International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

R 290 AS Substitution to R 22 and Mixture of Refrigerant in the VCRS- A Review

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Abstract: ***The outcome of R290 as a drop in replacement of R22 has been reviewed in this paper. As per Montreal Protocol, R22 is going to be phase out due to its unfavorable impacts related to environment e.g. ozone depletion potential (ODP) and global warming potential (GWP). R290 has zero ODP and considerably GWP as compared to R22. The releasing of refrigerants in the surroundings becomes the cause of issues pertinent in environment. A detailed review about the experimental studies associated with the performance of R407C is provided. The aim is to put together all the diversified information about the R290 in a single paper. It is found after the careful observation that R22 performs somewhat better than R290 in many aspects i.e. COP, Cooling Capacity, Energy Consumption, and Exergetic Analysis but retrofitting point of view, it is best suitable refrigerant and R290 is suitable for new design.***

Keywords: Natural refrigerant; refrigeration system; R22; R290.COP

I. INTRODUCTION

After an early struggle with natural refrigerants and issues like their flammability, the industry received a major catapult with the discovery of CFCs and HCFCs. Since their introduction in 1930, CFCs and HCFCs have been widely used. This success can be attributed to their excellent thermo-physical properties and security. However, in 1974, it had been observed that CFCs and HCFCs are responsible for ozone layer depletion. Ozone layer is a protective shield, the depletion of which leads the harmful ultra violet (UV) rays to enter the earth's atmosphere. Taking this effect into account, decisions were made regarding the phasing out of CFCs and HCFCs at the Montreal

Protocol in 1987. While manufacturers were still in the process of replacing CFCs with HCFCs and subsequently HCFCs with HFCs, another environmental issue, that is, global warming came into light. Climate change and rise in

average temperatures of earth's atmosphere are the serious consequences of the global warming. Though HFCs and many other substances had a lower value of ozone depletion potential (ODP) they were discovered to have higher global warming potential (GWP) value. This created the need for new environment friendly yet energy efficient refrigerants. The search for such a refrigerant seems to have taken researchers back to the natural hydrocarbon such

as Propane (R290).[2]

II. HISTORY OF REFRIGERANTS

The working fluid used to transfer the heat from low temperature reservoir to high temperature reservoir is called refrigerant. There are different types of refrigerant which are dissuasion below.

A. *CFC:* They are molecules composed of carbon, chlorine and fluorine. It contributes to the destruction of the ozone layer. These are R11, R12, R113, R500, R502 etc.
B. *HCFC:* They are molecules composed of carbon, chlorine, fluorine and hydrogen. They are less stable than CFCs, destroy ozone and to a lesser extent. These are R22, R123, R124, R401a etc.
C. *HFC:* They are molecules composed of carbon, fluorine and hydrogen. They do not contain chlorine and therefore do not participate in the destruction of the ozone layer. But it has a high Global Warming Potential (GWP). 2.4 Hydrocarbon
D. *(HC):* This is primarily propane (R290), butane (R600) and isobutene (R600a). These fluids have good thermodynamic properties, but are dangerous because of their flammability.[3]

III. ALTERNATIVES TO R22

Suggestive alternatives to R22 are R134a, R290 (Propane), R407C and R410A. R407C and R410A are a zeotropic blend of R32/R125/R134a (23/25/52 by wt %) and R32/R125 (50/50 by wt %) respectively. It is suggested that acid and poisonous

substances may be formed if R134a is decomposed by the sunlight in the troposphere and the world may face another catastrophe due to this which is worse than the CFC experience [1]. R134a required larger compressor and inapt for most of the refrigeration application. Flammability is the major disadvantage of R290. It shows unsuitability for adopting it as per an alternative to R22 due to safety issues. As per the literature survey, R407C is looking the best candidate as a drop in substitute for R22.[2]

Table 1. Properties of some Alternatives Refrigerants

Refrigerants	Molecular weight (kg/mol)	NBP (^{0}C)	T_{CR} (^{0}C)	P_{CR} (MPa)	ODP	GWP (100years)	Safety Group
R 22	86.47	-40.8	96.20	4.99	0.055	1700	A1
R 290	44.10	-42.1	96.8	4.25	0	11	A3
R 134a	102.03	-26.1	101.1	4.06	0	1300	A1
R 407 C	86.2	-43.6	86.1	4.62	0	1530	A1
R410 A	72.56	-50.5	72.5	4.96	0	1730	A1

IV. LITERATURE REVIEW

Ramesh P. Sah, and Ranadip K. Das As the analysis of they were found the result of entire range of evaporating temperatures from -10 to 4^{o}C and condensing temperatures from 40 to 54^{o}C.R290 has the lowest pressure

R143a requires the lowest compressor power for entire range of evaporating temperatures from -10 to 4^{o}C and condensing temperatures from 40 to 54^{o}C..

R290 has highest cooling capacity for entire range of evaporating temperatures from -10 to 4^{o}C and condensing temperatures from 40 to 54^{o}C.

R152 has the highest COP for entire range of evaporating temperatures from -10 to 4^{o}C and condensing emperatures from 40 to 54^{o}C.

R32 has the highest discharge temperature for entire range of evaporating temperatures from -10 to 4^{o}C and condensing temperatures from 40 to 54^{o}C.[11]

Ameya P. Shrivastava1, Choudhari Chandrakishor S. Evaluation of thermo physical properties showed that R290 is far better than R22, i.e. it has high specific heat and thermal conductivity & low viscosity and density values. Theoretical cycle performance of both the refrigerants for the varying temperature range of -30°C to 15°C shows that R290 is a promising alternative refrigerant to R22. Refrigerating effect is higher and discharge temperature is lower for R290 compared to R22. Though, COP value for R290 is slightly lower, but it can be improved by specially designing a refrigeration system for it. Hence, it can be concluded that refrigerant R290 is an excellent replacement for refrigerant R22 for medium temperature.[12]

V. CONSTITUENTS

A. Following Process for Constituting is Adopted.

1) The compressor is removed from air conditioner and recovering of R22 can be possible along with
2) Mineral oil. The quantity of mineral oil is measured further.
3) A small quantity of fresh polyolester oil is charged in compressor and it is run dry.
4) The oil was drained and same is repeated at least twice.
5) The compressor is reinstalled in the system and the filter-drier is replaced by a solid core filter-drier.
6) The system is checked for leaks with dry nitrogen and kept for evacuation for an hour.
7) Fresh charges of polyol ester oil same as the mineral oil is charged.
8) The system is evacuated to a vacuum of 500 microns.
9) R-290 is filled into the system. R-290 is 95% of the original R22 charge [2].

VI. CONCLUSION

Accelerated technological improvements in the areas of refrigeration and air conditioning have produced severed environmental problems i.e. ODP and GWP due to the use of CFC and HCFC. A large number of experimental studies of various researchers have shown in this review paper regarding performance of R290.

Performance of R290 is little low but it is the best alternative of R22 for retrofitting point of view. A brief summary is given below:

A. Parameter Effect of R290 in comparison to R22

COP	Lower
Cooling Capacity	Lower
Energy Consumption	Higher
Discharge Pressure	Higher
Pressure Ratio	Higher
Discharge Temperature	Lower
Specific Compressor Displacement	Same
TEWI	Lower
Exergetic Analysis	Lower

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