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Performance Investigation of R290 As A Substitute to R22 Refrigeration System

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***Abstract* –In this study, Use of natural refrigerant R290 can play a vital role in fulfilling the objectives of the international protocols like Montreal and Kyoto. Because of environmental issues such as ozone depletion and global warming, R22 needs to be phased out on urgent basis. This paper analyzes the possibilities of R290 as a potential substitute to R22. Thermodynamic performance analysis of refrigerants R290 and R22 was carried out using standard vapour compression cycle, with evaporating temperature range of -5ºC, condensing temperature of 30°C and compressor efficiency is taken as 65%, based on analytical calculations. Performance parameters like, coefficient of performance, refrigeration effect, and compressor work. All the analysis in this paper for performance comparison of refrigerant is done by engineering equation solver software commonly known as EES software. From the analysis it is found to be that R290 is a better substitute of R22. However, the flammable characteristics of R290 prevented its wide application in the large air conditioning system. Thus special precautions are needed for its use and maximum charge quantity of R290 in refrigeration system is also restricted by international safety standards. Recently the study of flammable refrigerants used in air conditioner has attracted worldwide attention. Coefficient of performance with R290 is slightly lower than that of with R22.**

However, by adding a liquid-vapour heat exchanger in the vapour compression cycle we can increase coefficient of performance and other properties. Engineering Equation Solver (EES) was used to simulate a mechanical refrigeration system in two configurations: modified system with liquid-vapour heat exchanger and system without liquid-vapour heat exchanger. The results revealed that the liquid-vapour heat exchanger has a significant effect on the system performance as it influences the sub cooling and superheating temperatures. The results showed us that the high value of the coefficient of performance (COP) was achieved by the modified system which has a single stage vapour compression refrigeration system with refrigerant R290. Overall, R290 can be a better substitute to R22 in real applications because of its excellent environmental properties and thermo physical properties.

R290 is a low cost, widely available and efficient. They also have zero ozone depletion potential and very low global warming potential. Despite the flammability, they are increasingly used in domestic refrigerators. In 2010, about one-third of all household refrigerators and freezers manufactured globally used isobutane or an isobutane/propane blend, and this was expected to increase to 75% by 2022.

Keywords: R22, R290, Single stage vapour compression refrigeration system, liquid vapour heat exchanger.

Nomenclature:

Single stage VCRs system

h_1= entropy at expansion valve outlet
h_2= entropy at evaporator outlet
h_3= entropy at compressor outlet

Single stage VCRs system with liquid vapour heat exchanger

h_2= entropy at liquid vapor heat exchanger outlet in superheated region
h_3= entropy at compressor outlet
h_6= entropy at expansion valve outlet

1. INTRODUCTION

Refrigeration technology has forever played an important role in improving the human standard of living. Inventions such as the refrigerator and air-conditioner have become a necessity for comfort living. However, right from its invention, the refrigeration industry has been constantly tackling the issues of safety and environmental impact of refrigerants. Despite the constant effort from the researchers, the industry has still been a major contributor towards environmental degradation.

Mechanical refrigeration system is one of the most usable refrigeration systems that can be used in domestic and commercial fields. It has four main parts: compressor, condenser, expansion valve and evaporator are connected in order together to build a vapour compression cycle. Many studies have been done to modify and enhance the performance and energy consumption of the mechanical refrigeration system by adding heat exchanger. Using heat exchanger in the mechanical refrigeration system is one of the effective techniques that can be used to improve the energy performance of the system. Meanwhile, refrigerant type can also influence the system performance, so it is a big challenge to obtain matching between the system modification and refrigerant type. Refrigerant R290 is one of the alternative refrigerants that can be used to achieve

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good performance. However, the system performance would be depending on the system modification such as using the liquid-vapour heat exchanger which can improve the performance.

Present work demonstrates the applicability of refrigerant R290 as a substitute to R22, with the comparative analysis of properties of R22 and R290. Also comparative analysis of performance Parameters done by engineering equation solver software between the refrigerant R22 and R290. 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 input condition and parameters. By sub-cooling and super heating using liquid vapour heat exchanger which leads to increase in refrigerating effect and power consumption remain same. Thus performance of cycle is improved. Along with this waste heat also recovered.

1.2 Literature Review

Major earlier investigations in the area of alternate refrigerants are reviewed below from the point of view of their ability to match the performance of the widely used (HCFC-22) R22 refrigerant.

Sharma's Vali Shaik, T. P.Ashok Babu [1] The present paper describes the theoretical thermodynamic performance of vapor compression refrigeration system using HFC and HC blends as an alternative to replace the refrigerant R22. In this study thermodynamic analysis of window air conditioner with R431A, R410A, R419A, R134a, R1270, R290 and fifteen refrigerant mixtures consist of R134a, R1270 and R290 was carried out based on actual vapor compression cycle. All the investigated refrigerant mixtures are ozone friendly in nature and they possess GWP in the range of 0.0244 to 1.685 times the GWP of R22. Thermodynamic performance analyses of all the investigated refrigerant mixtures were evaluated at the condensing and evaporating temperatures of 54.4oC and 7.2oC respectively. The results show that COP for the refrigerated mixture R134a/R1270/R290 (50/5/45 by mass percentage) is 2.10% higher among the R22, R431A, R410A, R419A, R134a, R1270, R290, and fifteen studied refrigerant mixtures. The compressor discharge temperatures of all the studied refrigerants were lower than that of R22 by 4.8oC-22.2oC. The power consumption per ton of refrigeration for the refrigerated mixture R134a/R1270/R290 (50/5/45 by mass percentage) is 2.01% lower among R22, R431A, R410A, R419A, R134a, R1270, R290, and fifteen studied refrigerant mixtures. Overall the thermodynamic performance of refrigerant mixture R134a/R1270/R290 (50/5/45 by mass percentage) is better than that of R22 with reasonable savings in the energy and hence it is an appropriate ecological energy efficient alternative refrigerant to substitute R22 used in air conditioning applications

Zaghdoudi M.C.[2] have simulated the performance of ten alternate refrigerants to replace R22 in an air conditioner of 9000BTU/hr(0.75TR) capacity by using NIST Cycle_D software and these refrigerants include R134a, R290, R600, R404A, R407A, R407C, R407D, R410A, R410B and R417. It was concluded that no single refrigerant possesses all the characteristics of R22.

Devotta S. [3] also assessed the suitability of various alternative refrigerants to R-22 for air conditioning applications. They have selected only zero ozone depleting potential refrigerants. NIST Cycle_D has been used for the comparative thermodynamic analysis. The objective of the analysis is to identify fluids that are likely to be close to HCFC-22 operating conditions. Among the refrigerants studied are HFC-134a, HC290, R407C, R410A, and three blends of HFC-32, HFC134a and HFC-125.They have concluded that the pressure ratios for R410A are slightly lower than that of R-22 but operating pressures are fairly large compared to R-22 at evaporator temperature of 7.2ºC and condenser temperature of 55ºC.

Prof. Jignesh K. Vaghela [4] The main aim of the research is to evaluate the different alternative refrigerants as a drop in substitute of R134a theoretically. For this purpose, thermodynamic properties of different alternative refrigerants i.e. R290, R600a, R407C, R410A, R404A, R152a and R1234yf are compared to R134a. Thermodynamic evaluation of the standard rating cycle of vapor compression refrigeration system is carried out. Engineering equation solver and refprop softwares have been used for the thermodynamic analysis purpose. From the thermodynamic analysis, it is derived that R1234yf is best suitable alternative refrigerants as a drop in substitute of R134a. R1234yf has the lowest coefficient of performance as compared to R134a; however, it is best suitable alternative refrigerants as a drop in substitute because it has a very low global warming potential and can be substituted in the existing automotive air conditioning system with minimum modification.

G. M P Yadav, P. R Prasad, G. Veeresh-[5] Because of simplicity and low cost, capillary tubes are used as the expansion device in most small refrigeration and air conditioning systems. Another advantage is that capillary tubes allow high and low side pressures equalize during the off-cycle, thereby reducing the starting torque required by the compressor. In this application the liquid line is usually placed in contact with the suction line, forming a counter flow heat exchanger. The liquid line is welded to the suction line in the lateral configuration. The temperature of the vapor refrigerant coming out from the evaporator is less than the temperature of the liquid coming out of the condenser. Before the expansion process, heat is transferred from the liquid line to the suction line. As a consequence, this in turn reduces the refrigerant quality at the inlet of the evaporator and therefore increases the refrigerating capacity. The suction line exit temperature also increases, eliminating suction line sweating and preventing slagging of the compressor. The main objective of this project is to evaluate the performance of refrigerating with liquid line suction line heat exchange for different lengths of heat exchange by using R134a and R404a as refrigerants and compare with different lengths of liquid line- suction line heat exchanger.

2. METHODOLOGY

For the performance analysis between refrigerants R22 & R290 in the single stage vapour compression refrigeration system which is also called as R22 & R290 unmodified system. We need consider certain parameters like coefficient of performance, refrigeration effect, and compressor work. Then we need to consider certain assumption like evaporating temperature, condenser temperature and compressor efficiency. Then we need derive the engineering equation solver codes (EES codes) for the single stage vapour compression refrigeration system for the performance analysis between the refrigerants. We get different parametric tables and comparison graphs for the consider parameters by which we get results for the R22 & R290 unmodified system. Then we derive a single stage vapour compression refrigeration system with liquid vapour heat exchanger for refrigerant R290 which we called as R290 modified system we need consider certain parameters like coefficient of performance, refrigeration effect, and compressor work. Then we need to consider certain assumption like evaporating temperature, condenser temperature, sub-cooled temperature, super-heated temperature and compressor efficiency. Then we need derive the engineering equation solver codes (EES codes) for the single stage vapour compression refrigeration system with a liquid vapour heat exchanger for R290. Then we compare R290 modified refrigeration system with R290 unmodified refrigeration system on the basis of above parameters with the help of graphs and tables. At the end we come to a conclusion from the above analysis.

3. PROPERTIES OF REFRIGERANTS R22 &R290

Selection of a refrigerant is a complex process involving detailed analysis of environmental properties, physical properties, and thermo physical properties.

3.1 Environmental properties

Table – 1: Environmental properties of R22 & R290

Refrigerant	Chemical Formula	Atmospheric Life in Years	Global Warming Potential	Ozone Depletion Layer
R22	$CHClF_2$	12	1700	0.055
R290	C_3H_8	0.041	20	0.000

Ozone depletion potential (ODP) and global warming potential (GWP) and atmospheric life are the significant factors demonstrating environmental impact of refrigerant when released to the surroundings. Atmospheric life of R-290 is very less, i.e. almost 99% as that of R-22 which means it will sustain in environment for very less time and hence it is environment friendly. R290 is a non-ozone depleting refrigerant whereas R22 is a non-zero ODP refrigerant. GWP value of R290 is 20, which is very low value compared to R22.

3.2 Physical and Thermo-physical Properties

As from the above table molecular weight of R22 is 86.47 and molecular weight of R290 is just 44.10. There is not much difference in the normal boiling point and critical temperature of refrigerant R22 and R290. Also there is not much difference in the critical pressure of refrigerant R22 and R290. Latent heat of evaporation of R290 is higher than that of R22 by 80 %, at a normal boiling point. The higher latent heat of evaporation indicates lower refrigerant mass requirement. Normal boiling points of two refrigerants closely match indicating similar pressure curves and similar areas of application. Hence there is not much difference in the physical properties of R22 and R290 can be used as the substitute of R22 due to its excellent.

indicating similar pressure curves and similar areas of application. Hence there is not much difference in the physical properties of R22 and R290. So, R290 can be used as the substitute of R22 due its excellent.

Table – 2: Physical properties of refrigerant R22 & R290

Refrigerant	**Molecular Weight**	**Critical Temperature**	**Critical Pressure**	**Latent Heat of evaporation**
R22	86.47	96.2	4.99	233.7
R290	44.10	96.7	4.25	425.4

Thermo-physical properties of refrigerant determine the energy performance of the refrigeration system. The above table shows show the thermo-physical properties of the refrigerant R22 and R290, at evaporating temperature of 10°C and condensing temperature of 45°C. The lower liquid density of R290 reflects the lower requirement of refrigerant mass resulting in lower friction and better heat transfer coefficients in evaporator and condenser. Refrigerant viscosity is the major source of irreversibility and influences condensation and boiling heat transfer coefficients. R290 has lower viscosity and higher thermal conductivity which improves the performance of condenser and evaporator. The higher specific heat of R290 gives lower discharge temperature.

Table – 3: Thermo-physical properties of R22 & R290

Property	**Temperature**	**State**	**R22**	**R290**
Saturation pressure	10	Liquid	0.640	0.601
	45	Vapour	1.729	1.534
Density	10	Liquid	1253.8	517.56
	45	Vapour	75.45	34.14
Viscosity	10	Liquid	197.97	115.69
	45	Vapour	13.69	9.13
Thermal Conductivity	10	Liquid	0.0911	0.101
	45	Vapour	0.0135	0.0224
Specific Heat	10	Liquid	1.1836	2.5318
	45	Vapour	1.0487	2.3714

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3.3 Safe use of R290 in air conditioning

For the safe use of R290, flammability and toxicity are very important parameters due which it was neglected alternative for so many years. R290 is classified under A3 safety class as per ASHRE34-2010 due to this it has been avoided. But it has good thermo physical properties which is similar to R22, hence can be effectively used with taking proper care of leakage factor during operation. The European standard EN378 gives the safety requirements for the use of flammable refrigerants in various applications. As per the EN378 and ASHRAE15, the charge limit is about 8g/m3 for R290. Toxicity safe index for HCFC22 and R290 are similar.

Table – 4: Flammability and toxicity of R290

LFL by mass (kg/m3)	LFL by volume (%)	Heat of Combustion (kJ/Kg)	Ignition Temperature (C)	Toxicity (ppm)	Safety Class
0.075	2.1	50500	466	1000	A3

According to European standard maximum allowable charge in the room can be calculated using equation.

$$m_{max} = 2.5 * LFL^{5/4} * h_o * A^{1/2}$$

where, m_{max}= maximum charge in a room in kg
A = room area in m^2
LFL = lower flammable limit in kg/m^3
h_o = installation height of the appliance in m

4. COMPARATIVE ANALYSIS OF REFRIGERANTS PERFORMANCE

Performance parameters for the comparative analysis of refrigerants R22 & R290 (single stage vapour compression refrigeration system)
(1) Coefficient of performance (COP):
The coefficient of performance of a refrigerator or air conditioning system is a ratio of useful heating or cooling provided to work (energy) required. Higher COPs equate to higher efficiency, lower energy (power) consumption and thus lower operating costs

$$COP = (h_2-h_1)/(h_3-h_2)$$

(2) Refrigeration effect (RE):
Refrigeration effect is the amount of heat that each pound of refrigerant retains from the refrigerated space to deliver helpful cooling. Refrigeration effect is an important term in refrigeration that defines the amount of cooling produced by a system.

$$RE = h_2-h_1$$

(3) Compressor work ($W_{comp.}$):
Compressor work as pump to control the circulation of refrigerant and it adds pressure to the refrigerant, heating it up. The compressor also draws vapour away from evaporator to maintain a lower pressure and lower temperature before sending it to the condenser.

$$W_{comp.} = h_3-h_2$$

Performance parameter for the analysis of R290 modified system (single stage vapour compression refrigeration system with liquid vapour heat exchanger)
(1) Coefficient of performance

$$COP = (h_2-h_6)/(h_3-h_2)$$

(2) Refrigeration effect

$$RE = h_2-h_6$$

(3) Compressor work

$$W_{comp.} = h_3-h_2$$

4.1 Model description

4.1.1 Single stage vapour compression refrigeration system

A schematic diagram of the single stage vapour compression refrigeration cycle and its corresponding pressure-enthalpy(P-h) and temperature-entropy(T-s) diagram.
The cycle consists of a compressor, condenser, expansion valve and evaporator. There is no temperature glide for pure and azeotropic mixture refrigerants during condensation and evaporation processes. The different cycle processes can be explained as follows: process (2-3) is a compression through the compressor, process (3-4) is a heat rejection in the condenser, process (4-1) is an expansion through the expansion valve, process (1-2) is a heat addition in the evaporator.

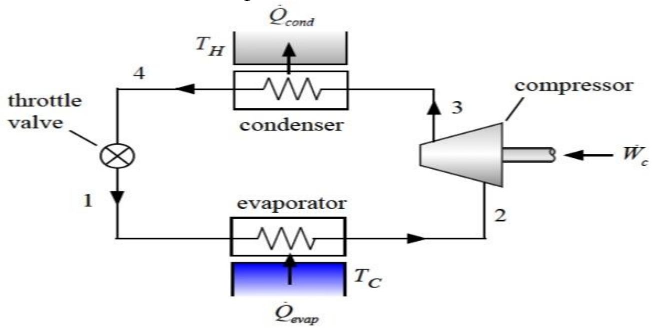

Figure – 1: VCRs system

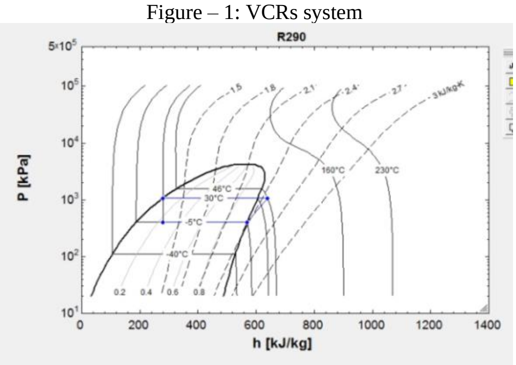

Figure – 2: P-h diagram in VCRs system

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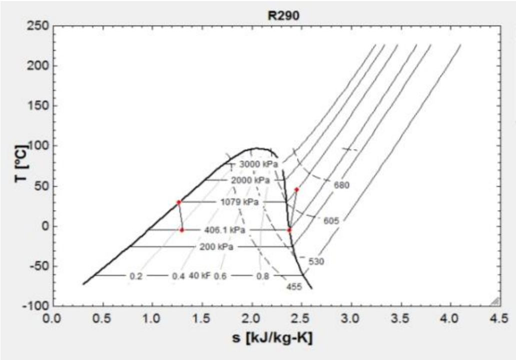

Figure – 3: T-s diagram in VCRs system

So, from the above model which is single stage vapour compression refrigeration system first we derive the EES code for the above system and then comparative analysis between R22 & R290 on the basis of above parameters. Here R22 & R290 refrigeration system are also called as unmodified refrigeration system.

4.1.2 Single stage vapour compression refrigeration system with liquid vapour heat exchanger

The coefficient of performance of the refrigeration cycle can be increased by increasing the refrigeration effect of the system. This can be achieved by using a liquid vapour heat exchanger in single stage vapour compression refrigeration cycle. One arrangement for single stage vapour compression refrigeration cycle with liquid vapour heat exchanger is shown below and its corresponding pressure-enthalpy (P-h) and temperature-entropy (T-s) diagrams. The single stage vapour compression refrigeration cycle with liquid vapour heat exchanger is differs from the single stage vapour compression refrigeration cycle by adding a liquid vapour heat exchanger which provide sub-cooling and super-heating region in the system which increases refrigeration effect of the system which leads to increase in coefficient of performance.

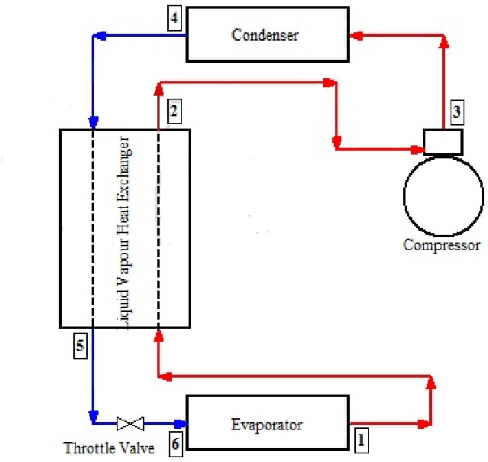

Figure – 4: VCRs system with liquid vapour heat exchanger

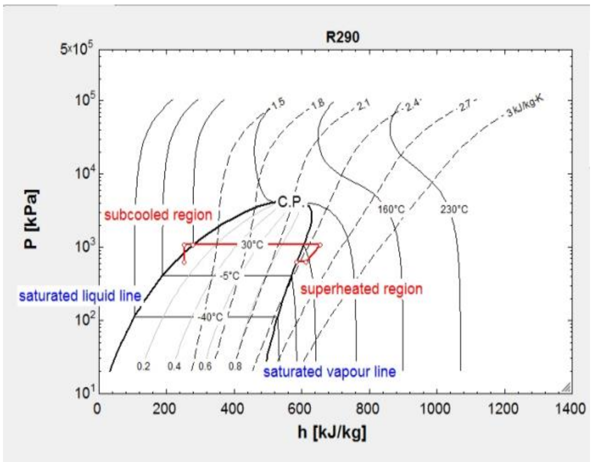

Figure – 5: P-h diagram in modified system

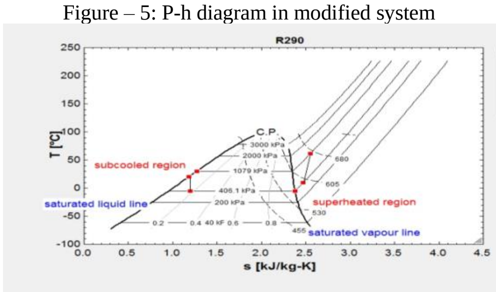

Figure – 6: T-s diagram in modified system

So, from the above model which is single stage vapour compression refrigeration system with liquid vapour heat exchanger first we derive the EES code for the above system and then we find the value of different parameters of R290 modified system. Here R290 refrigeration system is also called as modified refrigeration system.

4.2 Assumptions

4.2.1 Assumptions made for the comparative analysis of refrigerants R22 & R290

The comparative analysis presented in this presentation is based on the following relevant assumptions:

System is in steady state, Vapour compression refrigerant system is used for the analysis, There is no enthalpy change across the expansion device, The entropy remains constant across the compressor, When refrigerant leaves the condenser it is in saturated liquid state so quality is zero, When refrigerant leaves the evaporator it is in saturated vapour state so quality is one, In this VCR system evaporating temperature is -5 degree Celsius and condensing temperature is 30 degree Celsius, Compressor efficiency is taken as 65%.

4.2.2 Assumptions made for the analysis of R290 (modified system)

The comparative analysis presented in this presentation is based on the following relevant assumptions.System is in steady state, Vapour compression refrigerant system is used for the analysis, There is no enthalpy change across the expansion device, The entropy remains constant across the compressor, When refrigerant leaves the condenser it is in saturated liquid state so quality is zero, When refrigerant leaves the evaporator it is in saturated vapour state so quality is one, In this VCR system evaporating temperature is -5 °C and condensing temperature is 30 °C, Compressor efficiency is taken as 65%, Super heated temperature is 15 °C, Sub cooled temperature is 10 °C.

5. RESULTS AND ANALYSIS COMPARATIVE ANALYSIS OF RESULT BETWEEN R22 AND R290

Table – 5: Comparative analysis of R22 & R290 in VCRS system

PERFORMANCE PARAMETERES	R22	R290
Coefficient of performance(COP)	4.207	4.127
Refrigeration effect (RE)	166.3 kJ/kg	289.8 kJ/kg
Compressor work (W_{comp})	39.53 kJ/kg	70.2 kJ/kg

5.1 On the basis of Coefficient of performance

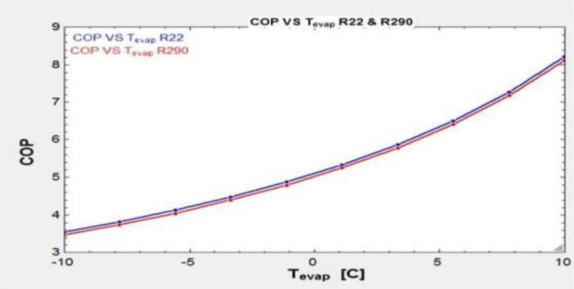

Figure – 7: COP VS T_{evap} for R22 & R290

The coefficient of performance of R22 and its potential alternative refrigerants R290 at varying evaporating temperature for condensing temperature of 30 °C. As it is observed from the above figure the COP increase with increase in evaporating temperature for both refrigerants COP of refrigerant R22 is slightly higher than the COP of refrigerant R290. With the special design of refrigeration system for R290, COP can be improved which can be higher than that of R22.

5.2 On the basis of Refrigeration effect

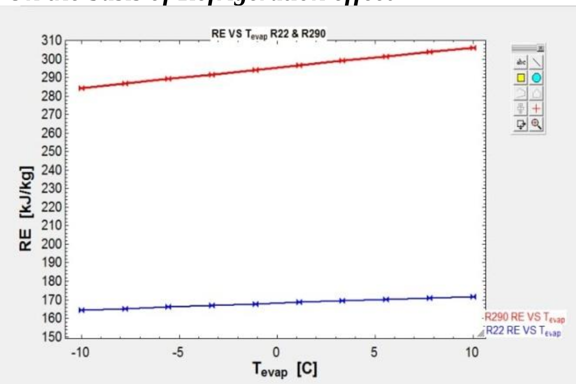

Figure – 8: RE VS T_{evap} for R22 & R290

The refrigerating effects of R22 and its potential alternative refrigerants R290 at varying evaporating temperature for condensing temperature of 30 °C, As it is observed from the above figure the refrigeration effect increase with increase in evaporating temperature for both refrigerants refrigeration effect of refrigerant R22 is very much lower than the refrigeration effect of refrigerant R290. With the special design of refrigeration system for R290, refrigeration effect can be improved more.

5.3 On the basis of compressor work

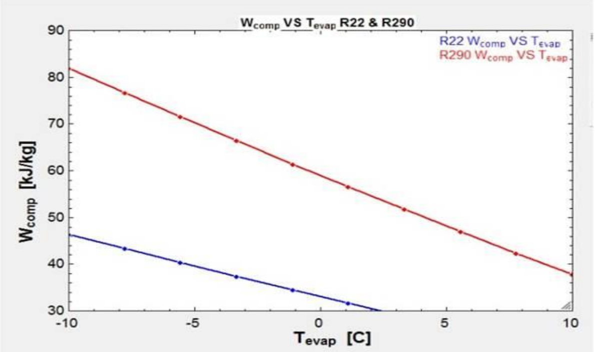

Figure – 9: W_{comp} VS T_{evap} for R22 & R290

The compressor work of R22 and its potential alternative refrigerants R290 at varying evaporating temperature for condensing temperature of 30 °C. As it is observed from the above figure the compressor work decrease with increase in evaporating temperature for both refrigerants compressor work of refrigerant R22 is lower than the compressor work of refrigerant R290.

COMPARATIVE ANALYSIS BETWEEN THE SIMPLE SYSTEM AND THE MODIFIED SYSTEM FOR R290

Table – 6: Comparative analysis of R290 in modified and unmodified VCRs system

PERFORMANCE PARAMETERS	VCR system (R290 unmodified refrigeration system)	VCR system with liquid vapour heat exchanger (R290 modified refrigeration system)
Coefficient of performance (COP)	4.127	4.523
Refrigeration effect (RE)	289.8 kJ/kg	343.1 kJ/kg
Compressor work ($W_{comp.}$)	70.2 kJ/kg	75.87 kJ/kg

5.4 On the basis of Coefficient of performance

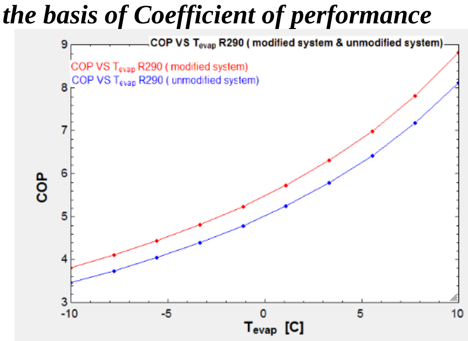

Figure – 10: COP VS T_{evap} for R290 modified & unmodified system

The coefficient of performance of R290 unmodified system and its potential alternative refrigerants R290 modified system at varying evaporating temperature for condensing temperature of 30 °C. As it is observed from the above figure the COP increase with increase in evaporating temperature for both refrigeration system COP of refrigerant R290 modified system is quite higher than the COP of refrigerant R290 unmodified system. The coefficient of performance (COP) is the measure of energy efficiency of a refrigeration system. With the special design of refrigeration system for R290, COP can be improved which can be higher than that of R22.

5.5 On the basis of Refrigeration effect

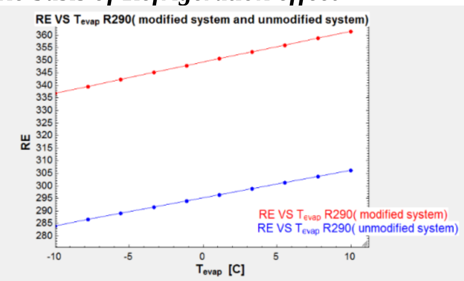

Figure – 11: RE VS T_{evap} for R290 modified & unmodified system

The refrigeration effect of R290 unmodified system and its potential alternative refrigerants R290 modified system at varying evaporating temperature for condensing temperature of 30 ºC. As it is observed from the above figure the RE increase with increase in evaporating temperature for both refrigeration system RE of refrigerant R290 modified system is to much higher than the RE of refrigerant R290 unmodified system.

5.6 On the basis of compressor work

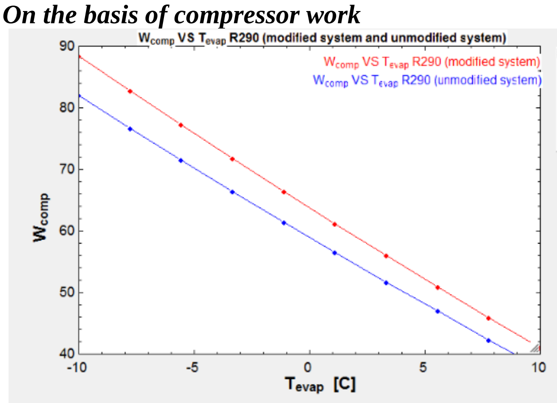

Figure – 12: W_{comp} VS T_{evap} for R290 modified & unmodified system

The compressor work of R290 unmodified system and its potential alternative refrigerant R290 modified system at varying evaporating temperature for condensing temperature of 30 ºC. As it is observed from the above figure the compressor work decrease with increase in evaporating temperature for both refrigeration system compressor work of refrigerant R290 modified system is quite higher than the compressor work of refrigerant R290 unmodified system.

6. CONCLUSIONS

In this work, comparative performance analysis of R290 with R22 on a single stage vapour compression refrigeration cycle was carried out for different evaporating temperatures at constant condensing temperature. The coefficient of performance with R290 closely matches with R22. However, higher COP can be expected by especially designed system pertaining to the properties of R290.Overall, R290 can be a better substitute to R22 in real applications because of its excellent environmental, thermo-physical properties and energy efficient performance.

The effect of adding the liquid-vapour heat exchanger in a mechanical refrigeration system was investigated theoretically using refrigerant R290. Engineering equation solver (EES) was used to solve set of equations based on the thermodynamic properties of the working fluid. The results were compared with the literature and obtained same trend and behavior. The results revealed that refrigerant R290 modified system higher COP compared with unmodified refrigeration system of R22 & unmodified refrigeration system of R290 . Thus COP can be improved and enhanced based on the refrigerant type and operating conditions when the liquid-suction heat exchanger used. It also presented that R290 has high response to increase the refrigerant effect when the liquid-vapour heat exchanger used. R290 is good alternative refrigerant and it can be used in mechanical refrigeration system. The superheating and subcooling effect were recorded with high value when the R290 was used in modified refrigeration systems.

7. FUTURE OF R290 AS AN ECO FRIENDLY REFRIGERANT

Figure – 13: 5 reasons why R290

While much of the United States is just beginning to make the transition to R290, it's already been in use across Europe for over 20 years. In fact, R290 is in use in an estimated 2.5 million commercial unit worldwide and in 2 billion household refrigerators and freezers. R290 is the refrigerant of choice for dozens of refrigeration manufacturers and many retailers, including target, have made the pledge to switch fully to this more eco-friendly refrigerant. Between its widespread industry applications, decades of successful use, and significant environmental benefits, R290 appears to be the accepted refrigerant of the future.

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