

Need of Eco Friendly Refrigerants to Reduce Environmental Impacts-A Case Study

Pramod Kinker

Sr. Lecture, Dept. of Mechanical Engg. Government Polytechnic College, Damoh (MP), India

ABSTRACT: The purpose of this study is to identify the various refrigerants on the basis of their environmental impacts. The refrigerant fluids are a key component for air conditioners and refrigerators, both of which are essential for comfortable living. Since the 19th century there have been many refrigerants developed and used but none of them has yet become the standard fluid. The objective of this study is to identify environmental impacts of the most prominent refrigerants as they apply to the refrigeration process. The conventions and the worldwide research on refrigerants suggests the approach of ideal refrigerants which are non hazardous for environment and called as eco friendly refrigerants consequently reduces the environmental impacts.

I. INTRODUCTION

An international agreement comes in existence in year 1987 as Montreal Protocol to stop or reduce the manufacturing of chloro fluoro carbons (CFCs) and other ozone-depleting substances. This international agreement required to stop using the widely used refrigerant, "Freon", that up to that time was considered as a "miracle compound". Since then, there have been many studies and much discussion about alternative refrigerants. However, as of now there is no single alternative refrigerant for air conditioners. This report is divided into five sections as shown in fig1.

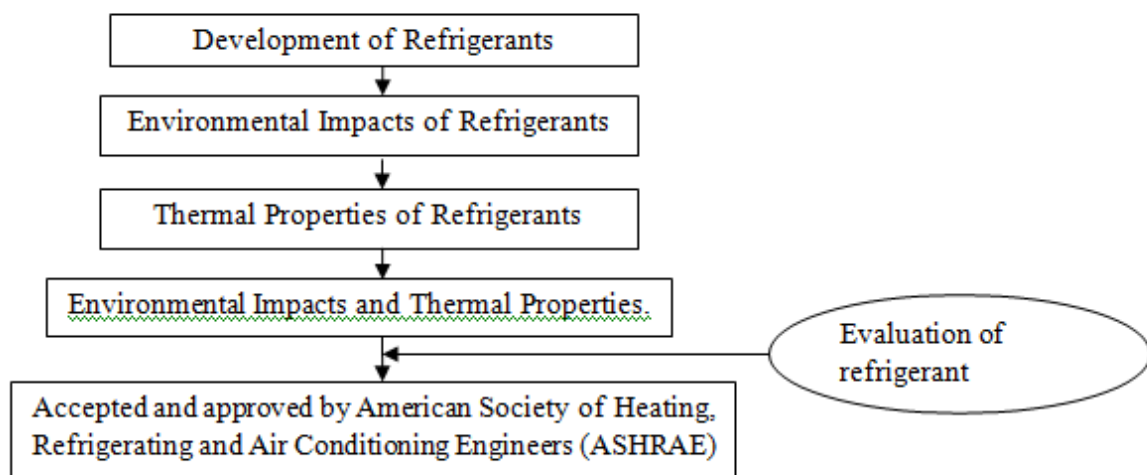


Fig 1

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II. IDEAL REFRIGERANTS

As need arises to save ozone depletion layer and environment it becomes necessary to search the refrigerants having various properties eco friendly in nature and consequently the concept of ideal refrigerant originate. In addition to having the desired physical properties, an ideal refrigerant should be non-toxic, nonflammable, fully stable inside a refrigeration system, environmentally benign even with respect to decomposition products, and easy to manufacture. It also should be self-lubricating (or at least compatible with lubricants), compatible with other materials that are used to fabricate and service refrigeration systems, easy to handle and detect, and low in cost. Furthermore, it should not require operation at extreme pressures. It is a very long list of qualities and none of the current refrigerants can be considered as coming close to the ideal one. When Midgley was asked to develop refrigerants, there were only seven criteria are as shown in fig 2

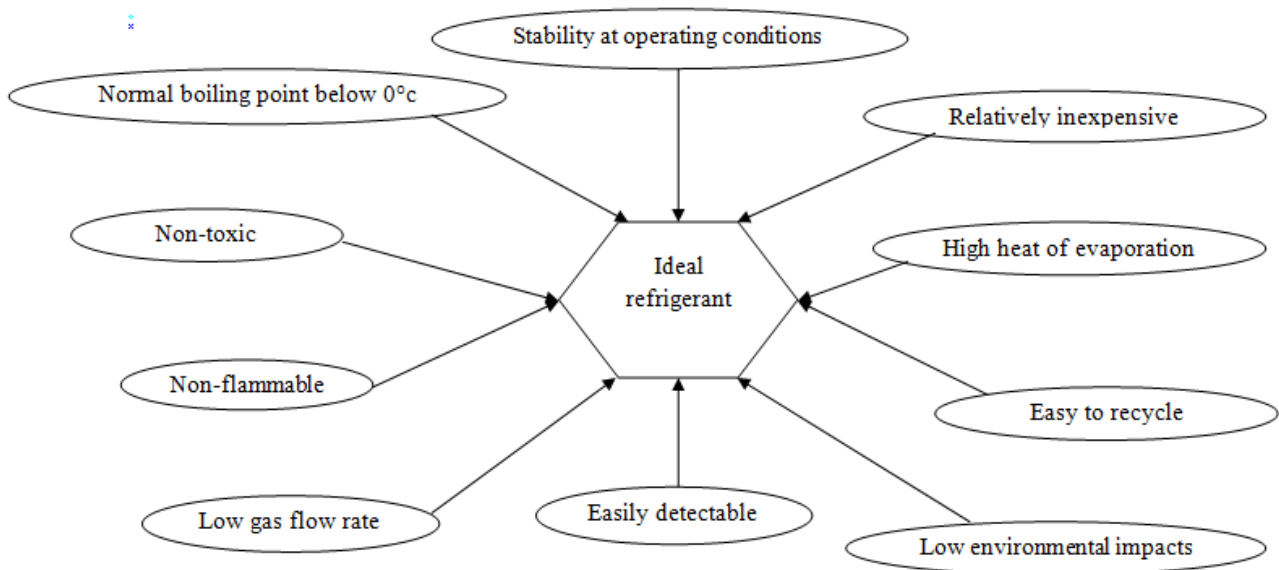


Fig 2

III. CONTROL OF CFCS AND HCFCs

From the study of properties of different refrigerants and the concept of ideal refrigerants worldwide research and conventions, it has been observed that the CFCs and HCFCs has the potential of hazardous environmental impacts and need to replace with the new eco friendly alternatives as shown in table-1

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Table:-1

Sn.	Year	Scientist/Events	Contribution
1	1974	James Lovelock	Acknowledged the existence of CFCs in the global atmosphere
2	1974	Rowland and Molina	Perception of ozone depletion due to CFC emissions
3	1977	United Nations Environment Program(UNEP)	World plan of action on the ozone layer
4	1987	Vienna Convention	Twenty-eight countries agreed for the Protection of the Ozone Layer
5	1989	Montreal Protocol	Introduced substances that deplete the ozone layer
6	1990	London Amendment	Added methyl chloroform, carbon tetrachloride and an additional range of CFCs to the phase-out schedules and established a mechanism for financial and technical assistance to developing country parties.
7	1992	Copenhagen Amendment	Added hydro chlorofluorocarbons (HCFCs), hydrobromofluorocarbons (HBFCs), and methyl bromide to the phase-out schedules and formally created the Multilateral Fund as the route for financial and technology assistance.
8	1997	Montreal Amendment	Created a system of licenses for imports and exports of ozone-depleting substances,
9	1999	Beijing Amendment	Added bromochloromethane to the phase-out schedules and extended the controls on HCFCs
10	1999	Montreal protocol including the Beijing Amendment	Protection of the ozone layer, many substances are controlled now under the Montreal Protocol on substances that deplete the ozone layer.

IV. LIFE CYCLE ASSESSMENT

There are different methods to measure environmental impacts. (i.e. production, operation, disposal stages). The Eco-indicator 99 has defined the term "environment" as being subject to three types of damage:

- a) Human health,
- b) Ecosystem quality, and
- c) Resources.

The higher the Eco-indicator numbers, the more adverse is the environmental impact. The indicators are numbers that express the total environmental load of a product or process and are included in the ISO 14042 standard (International Organization for Standardization).

Some people use the total equivalent warming impacts (TEWI) as defined by the Alternative Fluorocarbons Environmental Acceptability Study and the U.S .Department of Energy (DOE). They represent the sum of the direct contribution of emissions of a product to the atmosphere as greenhouse gases plus the indirect contribution of the carbon dioxide emissions resulting from its operation, including electricity consumption.

V. SUM OF ENVIRONMENTAL IMPACTS

The cumulative Eco-indicator 99 impacts are calculated from the production, operation, and disposal stages considering the required charging quantity. These results can be summarized as follows -

- The operation stage is the most important with regard to environmental impacts.
- With regard to least environmental impact, butane is the preferred refrigerant and is better than the present refrigerants such as R-22 and R-134a.

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- The traditional refrigerant, ammonia, has a low environmental impact.
- The Eco-indicator 99 for use of electricity has a large effect on environmental impact.
- The destruction stage of HCFCs and HFCs has seven times more impact than the production process.
- For HC refrigerants, the destruction process is favored due to energy

VI. ECO FRIENDLY REFRIGERANTS

The Montreal protocol phase out the CFC refrigerants like R11 R12 and R500 were the main stay of the refrigeration industry. These refrigerant replaced by HCFC, having small no of chlorine with good physical, thermodynamic and safety properties. Copenhagen revision of the Montreal protocol has depicts restricted HCFC refrigerant due to their considerable ozone depletion and global warming potential. None depleting substances is focused on HFC not contains any chlorine having no ozone depletion effect. HFC 134a in pure and blended mixtures like R404a, R407C and R410A are favorably consider for application in commercial and industrial refrigeration and air conditioning. The use of HFCs and blends is constantly ever-increasing in developed with developing countries. In the Kyoto agreement HFC have been acknowledged as a major green house gases and it may cause of global warming.

As the controlling measures under Kyoto protocol regarding emission of CO₂, CH₄, and N₂O will have a positive effect on ozone depletion. But decision regarding HFC may affect the ability to phase out CFC as per the Montreal protocol. The table 2 shows the comparative environmental properties of CFC with their possible alternative refrigerants.

Sno.	Refrigerants	ODP	GWP	Toxicity	Flammability
1	CFC11	1	4500	no	no
2	CFC12	1	8500	no	no
3	HCFC22	0.055	1700	no	no
4	HCFC142b	0.0065	2000	no	no
5	HFC32	0	580	no	yes
6	HFC125	0	3200	no	no
7	HFC134a	0	1300	no	no
8	HFC152a	0	140	yes	yes
9	ammonia	0	0	no	no
10	CO	0	1	no	no
11	PROPANE	0	3	no	yes
12	butane	0	3	no	yes
13	water	0	0	no	no

Table:-2

From the study it has been observed that HFCs have considerable global warming potential, while HFC 152a has a very small GWP and may considered as a medium term substitute with control of flammability. It has been reported that binary and ternary mixtures of R512a with any inflammable refrigerant perform better with increased COP and less power consumption if used in place of R12. The refrigerants NH₃, CO₂, hydrocarbons and water having no ozone depletion potential and negligible global warming potential can replace CFC. Ammonia is the refrigerant effectively used in vapor compression refrigeration cycle, and can be use for designing and developing new systems to meet the challenges of CFC replacement. The water as refrigerant is used in absorption system with developing technology permits it for use in compression cycles at higher working pressure in the system restricts the use of water as refrigerant. The CO₂ as an attractive refrigerant has increased manifolds due to its environmental and economic

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properties; particularly its use in supercritical series is in active consideration in mobile air conditioners and different applications. The hydrocarbons resembling propane, butane and isobutene are highly flammable but considered the best option as alternatives for replacing HFCs. The hydrocarbon mechanism accompany by suitable safety actions have been adopted by countries in Europe and showing acceptance in developing countries also. The table 3 gives overview of use of alternative eco friendly refrigerant for various applications.

Table:-3

Application	HFCs used	Possible eco friendly refrigerant
Domestic refrigeration	R134a,R152a	HC600a and blends
Commercial refrigeration	R134a,R404a,R407c	HC blends,NH3,CO2
Cold storage, food processing and industrial refrigeration	R134a R404a R507c	NH3,HCs,CO2
Unitary air conditioners	R410a,R407c	CO2,HCs
Centralized AC (chillers)	R134a, R410a,R407c	NH3,HCs,CO2,water
Transport refrigeration	R134a R404a	CO2
Mobile air conditioners	R134a	CO2,HCs
Heat pumps	R134a R152aR404a,R407c R410A	NH,HCs,CO2,water

VII. CONCLUSIONS AND RECOMMENDATIONS

The main concentration of this study is to find the need of eco friendly refrigerants to reduce environmental impacts. It is found that the Hydrocarbons are mainly environmental friendly. Therefore the alternate substitute can be used for the domestic and small commercial refrigeration appliances without the hazard of the global environment and lives.

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