreover deliberated approximately approach of charging and evacuation of Nano debris inside the device.

**Figure 3.1 - Experimental Setup.**

The test setup is positioned in a constant room temperature where proper insulation is maintained. The test equipment is made in the reference to domestic refrigerator. The variation in atmospheric temperature is acquired to be ±2%. An evaporator of the system is immersed in 10 litres of water and managed at fixed temperatures (25-260C) and (35-360C). All readings were noted at constant volume flow rate at 3.5 LPH. Initially all data is noted for pure hydrocarbon refrigerant and then nanoparticles are inserted having three different weights 0.15gm, 0.25gm and 0.35gm. The charged mass of the gas is 45gm. Assessment was conducted with nanoparticles of size20-30 nm. Tests are accomplished to evaluate C.O.P., power utilization, time taken for temperature fall from 400C to 250C, temperature fall in condenser, temperature rise in evaporator and temperature at all respective points. The temperature at entrance and exit of every elements is rated with the mercury thermometer which was as of now graded with approved fluid.

Foremost system is evacuated to take out moisture as mist might also brought with refrigerant and modify the thermo-physical properties. Because it could harm valves and compressor valves by means of growing an excessive amount of corrosive compound which causes pitting at the outside of the aspect. Chocking of the expansion valve is some other trouble, which reasons irregular growth go with the flow. Hence for doing away with the moisture, machine is evacuated with external air compressor. After that evacuated gadget is charged with hydrocarbon refrigerant (45 gm) by using manner of charging line. Now the machine is switched on till it attain in steady state situation. It nearly completed after one hours and twenty 5 mins. When machine is in balanced circumstance temperature and pressure analyzing at compressor access and outlet, condenser go out and after expansion were taken inside interval of 15 mins. The atmospheric temperature is likewise noted down. At the start and at the end of test readings of power-meter and heater is also mentioned. Similar process is applied for nanorefrigerant HC+CuO (20-30 nm) for zero.15 gm, 0.25 gm and zero.35 gm mass of CuO. Now most of these referred to readings are accounted to discover COP, temperature drop in condenser, temperature gain.

## 5). RESULT AND DISCUSSION

**Table 5.1: C.O.P., pressure and temperature for R290/R600a refrigerant and nanorefrigerants**

| Refrigerant | Evaporator Temperature load at (25-26$^0$C) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C.O.P. | P1 (kg/ $cm^2$) | P2 (kg/ $c^2$) | P3 (kg/ $cm^2$) | P4 (kg/ $c^2$) | T1 $^0$ ( C) | T2 $^0$ ( C ) | T3 $^0$ ( C) | T4 $^0$ ( C) | $T_{atm}$ |
| Pure R290/R600a | 1.18 | 20.37 | 249.45 | 239.30 | 27.28 | 26.61 | 73.95 | 49.81 | -0.76 | 29.32 |
| R290/R600a +0.15gm CuO | 1.20 | 20.22 | 260.20 | 246.22 | 26.75 | 27 | 78.36 | 50.74 | -1.15 | 30.35 |
| R290/R600a + 0.25gm CuO | 1.21 | 19.96 | 257.10 | 242.38 | 26.27 | 26.62 | 76.81 | 48.52 | -1.76 | 30.10 |
| R290/R600a + 0.35gm CuO | 1.24 | 19.73 | 254.20 | 238.60 | 25.80 | 26.37 | 75.26 | 46.28 | -2.5 | 29.65 |

**Table 5.2- C.O.P., pressure and temperature of pure R290/R600a and Nano refrigerant**

| Refrigerant | Evaporator Temperature load at (35-36$^0$ C) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C.O.P. | P1 (kg/ $c^2$) | P2 (kg/ $c^2$) | P3 (kg/ $cm^2$) | P4 (kg/ $c^2$) | T1 ( $^0$C ) | T2 ( $^0$C ) | T3 ( $^0$C ) | T4 $^0$ ( C) | $T_{atm}$ |
| Pure R290/R600a | 1.90 | 20.37 | 244.75 | 234.13 | 26.68 | 34.18 | 81.95 | 49.15 | -1.0 | 28.25 |
| R290/R600a +0.15gm CuO | 1.96 | 20.37 | 256.91 | 246.94 | 26.36 | 34 | 84.64 | 47.81 | -1.26 | 29.70 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| R290/R600a +0.25gm CuO | 2.12 | 20.68 | 258.63 | 248.31 | 27.3 | 34.56 | 85.47 | 47.57 | -2.13 | 30 |
| R290/R600a +0.35gm CuO | 2.32 | 21.1 | 260.33 | 249.69 | 28.23 | 35.12 | 86.34 | 47.35 | -3 | 30.33 |

### 5.1 TEMPERATURE DROP IN CONDENSER FOR GWP R1132a

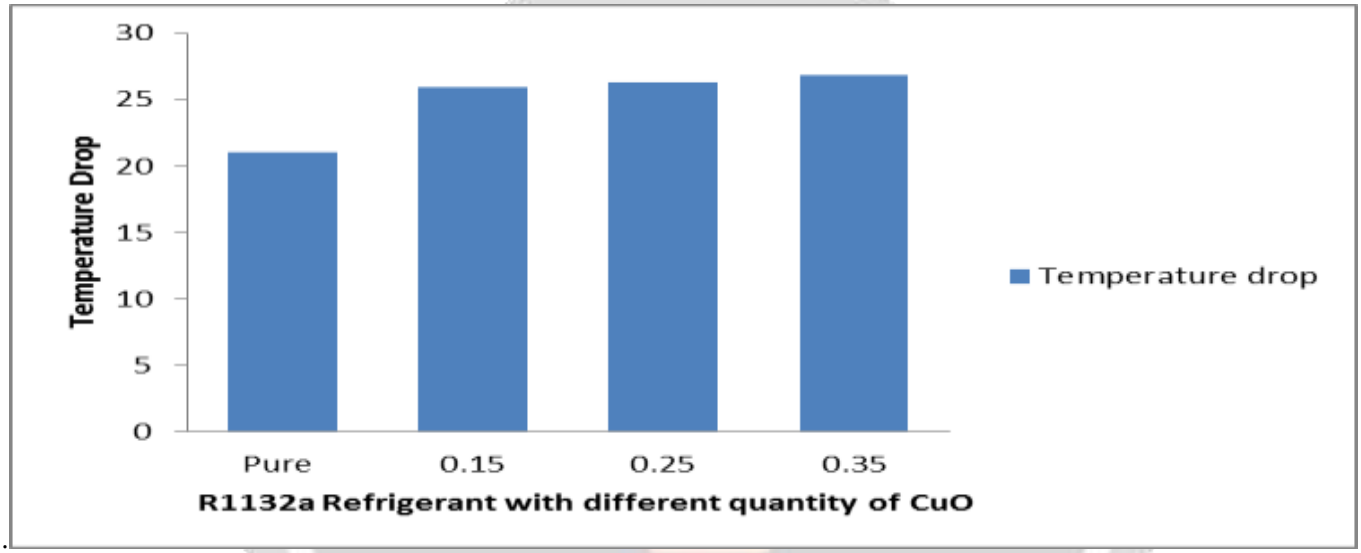


Figure: 7.1 Temperature drop in condenser for nanorefrigerant evaportor heat flux 25-26$^0$.

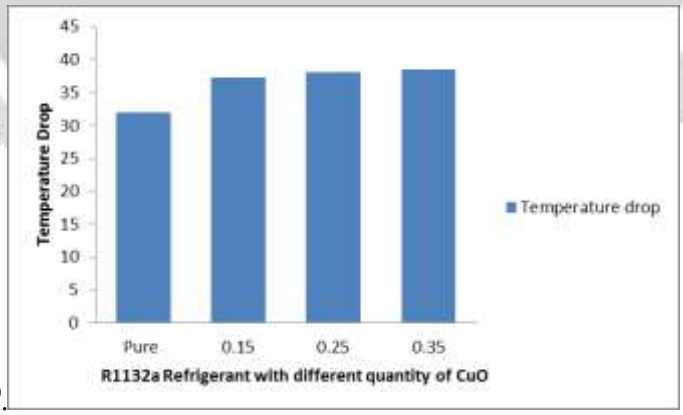


***Figure**: 7.2 Temperature drop in condenser for nanorefrigerant evaportor heat flux 35-36$^0$*

**R1141**

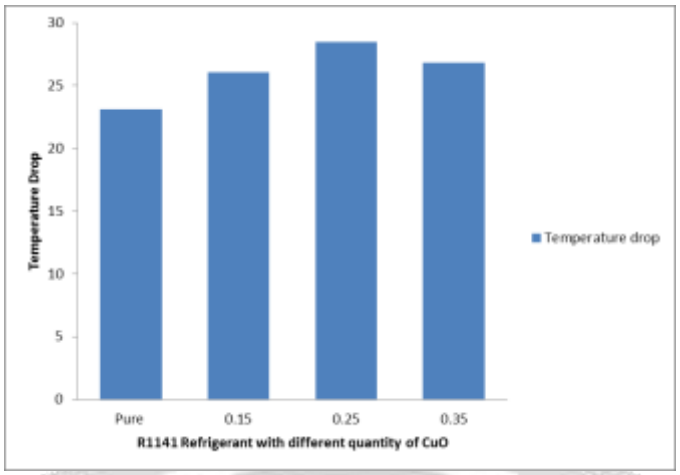


Figure: 7.3 Temperature drop in condenser for nanorefrigerant evaportor heat flux 25-26$^0$.

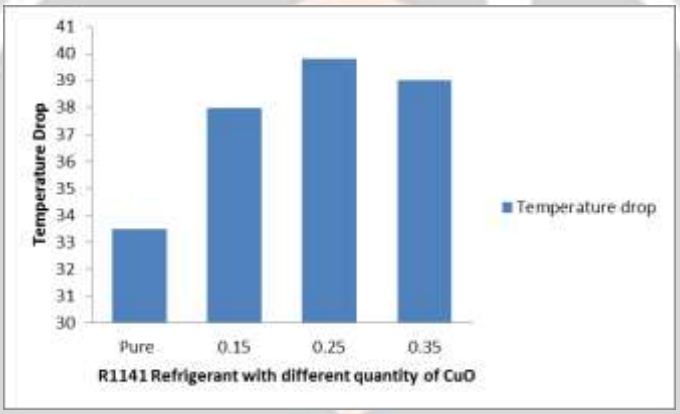


***Figure**: 7.4 Temperature drop in condenser for nanorefrigerant evaportor heat flux 35-36$^0$.*

**R1150**

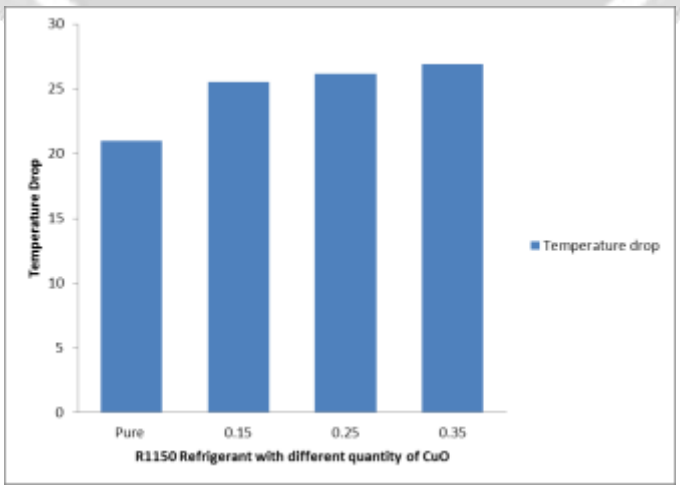


*Figure: 7.5 Temperature drop in condenser for nanorefrigerant evaportor heat flux 25-26$^0$*

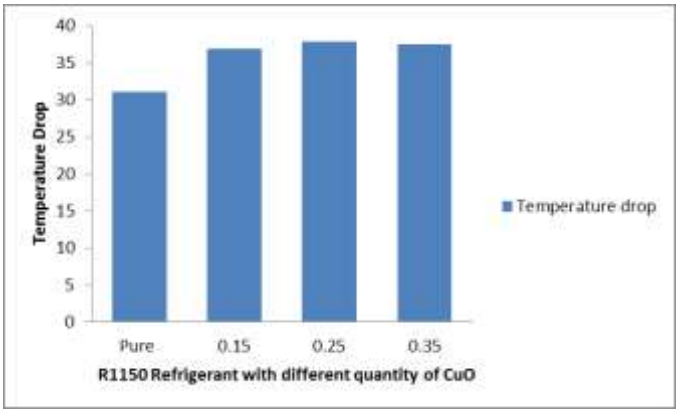


*Figure: 7.6 Temperature drop in condenser for nanorefrigerant evaportor heat flux 35-36$^0$*

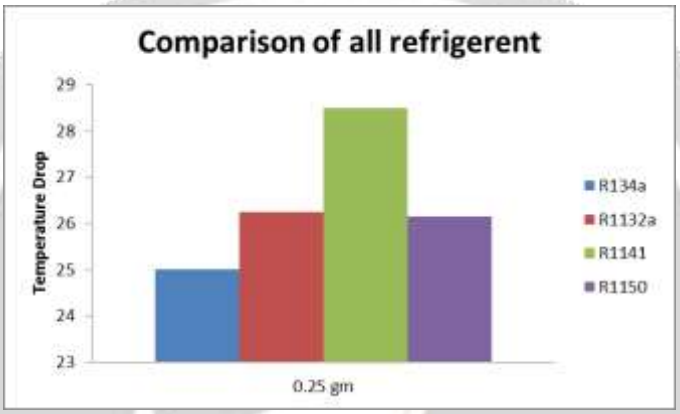


Figure: 7.7 Comparision of Temperature drop with all refrigerent heat flux 25-26$^0$

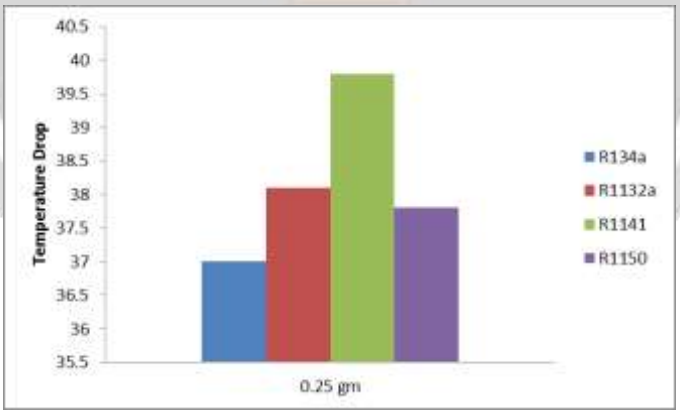


Figure : 7.8 Comparision of Temperature drop with all refrigerent heat flux 35-36$^0$

## 6). CONCLUSION

(i) The system was charged with Nano refrigerant R1132a, R1141, R1150+CuO 0.15gm mass, 0.25gm mass and 0.35 gm mass of nanoparticles.

(ii) Readings were gathered at 3.5LPH volume flow rate and for two heat fluxes in evaporator at temperature 25–260C and 35–360C.

(iii) Temperature raise in evaporator, temperature drop in condenser, Coefficient of performance (C.O.P) of the system and temperature-time chart were studied for pure refrigerant and Nano refrigerant at all volumetric concentrations being used.

(iv) It was pointed out that adding of CuO nanoparticles to the refrigerant results in preferment in the thermo-physical features and heat transfer abilities of the refrigeration unit.

(v) This was examined that there is more temperature drop over the condenser for the nano refrigerant (14.42% – 20.05%) in equivalence to pure R1141. In similar way, a gain of (2.85%- 5.48%) was found for evaporator temperature. An enhancement in coefficient of performance was also obtained during the investigation (3.18% – 11.57%). It was attained for constant evaporator load at 25-260C.
(vi) Similar outcome were also noticed when refrigerator is worked at heat load 35–360C
evaporator temperature. A decrement in consumption of power (13.5% to 19.7%) along with temperature drop (from 400C – 250C) is also acquired when nanorefrigerants are used.
(vii) The experimental interpretation signify that refrigerator works satisfactory with Nano refrigerant without adjustment in factual system.
(viii) Refrigerating effect enhances with the raise in concentration (0.15gm to 0.35gm) of nanoparticles in refrigerant.

## Future Scope

(i) A different combination of nanorefrigeran twith changed concentrations may be used.

(ii) There are many refrigerants other than hydrocarbon are available which may be used to check the execution of the framework.

(iii) By using highly precise and accurate temperature and pressure and other measuring devices for better results.

(iv) Other factors which can be varied for performance evaluation is different rate of flow, different evaporator loads, at different environmental conditions for different amount of refrigerant.

(v) System can also be made to work with nanoparticles in different combination of lubricant oil.

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