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Design and Development of R32a and HFO-1234yf Refrigeration blend in Air conditioning System

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Abstract: Refrigeration and air-conditioning systems become an integral part of modern society. Electricity-driven vapour compression systems have been dominating the heating, ventilation, air conditioning and refrigeration (HVAC&R) industry. The working fluids of these systems often contribute to the environmental issues in the forms of direct and indirection emissions. Pure refrigerants are often limited inmeeting criteria such as efficiency, flammability, toxicity, and compatibility. Meanwhile, refrigerant mixtures offer flexibilities to tune these criteria, This paper will review the status worldwide on technical and policy search for next-generation refrigerants with both low Global Warming Potential (LGWP) and low Life Cycle Climate Performance (LCCP) with particular focus on R410A replacement for unitary A/C & H/P. R32 and the HFO blends offer potential solutionsbut all involve tradeoffs among Global Warming Potential (GWP), efficiency, safety, and cost. With the U.S. mandating new higher regional efficiency standard taking effect January 2015, there is even more pressure in finding a Low-GWP refrigerant solution that is affordable and can sustain efficiency and reduce charge requirement. This paper focuses more on R32 as the available data for HFO blends is limited. And Mixing of both R32a and HFO-1234yf in Ac To Study the performance two different next generation refrigerants R32 and Hfo-1234yf.To determine most promising refrigerant blend for air conditioning system test observe, anaylize and compare result obtained with conventional refrigerant. To determine impact of R32 and HFO-1234yf refrigerant as a replacement of R410A

Keyword: MATLAB, Potential, blend, flammability, hydrofluoroolefin Refrigeration , COP, GWP, Thermodynamic properties

I. INTRODUCTION

Air-conditioning and refrigeration applications have been evolving from luxury to necessity. Demands for a better lifestyle and higher productivity has been pushing for the increased production of various types of power such as electricity, heating and cooling. The law of Physics dictates the mandatory heat rejection mostly to the ambient for the extraction of the useful effect from a thermodynamic cycle [1],[2]. The continuous rejection of heat, often with the mass flow, for instance; the exhaust gas from a power plant, is eventually detrimentalto the environment. Indeed, it is quite natural that the adverse environmental issues such as global warming further promote demands for systems that create a confined space at the desired temperature and humidity conditions. Along with the internal combustion engines, thermodynamic cycles at the heart of most heating, ventilation, air conditioning and refrigeration (HVAC&R) systems are often considered to be the major contributors to the environmental problems. The working fluids (the refrigerants) of the mechanical vapour compression (MVC) cycles are not always benign to the environment [3], [4], [5]. Thus the production and unavoidable leakages of these working fluids become a huge concern. Emissions associated with the production and leakages are termed as direct emissions. Palm reported that commercial refrigeration and mobile air conditioning systems were mainly responsible for the most substantialamounts of refrigerant leakage [6]. The ozone layer depletion is one of the damaging shreds of evidence of direct emissions. Early HVAC&R systems used chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFS). These refrigerants are considered as the culprits of the ozone layer depletion. R32 (Difluoromethane, HFC32, Methylene difluoride) is a single component refrigerant with critical pressure of 53.8 bar and -51.65 °C and 78.4 °C boiling point and critical temperatures respectively. As a substance, it has been studied for many decades, with the extensive research interest seen during the beginning of the 90ties, when the replacements for ozone depleting refrigerants have been searched for.nIn mixture with R125, R32 has been used to replace the ozone depleting R22 in small air conditioning systems and heat pumps. Considering generally better properties of R32, compared to R125, the later led to degradation of properties of the mixture while it has beenused as a fire suspension agent in order to mitigate R32 flammability. The 50/50% mixture of R32 with R125 is known as R410A and become a popular refrigerant used nowadays. HFO-1234yf was recently identified and selected as the preferred solution by global automotive OEMs.

It has vapor pressure and otherproperties similar to R-134a, but a 100 year GWP of 4 which meets the EU regulation requirements and also has excellent LCCP becauseits energy efficiency is similar to R-134a. It has no ozone depletion potential. It is marginally flammable, but extensive risk assessments have demonstrated it can be used safely in auto a/c systems (SAE, 2009). Recent research has begun to focus on the potential to use HFO-1234yf in stationary applications with small charge sizes wherethe flammability properties of HFO-1234yf can be managed. R32 and the HFO blends can offer near drop-in solutions with are seasonable balance of trade-offs among GWP, efficiency, A2L flammability, and system costs after appropriate building codes are available for commercialization. The refrigerants from chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) to hydrofluorocarbons (HFCs) have been evolved all over the world because of the ozone layer destruction. However, most HFC refrigerants have great global warming potential (GWP), for example R134a with a GWP of 1430, which are widely used in automobile air conditioning. And, R410a used in room air-conditioner widely with a GWP of 2088. The refrigerants with GWP higher than 150 are being phased out. With Europe's mobile air-conditioning (MAC) Directive went into force on Jan. 1, 2013, which requires new type-approved cars sold in EU market to use a refrigerant with GWP less than 150, HFo-1234yf has been proposed as a drop-in solution for current automotive air conditioners due to its low GWP of 4 [1], and similar thermophysical properties to those of R134a [2]. Meanwhile, R1234yf is not suitable as a substitute for R410a because of the limitation of thermal physical properties. Therefore, one of the resolution is the refrigerant mixtures, such as Hfo-1234yf/R32, that has a low GWP and higher performance. R-32 is a next generation refrigerant that efficiently carries heat and has lower environmental impact.

Refrigerant is a medium for conveying heatAir conditioners transfer heat while circulating refrigerant between the indoor and outdoor units.Although there are various types of refrigerants, R-32 is a new refrigerant currently receiving the most interest. Because R-32 efficiently conveys heat, it can reduce electricity consumption up to approximately 10% compared to that of air conditioners using refrigerant R-22. Furthermore, compared to the refrigerants widely used today such as R-22 and R-410A, R-32 has a global warming potential (GWP) that is one-third lower and is remarkable for its low environmental impact. Chemical Formula of R32a is CH_2F_2 R32a is known as difluoromethane and belong to the HFC family refrigerant R32a refrigerant Air Conditioning provide swing compressor for their high performance in their delivery pipe to provide extra cooling effect R410a refrigerant were using earlier because high GWP value and High Flammability is risk to use and many countries has banned R410a due this reason for replacement of 410a. R32a has been emerged as new refrigerant because of its Low GWP value and higher performance in AC it is completely environmental friendly and provide zero ozone depletion. R-32 can reduce electricity consumption by up to 10% claimed by Daikin. HFO-1234yf is a hydrofluoroolefin (HFO) refrigerant. HFO refrigerants are composed of hydrogen, fluorine and carbon atoms, but contain at least one double bond between the carbon atoms. Due to its composition, HFO -1234yf does not damage the ozone layer orhas minimal global warming impact. You do not need a refrigerant handling licence or a refrigerant trading authorisation to handle, sell or store this refrigerant. HFO-1234yf is a refrigerant that has a different chemical composition than traditional refrigerants used in automotive air conditioning. It is considered a hydrofluoro-olefin refrigerant. It also has zero ozone depletion potential and excellent Life Cycle Climate Performance (LCCP) compared to R-134a and CO_2 which indicates it has the least overall impact on global warmingin automotive air conditioning applications. A new low global warming potential (GWP) refrigerant hydrofluoro-olefin 2,3,3,3- tetrafluoropropene (HFO-1234yf) has been developed. HFO-1234yf has a very short atmospheric lifetime of 0.03 yrs and a GWP of 4.

These data allow for the design of new refrigeration systems and performance analysis of HFO-1234yf in existing air conditioning applications. HFO-1234yf has been shown to maintain both the capacity and efficiency previously seen in applications such as mobileair conditioning.

II. PROPERTIES COMPARISON - R32 VSR410A

1) The relative merits of R32 can be summarized based on a comparison of theoretical properties as shown in Table 1 :
2) considerably lower refrigerant cost than R410A and potentiallybetter affordability
3) available now in high volumes globally since it is 50% ofR410A composition
4) 8% higher critical temperature, better performance at higherambient conditions
5) similar pressure and pressure ratio, a close drop-in replacementfor R410A without major system redesign
6) 9% lower liquid density, lower system charge requirement
7) 28% lower vapor density and lower system mass flow rate,about 50% lower pressure drop expected
8) higher volumetric capacity despite the 28% lower mass flow dueto 43-50% higher latent heat
9) 41% higher liquid thermal conductivity, higher heat transfer coefficient at same mass fluxNo glide and potential to optimize heat exchanger with smaller tube volume for further charge

A. Chemical Properties of Hfo-1234yf

Sr.no	Parameter	Value
1.	Boiling Point	29°C
2.	Critical Point	95°C
3.	Saturation Point at 25°C	580 kPa Gauge
4.	Flammability Rating	Class A2L Refrigerant - Mildy Flammable
5.	Toxicity Levels	A (No ToxicityIdentified.)
6.	Lubricant Required	Pag Oil (Check unitfor specific type.)
7.	Sautration Pressure at 80°C	2400 kPa Gauge

B. Chemical Properties of R32a

Sr.no	Parameter	R32a values
1.	Molecular weight	52.02g/mol
2.	Melting Point ofSolid phase	-137ºc
3.	Boiling Point	-51.65ºc
4.	Critical Temperature	78.4ºc
5.	Standing Pressure	-245Psi - 255Psi
6.	Discharge Pressure	350Psi - 400 Psi
7.	Back Pressure	110Psi – 120Psi

C. List of Low GWP value of refrigerant :

While many of the proposed refrigerants have potential to replace R410A, R32 is the one the most studied. It has GWP value of 675 that is 3 times lower than that of R410A. Its thermodynamic and transport properties are well known and its vapor pressures are closeto that of R410A.

Refrigerant	Refrigerant	(Mass%)	Classification/expected classification
ARM-70a	R-32/R-134a/R-1234yf	(50/10/40)	A2L
D2Y60	R-32/R-1234yf	(40/60)	A2L
DR-5	R-32/R-1234yf	(72.5/27.5)	A2L
HPR1D	R-32/R-744/R-1234ze(E)	(60/6/34)	A2L
L41a	R-32/R-1234yf/R-1234ze(E)	(73/15/12)	A2L
L41b	R-32/R-1234ze(E)	(73/27)	A2L
R-32/R-134a	R-32/R-134a	(95/5)	A2L
R-32/R-152a	R-32/R-152a	(95/5)	A2L
R32	R32	100	A2L

The main limiting factor that restricts widespread use of R32 is that itis flammability. However, considering the requirements of F-Gas Regulation and absence of non flammable R410A replacement flammability is something engineers will have to deal with in thefuture refrigeration systems flammability is something engineers will have to deal with in thefuture refrigeration systems.

D. Analysis of R32a and Hfo-1234yf

Due to increase in GWP value in R410a So we require to check the COP value and GWP value which can replace the R410a. As per various information collect form the research paper blend of R32a and HFO-1234ze was there in last decade but due to flammability issue decrease in coefficient of performance, increase in environmental effect. We are in search for new refrigerant for the better result and increase in performance and reduce in the harmfull gases which release while using the Air conditioning system we can check the refrigerant effect and its performance by using MATLAB software which can provide analytical method, graphical form of the aspect which is require to calculate performance and its GWP value by its Vapor compression cycle, Energy calculation, Mass transfer etc which can provide better result to get the exact result for future use.

We are using the blend of R32a and HFO-1234yf as refrigerant in SplitAir conditioning System. In this MATLAB Software we can analysis various result by coding the mathematical formulae in the software for check the coefficient of performance R32a has GWP 675 and COPis 20% value it will make blend with HFO-1234yf which has GWP is 4has low flammability and reduce electricity usage we can reuses its gases and provide better blend by mixing both refrigerant to form single gas and it will create the better result in the Refrigeration system. We has got the composition of R32a and Hfo-1234yf is (60/40) whichis 60% of HFO-1234yf and R32a is 40% and another composition is 50% of R32a and 50% of HFO-1234yf which make balance in the blend of the refrigerant system we will perform the analysis of this combination in the MATLAB software and we will check all aspect which is require to make a blend of R32a and HFO-1234yf and increase its value of COP after mixing of both refrigerant in the proportion of which we will get result by the software analytical method of the refrigerating effect of the Air conditioning system.

E. MATLAB Software

Matlab software is a programming platform designed specifically for engineers and scientists to analyze and design systems and products that transform our world. The heart of MATLAB is the MATLAB language, a matrix-based language allowing the most natural expression of computational mathematics Today, it has been observed that with various protocols, halogenic chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) refrigerants will not be used in the future and various alternatives must be created. In the conventional cooling efficiency coefficient (COP) calculation method, thermodynamic property tables and pressure-enthalpy diagrams are used. Thanks to the proposed method, it will not be necessary to use these tables and diagrams when calculating the COP. It will be sufficient to take images from the regions indicated by the infrared imaging system. In this study, performance analysis of commercial refrigeration systems of R32a and HFO-1234yf fluids that are alternative to R410a fluid, which are friendly to the ozone layer, has been performed. With the prohibition of the consumption of CFC gases, the use of HCFC gases, another gas group that damages the ozone layer, has been restricted and then banned. The most used of these gases is R410a gas. There are two methods are proposed: COP with regional feature data acquisition and COP. In addition, on the two interfaces realized, the sizes obtained from infrared images are compared graphically and numerically. According to the obtained numerical and visual application results, R438A showed the closest recording performance to R410a gas. Compared to traditional computational performance tests, the ease of use of the system has shown that it is more advantageous in terms of remote measurement and simultaneous

III. CONCLUSION

In this research we got the various composition of mixing the two refrigeration blend R32a and HFO-1234yf which can get better result than the last decade refrigerant which has been used and recently banned by European countries due to high GWP value and Harmful effect on environmental condition for human comfort and higher ODPvalue which can create hole in Ozone layer and it will effect our human bodies its harmful for human comfort.

1) We has found the replacement for R410a which is R32a has one third GWP of R410a and higher COP value than the R410a and ZeroODP value which will reduce the harmful gas and provide better result.
2) In this blend we has got composition of mixing of two refrigerant and perform its analysis for get the result. The composition we got are(60/40) which is 60% of HFO-1234yf and R32a is 40% and another composition is 50% of R32a and 50% of HFO-1234yf which make balance in the blend of the refrigerant system

3) Another Composition we got in this HFO-1234yf values is higher than the R32a which make the 72.5 of HFO-1234yf and 27.5% of R32a which will definitely provide better result because of HFO-1234yf has lower GWP value which will create higher COP value and lower usage of electricity in the operation cost and result it will provide reuse of this gases and increase its efficiency of Air conditioning system
4) We will get the analysis in the MATLAB software can provideaccurate result and performance will be analytical method for the result in mathematical form by using the various formulae.
5) We will get the analytical method in MATLAB software by using the various method in which can provide analytical method, graphical form of the aspect which is require to calculate performance and its GWP value by its Vapor compression cycle, Energy calculation, Masstransfer etc.

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