Review on Experimental Investigation to Evaluate Coefficient of Performance by using Refrigerant Hc-22a in Domestic Refrigerator as Alternative With R-134a

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Abstract— Today environment safety is the greatest problem. Now a day's domestic refrigerator is working on refrigerant R-134a which has zero ozone depletion potential (ODP) but having considerable global warming potential (GWP). It must be phased out soon due its considerable global warming potential (GWP). Now in proposed work, an experimental investigation on domestic refrigerator with hydrocarbon refrigerant (HC22a) as an alternative to R-134a is to be carried out without any modification in refrigeration cycle or a system. Coefficient of performance (COP) and Refrigerating effect (RE) will be taken as parameters for evaluation. The refrigerator performance will be investigated using energy consumption test. This paper presents review on experimental investigations performed to evaluate coefficient of performance of various eco-friendly refrigerants in domestic refrigerator as an alternative to R-134a.

Keywords- *Domestic refrigerator, HC22a, R134a, Refrigerating effect. COP.*

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I. INTRODUCTION

The ozone depletion potential (ODP) and global warming potential (GWP) is the most important criteria while selecting the new refrigerants. Now a day's domestic refrigerator is working on the refrigerant R-134a which has zero ozone depletion potential (ODP) but having low global warming potential (GWP). Results from many researches show that ozone layer is being depleted due to the presence of chlorine in the refrigerants. The presence of fluorine atoms in R-134a is responsible for the major environmental impact (GWP) with serious application for future development of the refrigeration based industries and also increase the earth temperature.

In proposed experiment hydrocarbon HC22a used as alternative to R-134a, which has also zero ozone depletion potential (ODP) but having negligible global warming potential (GWP) compared to low GWP of R-134a.

II. LITERATURE REVIEEW

Ratnesh Sahu comparatively analyased mint gas with R-12 and R-134a refrigerants. Mint gas is an azeotropic mixture of propane (R290) and isobutene (R600a). It has property similar to R-12 and R-134a which is commonly used refrigerant now a days. This blend of hydrocarbons is used in most of the ac of European cars. It contains 60% propane+40% isobutene. It is named as mint gas because it has cooling property like mint. Moreover it has zero ozone depletion potential and negligible global warming potential. He made the following tabulated comparison:

Product	Mint gas	R12	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	-31c	-30c	-26c
Latent heat	367 KJ/Kg	145 KJ/kg	189 KJ/kg

This blend is used for domestic refrigerator because of its following reasons-

- Operates at similar pressure to R-12 and R-134a.
- Having similar volumetric refrigerating effect to R-12 and R-134a.
- Can be used with R-12 and R-134a heat exchangers and expansion devices.

Through his experimental investigation he concluded that mint gas was giving more COP than refrigerants R-12 and R-134a and it has advantage that it does not react with compressor oil. The only disadvantage regarding with this gas is flammability, which can be an obstacle in its implementation.

Abhishek Tiwari and R. C. Gupta experimentally studied the performance of R-404a and R-134a in domestic refrigerator. In this experiment instead of R-134a, the refrigerant R-404a is used in domestic refrigerator which is environment friendly refrigerant with zero ozone depletion potential (ODP) and low global warming potential (GWP). They analyzed the performances by considering the following parameters: Refrigerating effect, COP and compatibility of compressor.

It is found that R-404a has better cooling capacity than R-134a. It also increases life of compressor. And it is found that it is best alternative to refrigerant R-134a. So in the proposed project HC-22a can be used as a refrigerant as it too has a zero ozone depletion potential (ODP) and negligible global warming potential (GWP). This leads to the possibility that HC-22a can perform better than R-134a as done by R-404a.

Somchgai Wongwises and Nares Chimres presented an experimental study on the application of hydrocarbon mixture to replace HFC-134a in domestic refrigerator. The hydrocarbon refrigerants are propane (R290), butane (R600) and isobutene (R600a). This experiment is done by dividing the mixtures in three groups: the mixture of three hydrocarbon, the mixture of two hydrocarbon and the mixture of two hydrocarbon and comparison was made with HFC-134a. The experiments are conducted with the refrigerants under the same load condition at a surrounding temperature of 25^0C.

This experiment consider the parameter like energy consumption, compressor power, refrigerant temperature, and pressure at inlet and outlet of the compressor It is found that among all three hydrocarbon mixture, mixture of propane (60%) and butane (40%) is the appropriate alternative refrigerant to HFC-134a. similar investigation can be performed by using HC-22a as a refrigerant.

B. Baskaran and P. Koshy Mathews performed an analysis on vapour compression refrigeration system with various eco-friendly refrigerants of HFC-152a, HFC-32, HC-290, HC-1270, HC-600a and RE-170.

Considering the comparison of performance coefficient (COP) and pressure ratio of the tested refrigerants and also the main environmental impacts of ozone layer depletion and global warming, refrigerant RE-170 was found to be most suitable alternative among refrigerant tested for R-134a. The performance coefficient of the system increases with increase in evaporating temperature for constant condensing temperature

M.A.Sattar[1], R.Saidur[2], and S.S.Masjoki[3] designed a domestic refrigerator to work with R-134a and was used as test unit to determine the possibility of using hydrocarbons and their blends as refrigerants. Pure butane, isobutene and mixture of propane, butane and isobutene were used as refrigerants. The performance of refrigerator using hydrocarbons as refrigerants was investigated and compared with the performance of refrigerator when R-134a was used as a refrigerant.

In this experiment effect of condenser temperature and evaporator temperature on COP, refrigerating effect. Condenser duty, work of compression and heat rejection ratio were investigated. After successful investigation on the performance of hydrocarbon and blends of hydrocarbon refrigerants it is found that COP of the system is comparable to R-134a and also energy consumption is similar to R-134a. This suggests that blends of hydrocarbon can be used as an alternative to R-134a.

M. Fatouh and M. El. Kafafy conducted tests to examine LPG of 60% propane and 40% commercial butane as a drop in substitute for R-134a in a single evaporator domestic refrigerator with a total volume of 0.283m3. They found that freezer air temperature of -12^0C can be achieved using LPG charge of 50g or more for capillary tube length ranging from 4m to 6m.They also found that as LPG charge increases, freezer and cabinet air temperature decreases. Minimum electric energy is achieved with LPG charge of 60g and capillary tube length of 5m combination. This experiment also indicates using of an alternative refrigerant for r-134a. Flammability is one of the drawbacks of using LPG as a refrigerant. Also the overall size of domestic refrigerator will increased if LPG kit is installed. This may increase the cost of domestic refrigerator and also it may acquire large area.

A.S. Dalkilic and S.wongwises performed the theoretical study on traditional vapour compression refrigeration system with refrigerant mixtures based on HFC134a, HFC152a, HFC32, HC290, HC1270, HC600 and HC600a for various ratios and their results are compared with CFC12, CFC22 and CFC134a as possible alternative replacement.

Considering the comparison of coefficient of performance (COP) and pressure ratio of tested refrigerants and also the main environmental impacts of ozone layer depletion and global warming, refrigerant blends of HC290 (40%) + HC600a (60%) and HC290 (20%)+HC1270 (80%) are found to be the most suitable alternatives among refrigerants tested for R12 and R22 respectively. The refrigeration efficiency, coefficient of performance (COP) of the system increases with increasing evaporating temperature for a constant condensing temperature. Similarly Hc22a can be tested for R-134a.

Dr. A.C. Tiwari and Shyam Kumar Barode performed an analysis on vapour compression refrigeration system by using four ozone friendly hydro-fluorocarbon HFC refrigerants R125, R134a, R143a and R152a to replace R-12. The experiment was done to evaluate the coefficient of performance (COP), refrigerating capacity (RC) and compressor work at various evaporating and condensing temperature.

Among all the tested refrigerants R152 has higher coefficient of performance (COP), higher refrigerating capacity than R12, while R134a has a slightly lower COP and higher refrigerating capacity than R12. On the basis of this study HC22a which is also an eco-friendly refrigerant can be evaluated for its COP and refrigerating capacity.

III. CONCLUSION

The review from the above studies concludes that although R-134a is conventionally used refrigerant, there is an immense possibility of using alternative refrigerants conventionally.

R290, R600a, R404a, HFC-152a, HFC-32, HC-290, HC-1270, HC-600a, RE-170 and LPG are found to be certain alternative refrigerants. The comparative studies between these refrigerant and R-134a shows that different blends and other new refrigerant has a possibility of being used conventionally. Overcoming certain drawbacks, if possible could result into the use of more eco-friendly refrigerants, HC22a is one such suggested refrigerant. So the proposed project aims at studying the performance of HC22a in the domestic refrigerator

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