EXPERIMENTAL INVESTIGATION AND MATHEMATICAL MODELING OF THRMO-PHYSICAL PROPERTIES OF R134a AND ITS MIXTURE WITH OTHER REFRIGERANTS

Dissertaion-2

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By

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CERTIFICATE

I hereby certify that the work being presented in the dissertation entitled ***" Experimental Investigation and Mathematical Modeling of R134a and its Mixture with other Refrigerants"*** in partial fulfillment of the requirement of the award of the Degree of Master of Technology and submitted to the Department of Mechanical Engineering of Lovely Professional University, Phagwara, is an authentic record of my own work carried out under the supervision of Mr. Vijay Shankar, Assistant Professor, Department of Mechanical Engineering, Lovely Professional University. The matter embodied in this dissertation has not been submitted in part or full to any other University or Institute for the award of any degree.

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This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

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ABSTRACT

Vapour Compression Refrigeration system basically is the device which absorbs heat from a lower body temperature and rejects it to the body or environment at higher temperature at the expense of some external work done on it. It is widely used everywhere ranging from commercial use in homes and shops to large scale and heavy cooling loads in industries. They vary in size and capacity as per their cooling requirements. In order to achieve high cooling loads with lesser energy or power consumption by the compressor and work with high performance It has always been the area of interest for plethora of researchers working in thermal engineering field.

With the advent of mixed refrigerant in every science and technology field, the field of Refrigeration is also now not left untouched of it. It been seen that some of the liquids and its compounds have high heat dissipation capacity, this formed the basis of its use in refrigeration. Many of the refrigerants have been tested with many of the refrigerants and optimum concentrations have been found to ensure the enhanced Coefficient of performance of the VCRS.

In this work also a unique combination is taken and study is to be performed on VCRS. Here the mixed refrigerants like propane and butane done with refrigerant R134a and the attempt of finding the optimum concentrations is to be done.

CHAPTER 1

INTRODUCTION

Now a days in the process of refrigeration refrigerants play a very important role refrigerant is a type of fluid in which heat transfer will takes place while refrigerant is going in the process. We know the following process will take in the refrigeration

1)Compression

2)Condensation

3)Expansion

4)Evaporation

Compression process takes in the compressor in which the refrigerant get compressed and gets heated and converted to high pressure vapour

Condensation is a process in which heat is rejected and vapour gets converted into liqid

In the expansion process the liquid gets highly cooled and sent to evaporator

In the evaporator the heat is recived from the object and get converted to vapour in this way refregeration process takes place

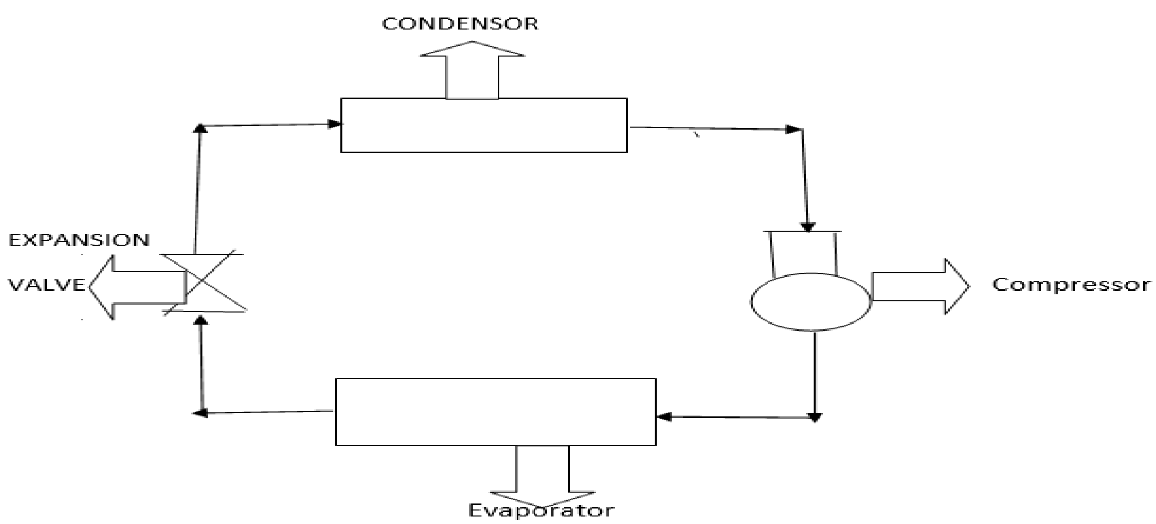

Figure 1 Schematic Diagram of Domestic Refrigerator

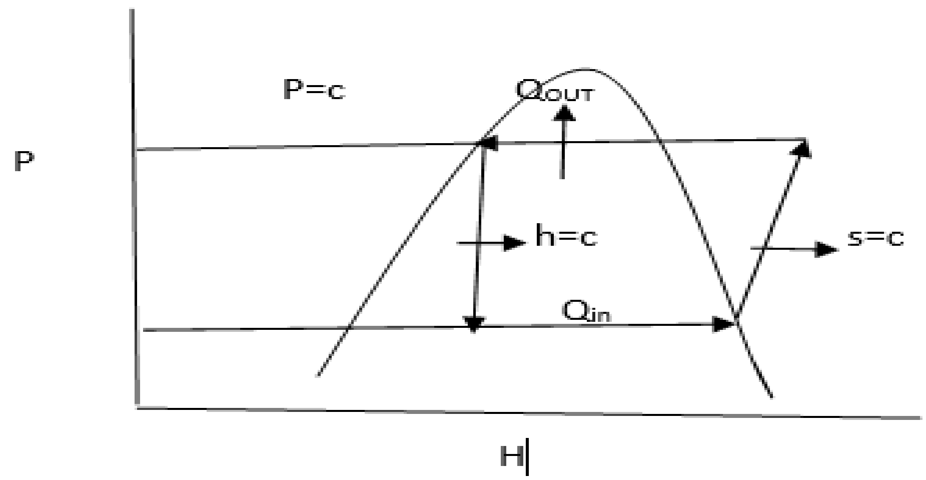

Figure 2 : P-h Plot of VCRS

In earlier days nature of ice and mixed ice and salts are used in the refrigeration process as the refrigerants. Later on many refrigerants come into existence like ether ammonia, methyl chloride, Sulphur dioxide, carbon dioxide. As those refrigerants come into existence still a lot of research is going on the field of refrigerants because the earlier refrigerant material gets discarded because of many factors and safety measures like chemical properties and physical properties.

PROPERTIES FOR DESIRABLE REFRIGERANT

- Low boiling point & freezing point
- High critical pressure & temperature
- Availability should be easy
- Nonflammable & non toxic
- High thermal conductivity
- Non corrosive material
- Non toxic
- Lower price
- Eco friendly

Mixed refrigerants are used to get the cooling effect in less time when compared with the refrigeration system used with single refrigerant. Recent studies on refrigeration systems, with regard to the search for more efficient systems, have concentrated their efforts mainly in two specific areas namely, the development of new technologies using alternative cycles to obtain a better performance and the use of new refrigerants, pure or mixtures without compromising on the energy efficiency and environmental balance [1]. The block diagram of the domestic refrigeration with the Data Acquisition System is shown in Figure 1. Figure 2 shows the schematic diagram of VCR system. The pressure-enthalpy diagram for the different process are shown in Figure 3. Many researches carried out experiments to increase the COP, reduce the power consumption, decrease the ozone depletion potential (ODP) and global warming potential (GDP).

<u>Some of the chemical and physical properties of refrigerants are to be considered</u>

Chemical properties to be considered

1) Flammability: We know hydrocarbons like ethane, propane are highly explosive. Ammonia is also explosive. Hydrocarbons are not explosive and flammable
2) Solubility: The refrigerant which are used should be highly soluble in nature and also should be less corrosive
3) Miscibility: The capability of mixing refrigerant with oil is known as miscibility. The Freon group is highly miscible in nature while ammonia ,methyl chloride are less miscible
4) Toxicity: the toxicity of refrigerants should be less in order to have less ozone layer depletion and global worming potential

Physical properties to be considered

1) Stability & inertness: An ideal refrigerant should have high stability like it should not melt at any temperature and it should be highly inert in nature
2) Corrosive property: the corrosive nature of a refrigerant should be as low as possible
3) Viscosity: viscosity should be low in order to have a free flow

4) Thermal conductivity: the refrigerant should have high thermal conductivity in order to absorb or extract heat

1.1 REFRIGERANT R-134a

R134a formally known as Tetra flouro ethane (CF_3CH_2F) from the group of HFC refrigerant. It is known that the harm full causes of CFCs and HCFCs to the ozone layer depletion, the HFC group of refrigerant has used as their replacement.

It is now a days used as a substitute for R-12 CFC refrigerant in the field of centrifugal, rotary screw, reciprocating compressors. It is safe to handle normally as it is non-flammable, non-toxic and non-corrosive.

It is also used in the air conditioning system in new automotive vehicles. The manufacturing unit it is used for plastic foam blowing. Pharmaceutical unit uses like a propellant.

Table 1: PropertiesofRefrigerantR134a

No	Properties	R-134a
1	Boiling point	-14.9°F or -26.1°C
2	Auto ignition temperature	1418°F or 770°C
3	Ozone depletion potential	0
4	Solubility In Water	0.11% by weight at 77°F or 25°C
5	Critical Temperature	252°F or 122°C
6	Cylinder color code	Light Blue
7	Global Warming potential(GWP)	1200

Table 2Physical, Safety and Environmental Properties Refrigerant R134a

Sl. No.	**Refrigerant**	**R134a**
1.	Chemical Formula	CH_2FCF_3
2.	Molecular Mass	102.03
3.	Critical Temperature (0 F)	214.00
4.	Critical Pressure	589.00
5.	Normal Boiling Point (0 F)	-15.00
6.	Lubricant	POE/PAG
7.	Stability	Stable
8.	OSHA Permissible Exposure Limit	1000
9.	Lower Flammability (% Volume in Air)	None
10.	Heat of Combustion (Btu/lbm)	1806
11.	Safety Group	A1
12.	Auto Ignition Temperature (0 F)	1418
13.	Atmospheric Life (yr.)	14
14.	Ozone Depletion Potential	0
15.	Global Warming Potential (100 yr.)	1300

Table 3Physical, Safety and Environmental Properties Refrigerant R134a

Physical Properties for Propane

Table 4Properties.

Formula	**C3H8**
Molecular Weight (lb/mol)	**44.10**
Critical Temp. (°F)	**206.6**
Critical Pressure (psia)	**617.6**
Boiling Point (°F)	**-43.7**
Melting Point (°F)	**-305.8**

Comparison of R134a and propane

Table 5: Comparison of R134a and propane

Properties	R134a	Propane
FORMULA	CH_2FCF_3	$C_3 H_8$
Melting point	-103.3 °C	-305.80F
BOILING POINT	-26.1°C	-43.70F
CRITICAL TEMP	214.00	206.6
CRITICAL PRESSURE	589.00 psia	617.6 psia

Comparison of HC, CFC, HFC

Table 6:Comparison of HC, CFC, HFC

Product			R134a
Chemical type	HC	CFC	HFC
Composition	Azeotropic mixture	Pure	Pure
Ozone depletion potential	0	0.9	0
Global warming potential	3	10600	1600
Normal boiling point	-31^0c	-30^0c	-26^0c
Latent heat	367 kJ/kg	145 kJ/kg	189 kJ/kg

CHAPTER 2

OBJECTIVES AND SCOPE OF THE PRESENT STUDY

Several experiments have been undertaken to solve the problem of Ozone layer & Global Warming depletion due to the presence of chlorine atoms.so with the help of other refrigerants in the domestic refrigeration system it is felt that a detailed investigation on other refrigerant and mixing of two mixed refrigerants(R134a &propane) and studying the different properties and efficiency to have better outcomes. So some of the objectives of the research work contains some of the following

1.2 Objectives of Experiment

The main objective of this is to analyze the performance of Experimental Vapour Compression Refrigeration System by introducing the mixture of refrigerant R134 & propane in various proportions into the system.

1.3 Experimental Scopes

If everything goes as per the expectation then, after the completion of this research the scope of this work can be seen in various fields wherever the requirement of refrigeration is there, since the heat dissipation rate would definitely increase which at the end will result in optimum refrigeration.

Some of the industries where it can be applied are as follows:

- Food Processing Industry
- Materials and Chemical Industry
- In Power Plants especially in Nuclear Power Plants where high cooling is required in reactors and cooling towers.
- Oil and Gas Industry

- In Automobile Industries for checking its use in automobile's engine cooling In Non-Traditional Machining Environment like refrigeration requirement in Laser Machining since high temperature generates during the machining

- In Cold Storage Plants

- In Automobile Industries for checking its use in automobile's engine cooling

CHAPTER-3

LITERATURE REVIEW

Main et al [1] **2007:**The replacement for R12 and R134a and comparison with a drop in mixed refrigeration system with R290/R600a VCRs system experimental study was carried by Main et al. The evacuation of refrigerants has been carried out after their charging. At lower evaporation temperature below -5 degrees it was found that R290/R600a had higher refrigeration than R12 and R134a by almost 25% on average. At higher temperatures (evaporating) it was observed that the COP of the refrigerant increased from R12 and R134a for all operating conditions. So finally R290 R134a has higher refrigeration capacity.

Zeechin [2] **2008:** Temperature Glides (difference in properties of blends) are formed from binary blends. These are very much useful and have much capacity than the individual refrigerants.

Austin et al [3] **2009:** Experiments were conducted by Austin et al on temperature on COP and comparing the refrigeration effect. The refrigerants are 110g of R134 and mixed refrigerants (17.2% isobutane of 80g, 56.4% butane 24.4% propane). The results are such that consumption was reduced by mixed refrigerants as compared to R134a and COP of mixed system was higher by 10.8%. Therefore mixed refrigerants show the future.

Eckels et al [4] **2010:** The HCF's cannot be used in high attaining temperatures due to high flammability property. The HFC's are good refrigerants to mix with HC's to attain blends to give higher COP and less pollution.

Jwo [5] **2010 :**Replaced hydrocarbon refrigerant R290/R600a mixture with 150g of R134a refrigerant with modifications in rig. In experiment temperature was measured in 14 points with sensor.

The hydrocarbon mixture showed double refrigeration effect with total conserving energy

Jose Vicente d' Angeloa et al [6] **2011:** the comparison between R-290 and R-600a was carried by Jose Vicente d' Angeloa et al on vapor injection refrigeration system. The best results were obtained between 40-50 % R-290 and expansion ratio of 50%.

Investigation on energy and exergy analysis of zeotropic mixture R290 and R600a .Study on effect of evaporating temperature, condensation temperature had been conducted. The mathematical model of the system with phase separator has been developed for theoretical analysis. [7]

Dobson and Chato [8] **2012:** the refrigerants R22, R134a, R410a, R32/R125 report data was taken by Dobson and Chato inside diameters ranging from 3.14 to 7.04mm. The flow regimes and developed criteria and two correlation have been found. Fluid thermos physical properties have become absolute since and new ones are available.

Ebisu and Torokoshi and Eckels[9**] 2012:** the Refrigerants R22, R407C,R410A in tubes were reported by Ebisu and Torokoshi and Eckels and Tesene in a 8mm inner diameter tube showing agreement with predictions from Haraguchi et al. Comparing experimental data with predictions.

Haraguchi et al.[10] **2014:** Dobson and Chato developed model by two additional computational models but the model which covers both shear and gravity controlled condensation phenomena is developed by Haraguchi et al.

Kosky [11] **2014:** thick condensate layer flows in the tube leaving a thin liquid film in the upper part of the tube. Aster and Kosky suggested Nusselt Theory for analyzing the heat transfer.

Tang [12**] 2009:** with refrigerants R22, R14A, R410a considering inside a tube with dia 8.8mm reports quasi local data. Also developed a new correlation valid in reduced pressure and greater mass velocities and in the flow regime.

Traviss et al [13]**2006:** the two phase flow pattern will be dominated by gravity forces. Annual flow pattern is linked up with wavy and slog flows appear .There will be a thin uniform condensate fil inside fully developed annual flow pattern. Several heat transfer models in annual flow pattern have been developed by Cavallini Zeechin Shah and Tang and theoretical analysis by Traviss et al Cand staub and kosky.

Avallini[14] **2015:**The comparison between Cavillini et al against present authors shows that some data fall behind the range given for predictions This phenomena happens with HFC refrigerants such as R125, R410A mainly. Cavallini and Zeechin equations and Haraguchi et al model and predictions by the Dobson and Chato are unsatisfactory Shah model has been quite useful and better results are by the Shah model .Even better results are obtained by Tang equation with limited applications within validity range

Exergy and Energy analysis of multi evaporators at different temperatures in vapor compression refrigeration system is been done in terms of performance parameter for thirteen different refrigerants, R507a, R125, R134a, R290, R600, R600a, R410a, R407c, R404a and R152a refrigerants. He used these refrigerants in primary circuit and TiO2 nanoparticle mixed R718 in secondary circuit. For both the systems the numerical computations had been carried out. Results for these many refrigerants for the same nanoparticles gives the good understanding of its usage and its feasibility. Results shows that R152a on using as primary refrigerant gives the best performance and R410a gave the worst.

Also in terms of COP system TiO2 nanoparticle mixed R718 with gave out the better performance as compared to system with R410

CHAPTER 4

RESEARCH METHODOLOGY

4.1Introduction to Methodology

The methodology adopted to perform any experiment can be many and the results procured from that could also vary to a scale. This topic could also be performed by using different methodologies. Any experiment can generally imply these following methodologies to perform the tests and to get the result.

4.1.1 Constructing the Experimental setup

For performing the different tests in an experiment, methodology could be adopted. An experimental setup could be constructed as per the requirements for performing the same. The testing is then done in it and results are obtained. Here, for this topic also same approach or more appropriately similar methodology is adopted. Firstly, the setup of VCRS is constructed and then the mixed refrigerant testing is done to procure the result in the form of COP by doing energy tests.

4.1.2 Working or Experimenting on a commercial Model

The same tests could also be performed on a commercial model as well which is used by the world. This methodology is also used by various researchers to watch or observe the direct implication of the experiment and to check its feasibility for the future. This topic had also been performed using the same methodology earlier.

4.1.3Using Computers for Simulation

Again it is also one of the methodology adopted by number of researchers now a days. There is no need of making any physical setup, in the computer only the virtual setup can be created and defining the conditions of inner and outer regions of the system drawn. Further the simulation can be done to perform the experiment, it is like performing the tests in the same way just the setup is virtual. The results can be procured in this also and final verdict can be made.

4.2 VCRS system construction

For performing on this very topic i.e. Experimental Investigation of Vapour Compression Refrigeration System by comparing the results procured after using pure refrigerant R134a with and without any other refrigerant, the methodology adopted was to create the experimental setup. So to make a setup the following steps were taken

a. Firstly a full-fledged working plan is made before the construction is started. Working plan is made in the form of schematic diagram. Yes, a schematic diagram of VCRS is drawn showing system undergoing various processes and the positions of major equipment's required for the system to run.
b. After the components are listed and purchased, the real construction starts and it starts with the construction of base or foundation on which all the components is to be mounted. Firstly the welding of iron bars is done after they are cut in 4 equal parts to make its leg and then its frame. Then the wooden boards of appropriate sizes are fitted into iron frame and the foundation is ready.
c. All the major components of VCRS is now fitted on the foundation, those components are compressor, condenser, evaporator, expansion valve, energy meters.
d. Now, the copper coiling is done in evaporator and all copper tubes connections are made to complete the VCRS cycle via brazing them.
e. Then the pressure gauges both high and low are implied carefully in the inlet and outlet of compressor by using T joints.
f. Now the electrical connections are made i.e. energy meters are connected to the heater and compressor respectively, also switch connections are made to complete the whole electrical circuit.
g. Finally, applying all temperature sensors at all the measuring points and in this way the setup is ready to perform test.
h. Secondly the list of all the components is made which will be required in the construction of VCRS setup. The components required were as follows:

- Copper tubes (25 foot, quarter inch)
- Compressor (hermetically sealed)
- Condenser
- Expansion valve (quarter inch)

- Thermal Insulation
- energy meters (2 for heater and compressor)
- Refrigerant cylinder (R134a)
- Heater (to be applied in evaporator for maintaining temperature)
- Bucket, Teflon tape, Electrical wires for connection
- High and Low Pressure gauges
- Temperature sensors (4)
- Pin valve (for insertion of refrigerant).
- Copper filter
- Relay overload and electrical condenser for compressor.

4.3Formula to be used

To find the COP in this experiment, energy tests were performed to calculate COP by measuring the power consumed by heater to power consumed by compressor. This formula will be used for comparing the results obtained firstly, by testing only with R134a and then testing with mixed refrigerant.

$$cop = \frac{\text{Kwh of power consumes by heater}}{kwh\ of\ power\ consumed\ by\ compressor}$$

Figure 3

Table 7 Nomenclature

T1	Compressor outlet
T2	Condenser outlet
T3	Expansion valve outlet
T4	Evaporator temperature
P1	Compressor outlet pressure
P2	Compressor inlet pressure
C(kW)	Compressor power
E(KW)	Heater power

Table 8: Readings of R134a at 25^0 C evaporator temperature

T1	T2	T3	T4	P1	P2	C(kw)	E(kw)
40	24	-2.2	25	150	8	3.6	3
41.8	26.5	-3.2	25	150	8	3.75	3.25
43.3	26.8	-3	25	150	8	3.8	3.3
44.3	26.6	-3.1	25	150	8	3.85	3.35
44.1	26.7	-3	25	150	8	3.90	3.41
44.2	27	-2.9	25	150	8	3.94	3.44
44.5	26.9	-3	25	150	8	3.98	3.49
44.4	26.7	-3.1	25	150	8	4.02	3.54
44.3	27	-3.1	25	150	8	4.06	3.58
43.9	26.4	-3.1	25	150	8	4.11	3.63
44.0	26.5	-3	25	150	8	4.15	3.67

Table 9: Readings of R134a at 30^0c evaporator temperature

T1	T2	T3	T4	P1	P2	C(kw)	E(kw)
46	24	0.9	30	195	18	5.15	3.85
47.5	26.5	1.3	30	200	20	5.22	4.25
47.9	26.8	0.2	30	210	20	5.28	4.28
47.4	26.6	-0.9	30	210	18	5.32	4.31
47.5	26.7	-1.1	30	215	18	5.38	4.34
47.7	27	-2.1	30	215	16	5.42	4.36
47.6	26.9	-2.5	30	215	18	5.48	4.38
47.5	26.7	-2.4	30	210	18	5.52	4.41
47.6	27	-2.2	30	215	18	5.56	4.44
47.5	27	-2.3	30	215	18	5.60	4.47
47.6	26.4	-2.3	30	215	18	5.64	4.50
47.5	26.5	-2.2	30	215	18	5.68	4.53
47.4	26.4	-2.3	30	215	17	5.72	4.56

Table 10: Readings of R134a and propane at 80%-20% at 25^0c evaporator temperature

T1	T2	T3	T4	P1	P2	C(kw)	E(kw)
44.9	29.1	-3.5	25	190	8	8.42	6.30
45.4	29.6	-5.9	25	195	8	8.46	6.34
45.5	29.3	-6.8	25	195	8	8.50	6.38
45.8	29.1	-3.8	25	200	10	8.54	6.43
47.8	29.9	-5.8	25	205	18	8.58	6.48
47.3	30.0	-5.3	25	205	16	8.61	6.53
47.2	28.7	-6.1	25	200	14	8.67	6.60
46.4	28.8	-7.1	25	200	14	8.71	6.66
46.3	28.5	-6.3	25	195	14	8.76	6.71
46.2	28.0	-7.3	25	200	12	8.80	6.77
46.7	28.6	-7.4	25	200	10	8.85	6.81
46.5	28.4	-7.1	25	205	10	8.89	6.86
46.5	28.1	-7.2	25	205	10	8.93	6.90

Table 11: Readings of R134a and propane at 80%-20% at 30^0c evaporator temperature

T1	T2	T3	T4	P1	P2	C(kw)	E(kw)
46.1	28.3	-3.6	25	210	10	8.99	6.90
46.3	28.4	-3.7	25	210	12	9.04	6.97
46.7	28.9	-4.0	25	215	14	9.09	7.04
46.8	28.9	-4.1	25	215	12	9.14	7.11
47.0	29.0	-4.7	25	220	12	9.19	7.18
47.5	29.3	-4.4	25	220	14	9.24	7.24
47.6	29.6	-5.0	25	225	12	9.29	7.31
48.0	29.7	-5.2	25	225	16	9.34	7.37
48.0	29.4	-5.1	25	220	14	9.39	7.43
48.2	29.7	-5.4	25	225	12	9.44	7.49
48.5	29.7	-5.5	25	230	14	9.49	7.55
48.3	30.0	-5.2	25	225	12	9.54	7.61

able 12: Readings of R134a and propane at 60%-40% at 25^0c evaporator temperature

T1	T2	T3	T4	P1	P2	C(kw)	E(kw)
46.1	28.3	-3.6	25	210	10	9.61	7.61
46.3	28.4	-3.7	25	210	12	9.66	7.67
46.7	28.9	-4.0	25	215	14	9.71	7.73
46.8	29	-4.1	25	215	12	9.76	7.79
47.0	29.3	-4.4	25	22	12	9.80	7.85
47.5	29.6	-4.4	25	220	14	9.85	7.91
47.6	29.7	-5.0	25	225	12	9.89	7.96
48.0	29.4	-5.2	25	225	16	9.94	8.01
48.2	29.7	-5.1	25	220	14	9.98	8.05
48.5	29.7	-5.4	25	225	12	10.02	8.10
48.3	30.0	-5.5	25	230	14	10.06	8.15
48.0	29.5	-5.2	25	225	12	10.10	8.20
48.5	30.0	-5.1	25	220	12	10.14	8.25

Table 13: Readings of R134a and propane at 60%-40% at 30^0c evaporator temperature

T1	T2	T3	T4	P1	P2	C(kw)	E(kw)
45.6	29.6	-4.1	30	190	8	10.19	8.25
45.7	29.5	-4.0	30	195	10	10.24	8.32
45.2	29.4	-3.8	30	205	10	10.29	8.38
45	29.3	-4.4	30	205	10	10.34	8.45
45.8	29	-4.2	30	205	14	10.39	8.51
45.6	28.4	-4.3	30	205	12	10.44	8.57
45.4	29.3	-4.2	30	210	10	10.49	8.64
44	29.4	-4.3	30	210	14	10.54	8.71
43.2	28.7	-4.3	30	210	10	10.59	8.77
45	29.3	-4.3	30	210	10	10.64	8.83
45.4	29.5	-4.3	30	210	12	10.69	8.89
45.6	29.6	-4.3	30	210	14	10.73	8.96
45.8	29.7	-4.3	30	210	14	10.77	9.02

Table 14: Readings of R134a and propane at 40%-60% at 25^0c evaporator temperature

T1	T2	T3	T4	P1	P2	C(kw)	E(kw)
45.3	26.9	-2.9	25	200	18	10.84	9.02
45.7	27.1	-3.1	25	205	16	10.89	9.08
46.0	27.2	-3.3	25	210	16	10.94	9.14
46.2	27.3	-3.5	25	210	14	10.99	9.20
46.5	27.6	-3.6	25	215	14	11.04	9.26
46.7	27.9	-3.7	25	210	14	11.09	9.32
47	28.1	-3.8	25	215	12	11.13	9.37
47	28.2	-3.9	25	220	14	11.17	9.43
47.1	28.5	-3.7	25	220	12	11.21	9.48
47.3	28.3	-3.6	25	220	12	11.25	9.52
47.4	28.2	-3.7	25	215	10	11.29	9.57
47.3	28.2	-3.7	25	215	8	11.33	9.62
47.3	28.2	-3.8	25	210	8	11.37	9.66

Table 15: Readings of- R134a and propane at 40%-60% at 30^0c evaporator temperature

T1	T2	T3	T4	P1	P2	C(kw)	E(kw)
45.2	28.6	-2.6	30	220	10	11.45	9.69
45.4	28.4	-2.4	30	225	12	11.50	9.75
45.4	28.4	-2.6	30	210	14	11.55	9.81
45.6	28.2	-1.8	30	200	12	11.59	9.87
45.8	28.4	-2.2	30	210	12	11.64	9.92
45.8	28.4	-2.1	30	205	14	11.69	9.98
45.9	28.2	-2.4	30	210	12	11.73	10.03
46.2	28.6	-2.3	30	210	14	11.78	10.08
46.4	28.8	-2.4	30	205	14	11.82	10.13
46.4	28.8	-1.6	30	215	12	11.86	10.18
46.8	28.8	-1.4	30	215	12	11.90	10.24
46.8	28.9	-1.2	30	215	14	11.94	10.28
47.4	28.9	-1.2	30	215	12	11.98	10.34

Table 16: Readings of R134a and propane at 80%-20% at 250 c evaporator temperature

T1	T2	T3	T4	P1	P2	C(kw)	E(kw)
45.4	26.7	-2.7	25	190	8	12.02	10.35
45.5	26.8	-2.9	25	190	10	12.07	10.40
45.5	26.9	-3.0	25	205	10	12.13	10.45
45.6	26.9	-2.9	25	210	12	12.17	10.49
45.6	27.2	-3.1	25	195	12	12.22	10.53
45.6	27.4	-3.3	25	200	10	12.26	10.59
45.7	27.4	-3.6	25	195	12	12.30	10.64
45.7	27.9	-3.7	25	205	14	12.34	10.70
46	28.1	-3.7	25	200	12	12.38	10.76
46.1	28.1	-3.9	25	195	10	12.42	10.82
46.2	28.3	-3.7	25	205	8	12.48	10.88
46.4	28.4	-3.7	25	205	10	12.52	10.93
46.4	28.4	-3.8	25	210	12	12.56	10.98

Table 17: Readings of R134a and propane at 80%-20% at 250 c evaporator temperature

T1	T2	T3	T4	P1	P2	C(kw)	E(kw)
45.6	29.6	-2.6	30	195	10	12.64	10.98
45.7	29.5	-2.4	30	200	10	12.69	11.04
45.2	29.4	-2.6	30	205	12	12.74	11.10
45	29.3	-1.8	30	205	14	12.79	11.14
45.8	29	-2.2	30	210	12	12.82	11.20
45.6	28.4	-2.1	30	210	12	12.86	11.26
45.4	29.3	-2.4	30	215	10	12.90	11.31
44	29.4	-2.3	30	215	10	12.95	11.35
43.2	28.7	-2.4	30	210	8	13.00	11.41
45	29.3	-1.6	30	205	8	13.04	11.46
45.4	29.5	-1.4	30	205	10	13.08	11.51
45.6	29.6	-1.2	30	210	10	13.12	11.56
45.8	29.7	-1.2	30	210	12	13.17	11.61

Calculation of coefficient of performance

1) C.o.p of R134a at 25^0c $= \frac{C(kw)}{E(kw)}$

$$= \frac{3.67-3}{4.15-3.6}$$

$$= 1.218$$

C.o.p of R134a at 30^0c $= \frac{C(kw)}{E(kw)}$

$$= \frac{4.56-3.85}{5.72-4.56}$$

$$= 1.24$$

2) C.o.p of R134a & propane in (80%-20%) at 25^0c $= \frac{C(kw)}{E(kw)}$

$$= \frac{6.90-6.30}{8.93-8.42}$$

$$= 1.176$$

C.o.p of R134a & propane in (80%-20%) at 30^0c $= \frac{C(kw)}{E(kw)}$

$$= \frac{7.61-6.90}{9.54-8.99}$$

$$= 1.290$$

3) C.o.p of R134a & propane in (60%-40%) at 25^0c $= \frac{C(kw)}{E(kw)}$

$$= \frac{8.25-7.61}{10.14-9.61}$$

$$= 1.207$$

C.o.p of R134a & propane in (60%-40%) at 30^0c $= \frac{C(kw)}{E(kw)}$

$$= \frac{9.02-8.25}{10.77-10.19}$$

$$= 1.327$$

4) C.o.p of R134a & propane in (40%-60%) at 25^0c $= \frac{C(kw)}{E(kw)}$

$$= \frac{9.66-9.02}{11.37-10.84}$$

$$= 1.207$$

C.o.p of R134a & propane in (40%-60%) at 30^0c $= \frac{C(kw)}{E(kw)}$

$$= \frac{10.34-9.69}{11.98-11.45}$$

$$= 1.226$$

5) C.o.p of R134a & propane in (80%-20%) at 25^0c $= \frac{C(kw)}{E(kw)}$

$$= \frac{10.98-10.35}{12.56-12.02}$$

$$= 1.166$$

C.o.p of R134a & propane in (80%-20%) at 30^0c $= \frac{C(kw)}{E(kw)}$

$$= \frac{11.56-10.98}{13.17-12.64}$$

$$= 1.188$$

Comparison of coefficient of performances at different temperature

Comparing c.o.p at two different temperatures 25^0c and 30^0c of R134a

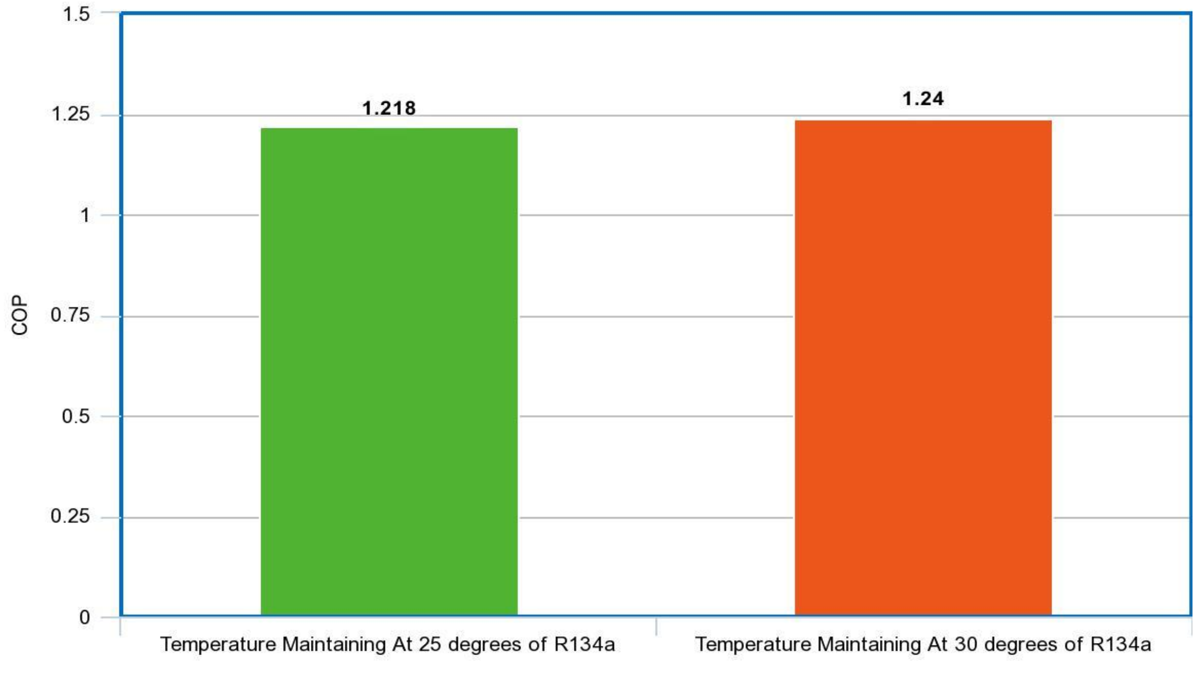

Figure 4

2) Comparing c.o.p at two different temperatures 25^0c and 30^0c of mixture of R134a and propane at 80%-20%

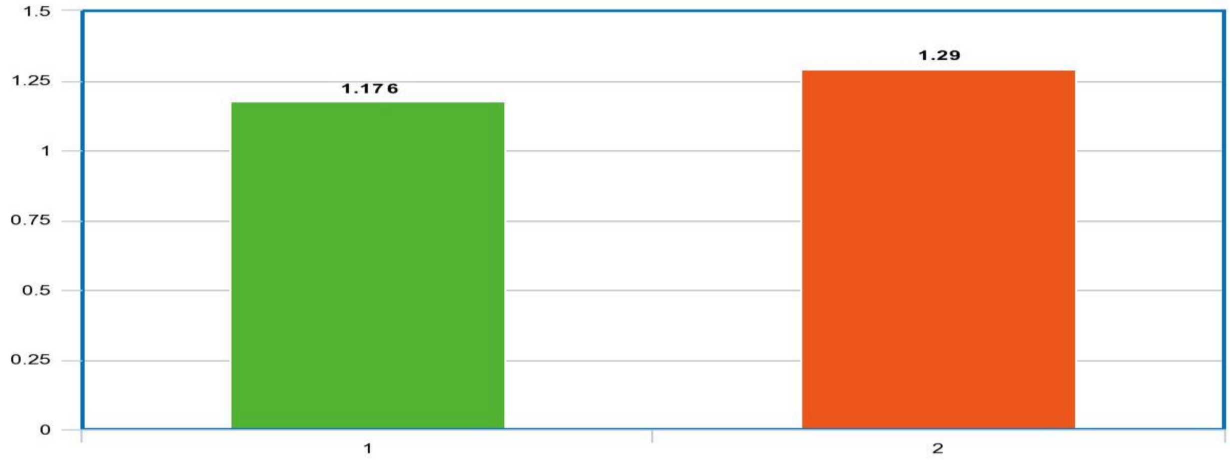

Figure 5

1 -> Mixture of R134a & propane in 80%-20% at 25^0c

2 -> Mixture of R134a & propane in 80%-20% at 30^0c

Comparing c.o.p at two different temperatures 25^0c and 30^0c of mixture of R134a and propane at 80%-20% and R134a

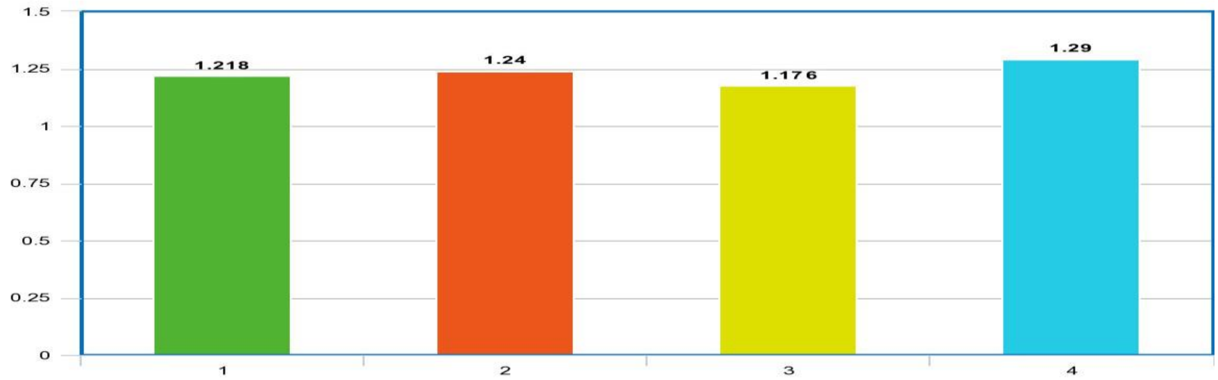

Figure 6

1 -> c.o.p of R134a at 25^0c 2 -> c.o.p of R134a at 30^0c

3 -> Mixture of R134a & propane in 80%-20% at 25^0c

4 -> Mixture of R134a & propane in 80%-20% at 25^0c

3) Comparing c.o.p at two different temperatures 25^0c and 30^0c of mixture of R134a and propane at 60%-40%

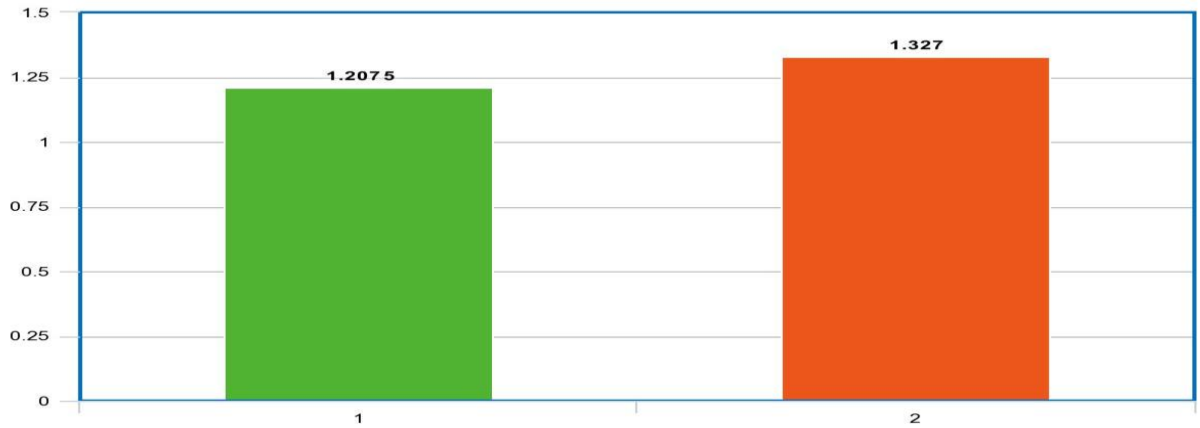

Figure 7

1 -> Mixture of R134a & propane in 60%-40% at 25^0c

2 -> Mixture of R134a & propane in 60%-40% at 30^0c

Comparing c.o.p at two different temperatures 25^0c and 30^0c of mixture of R134a and propane at 60%-40% and R134a

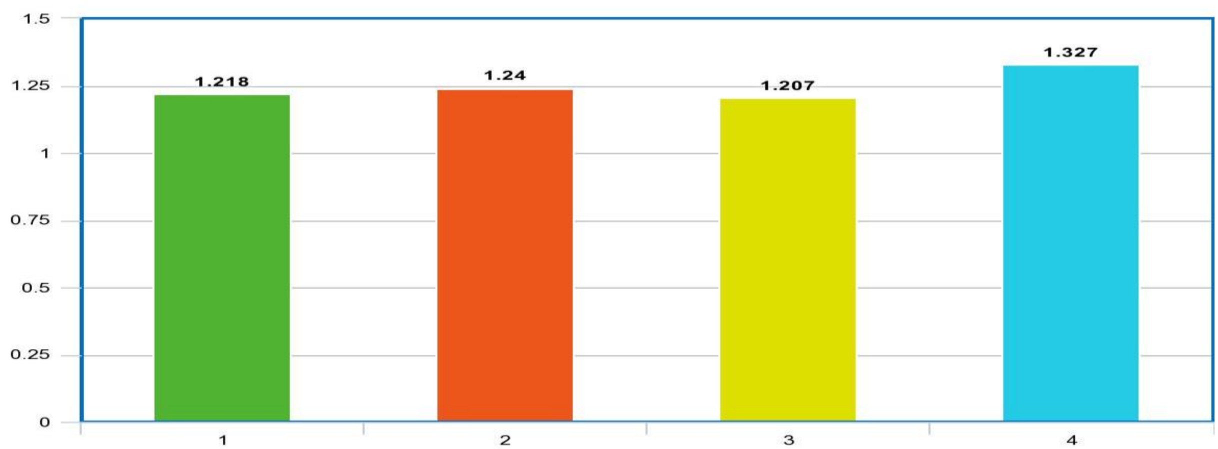

Figure 8

1-> c.o.p of R134a at 25^0c **2 -> c.o.p of R134a at 30^0c**

3 -> Mixture of R134a & propane in 60%-40% at 25^0c

4 -> Mixture of R134a & propane in 60%-40% at 30^0c

4) Comparing c.o.p at two different temperatures 25^{0}c and 30^{0}c of mixture of R134a and propane at 40%-60%

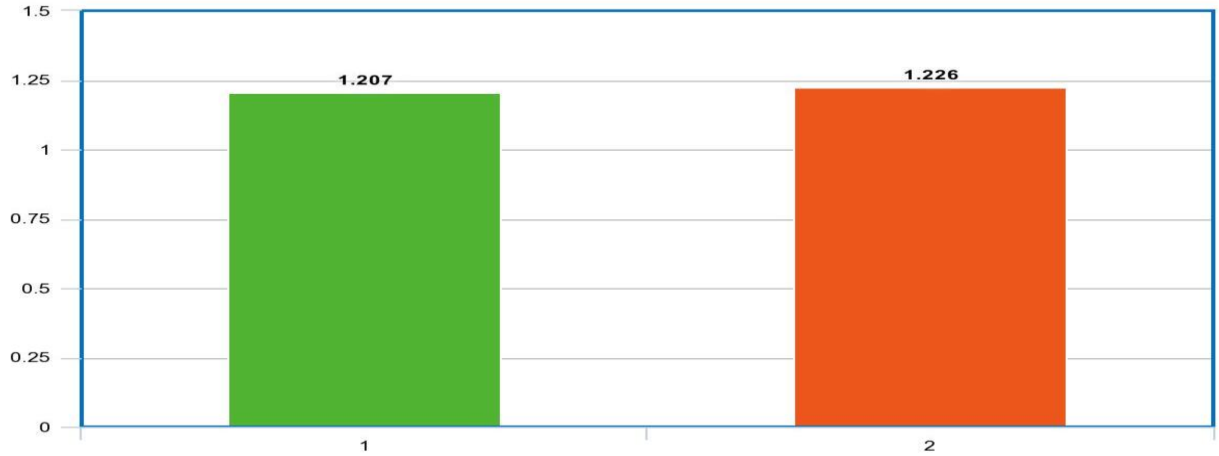

Figure 9

1 -> Mixture of R134a & propane in 40%-60% at 25^{0}c

2 -> Mixture of R134a & propane in 40%-60% at 30^{0}c

Comparing c.o.p at two different temperatures 25^{0}c and 30^{0}c of mixture of R134a and propane at 40%-60% and R134a

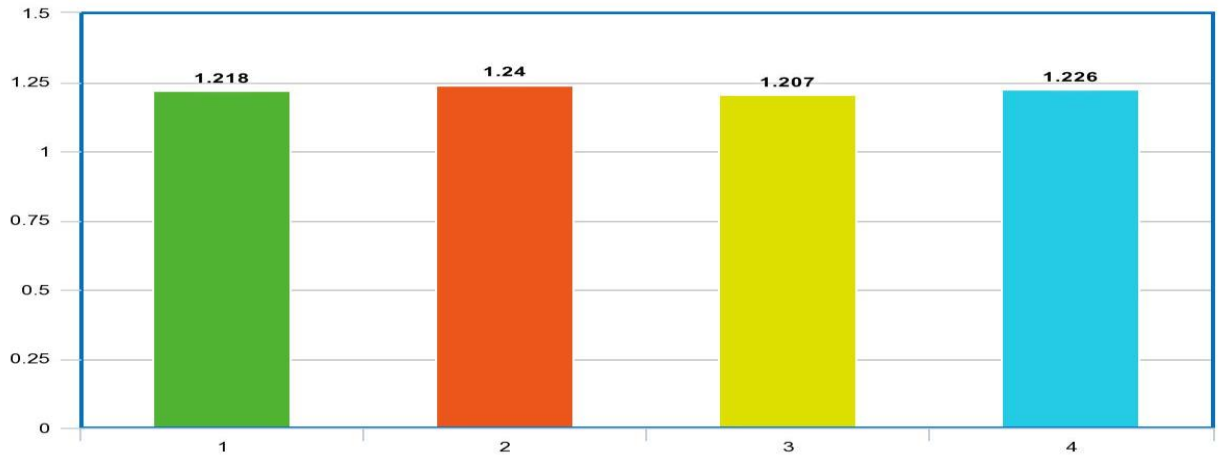

Figure 10

1-> c.o.p of R134a at 25^{0}c   2 -> c.o.p of R134a at 30^{0}c

3 -> Mixture of R134a & propane in 40%-60% at 25^{0}c

4 -> Mixture of R134a & propane in 40%-60% at 30^{0}c

5) **Comparing c.o.p at two different temperatures 25^0c and 30^0c of mixture of R134a and propane at 20%-80%**

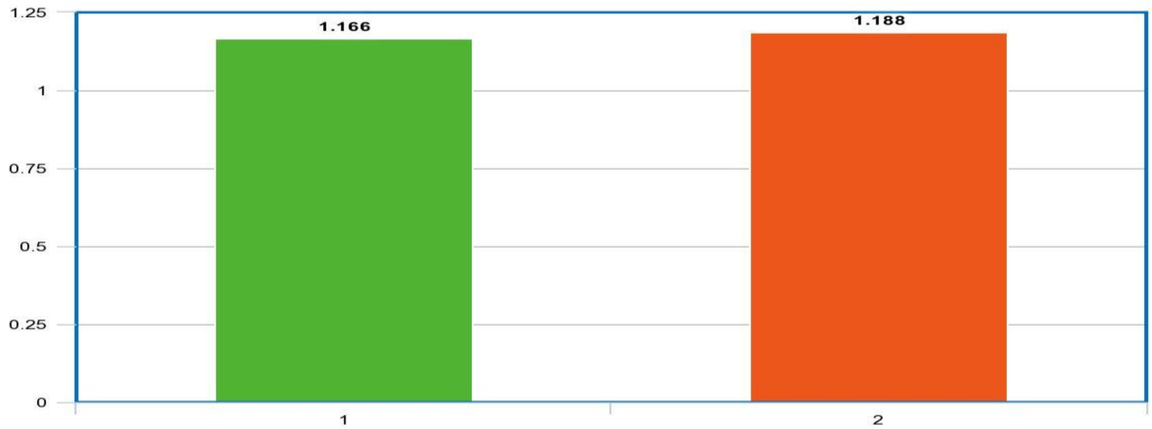

Figure 11

1 -> Mixture of R134a & propane in 20%-80% at 25^0c

2 -> Mixture of R134a & propane in 20%-80% at 30^0c

Comparing c.o.p at two different temperatures 25^0c and 30^0c of mixture of R134a and propane at 80%-20% and R134a

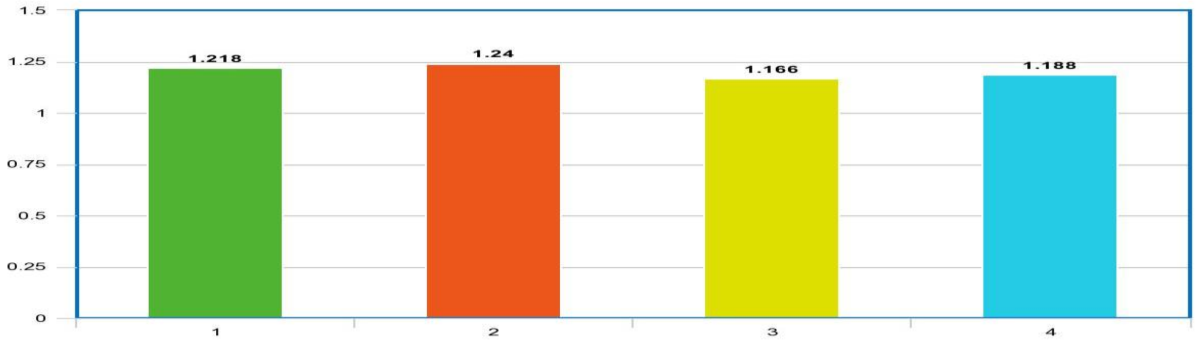

Figure 12

1-> c.o.p of R134a at 25^0c 2 -> c.o.p of R134a at 30^0c

3-> Mixture of R134a & propane in 20%-80% at 25^0c

4-> Mixture of R134a & propane in 20%-80% at 30^0

Comparison of all coefficient of performances at different temperatures

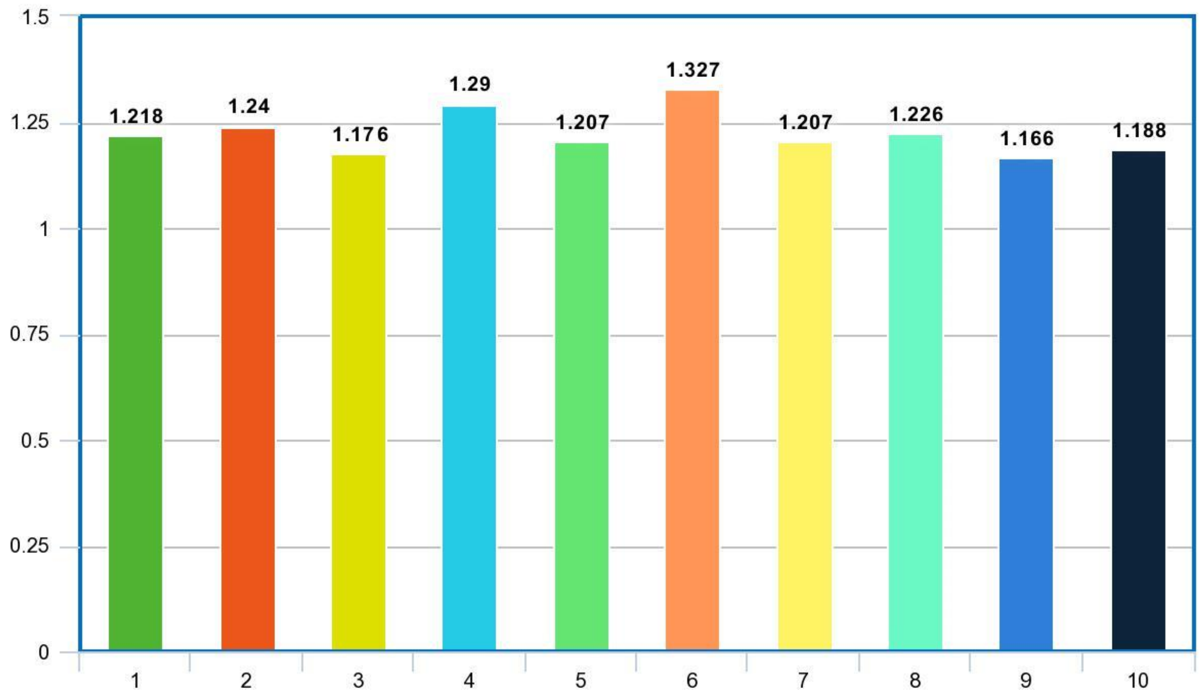

Figure 13

1-> c.o.p of R134a at 250c **2 -> c.o.p of R134a at 30^0c**

3-> Mixture of R134a & propane in 80%-20% at 25^0c

4-> Mixture of R134a & propane in 80%-20% at 30^0c

5 -> Mixture of R134a & propane in 60%-40% at 25^0c

6 -> Mixture of R134a & propane in 60%-40% at 30^0c

7 -> Mixture of R134a & propane in 40%-60% at 25^0c

8-> Mixture of R134a & propane in 40%-60% at 30^0c

9-> Mixture of R134a & propane in 20%-80% at 25^0c

10-> Mixture of R134a & propane in 20%-80% at 30^0

RESULTS AND DISCUSSION

The main objective of this experiment was to study the influence of mixed refrigerants with R134a And seeing for the various parameters which influence like cooling effect, evaporator temperature, compressor pressure, freezing at the expansion valve, diameter of the copper tube from which refrigerant flows, coefficient of performances. These are the parameters which we have taken into consideration and worked upon domestic refrigerator to test the coefficient of performance of mixed refrigerant R134a & propane at different proportions and compared with the R134a refrigerant.

From the experimental results we have compared different proportions of R134a & propane at (80%-20%, 60%-40%, 40%-60%, 20%-80%).

We obtained the results

REFRIGERANT ITs COMBINATION	C.O.P AT 25^0c	C.O.P AT 30^0c
Only R134a	**1.218**	**1.24**
R134a & propane At (80%-20%)	**1.176**	**1.290**
R134a & propane At (60%-40%)	**1.207**	**1.327**
R134a & propane At (40%-60%)	**1.207**	**1.226**
R134a & propane At (20%-80%)	**1.166**	**1.188**

So at R134a & its mixture propane at (60%-40%) combination maintained at 30^0c gives slight high amount of increase in C.O.P.

CONCLUSION

Our experiment proves that using same energy one can get more cooling effect in less time.

Though propane is highly flammable gas due to zero depletion ozone layer and very less global warming the replacement of R134a can be done with the help of mixture of R134a & propane

The mixed refrigerants are charged at different proportions for obtaining better results

As the density is less for the mixture it can handle at low power compressors also.

The refrigerant at the outlet of expansion valve is going -3^0c to -7^0c

The pressure at the outlet is about low compared to R134a which can be able to handle at low pressure capacity compressors

So we can reduce the cost basis by using the mixed refrigerant R134a and propane at different proportions

CHAPTER 5

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