

HYDROCARBON REFRIGERANTS, PROMISING SUBSTITUTES IN LOW CAPACITY REFRIGERATION SYSTEMS-A REVIEW

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ABSTRACT

The CFC refrigerants are the most promising refrigerants for a long time but after noticing the harmful effect on the Earth's protective ozone layer they have been regulated internationally by Montreal Protocol since 1989. Subsequently, it was found that CFCs also contributed significantly to the global warming problem. The initial alternatives like HCFS also contributing considerably to the Global Warming. The Hydro carbon refrigerants are found to be promising substitutes to CFC in low capacity refrigeration systems.

KEYWORDS: CFC, HCFC, HC, ODP and Global Warming

INTRODUCTION

Since the 1930s, chlorofluorocarbons (CFCs) have been widely used as foam blowing agents, aerosols and refrigerants due to their excellent properties such as stability, non-toxicity, non-flammability, and good thermodynamic properties. In particular, R12 has been predominantly used for small refrigeration units including domestic refrigerators. They also have harmful effect on the Earth's protective ozone layer [1]. So, they have been regulated internationally by Montreal Protocol since 1989. Subsequently, it was discovered that CFCs also contributed significantly to the global warming problem. The global warming potential of R12 is considered to be 8500 times that of CO₂ over 100 years [2]. Greenhouse gas emissions led to the Kyoto Protocol in 1997. It was thus decided that by 2010, producing and using of CFCs should be prohibited completely all over the world. In consequence, lots of researches have been done to find the suitable replacement for CFCs.

Initial alternatives included some hydro chlorofluorocarbons, or HCFCs, but they would be also phased out internationally around 2020- 2040 because their ozone depletion potentials and global warming potentials are in relative high levels though less than those of CFCs. By that time compounds such as HFCs (hydro fluorocarbons), which are benign to the ozone layer, are expected to have replaced HCFCs. As a result, it became a very urgent issue to search and develop CFC and HCFC alternatives.

For the past decade, R134a has been used to replace R12 used in refrigerators and automobile air conditioners. At present in India more than 80% of the refrigerators working with R134a[3]. R134a has such favourable characteristics as zero ODP, non-flammability, stability, and similar vapour pressure to that of R12.

HYDRO CARBON REFRIGERANT

Hydro fluorocarbons, such as R134a, have almost zero ozone depletion potential, since they do not contain chlorine atoms in their chemical structure. They are safe, non inflammable and have vapour pressures similar to that of R12. Hydrocarbon Refrigerants are natural, nontoxic refrigerants that have no ozone depleting properties and absolutely minimal global warming potential. The most efficient and environmentally safe refrigerants in the world are the five natural refrigerants which are Air, Water, Carbon Dioxide, Ammonia and Hydrocarbons.

We call them 'The Famous Five'. All existing Fluorocarbon Refrigerants will be phased out in some shape or form over the coming years because of their ozone depleting properties or global warming potential. However, there is an answer created by nature, not by a chemical company — Hydrocarbon Refrigerants. Hydrocarbon Refrigerants are not just good for the environment; they can also save you up to 36% on your energy costs. Air-conditioning systems are the largest consumers of electricity for any building. The energy used in cooling generally accounts for 60% of buildings total energy consumption. By converting to hydrocarbon refrigerants, substantial energy savings can become a reality.

Hydrocarbon Refrigerants are 50% more efficient conductors of heat than Fluorocarbon Refrigerants and their operating pressures are about 20% lower than that of Fluorocarbon Refrigerants. These lower operating discharge pressures reduce the work that the compressor has to do thus reducing wear and tear. There is less pressure on pipe work, joints, hoses, fittings and the like reducing the likelihood of leaks. This can and will extend the working life of your equipment. All these advantages equate to an energy saving of between 17% and 36% with an average of 25%. Many European manufacturers of commercial and domestic refrigeration equipment have changed to hydrocarbon technology. Every year approximately 8 million hydrocarbon based refrigerators are produced in Europe, each using around 30% less energy than refrigerators using fluorocarbon refrigerants. These include companies such as Bosch, Electrolux, Miele, Whirlpool and AEG. The large supermarket chain in the UK called Sainsbury's has built six new stores using hydrocarbon refrigerants to refrigerate the entire store.

In Asia LG produces over 11,000 refrigerators per day using hydrocarbon refrigerant. In China, hydrocarbon refrigerants are used by 3 out of 4 of the largest refrigerator manufacturers. The technology to convert existing refrigeration or air-conditioning systems to hydrocarbon refrigerants has been available for the last 20 years. Properly trained Technicians and Engineers can ensure adequate control of health and safety risks associated with any use of hydrocarbon refrigerants.

Naturally occurring substances such as water, carbon dioxide, ammonia and hydrocarbons are believed to be environmentally safe refrigerants. Now in India CFC phase out were successfully implemented by replacing R12 with R134a, but it has to be controlled due to relatively high GWP. So, interest of the environmentally safe refrigerants is growing. Furthermore, it is desirable that the designed refrigerants, replace the current refrigerants without any major change in the system equipment. A trade-off between all these factors have been considered while proposing the mixtures in our thesis. The present study mainly concentrated on substitutes R134a refrigerators.

Hydrocarbons (HCs) are an environmentally sound alternative for CFCs/HFCs. HCs as a refrigerant have been known and used since the beginning of 20th century. The development of the CFCs in the 1930s put the HC technology in the background. Now the Hydro Carbon Refrigerants are gaining importance. Most of the natural refrigerants are also considerably cheaper than their synthetic alternatives.

In fact, hydrocarbons are known to offer such advantages as a low cost, availability, compatibility with the conventional mineral oils as well as PAG and POE. However, their use has been hindered in other developed countries mainly due to their high flammability. They are environmentally friendly with zero ozone depletion potential, and they do not cause the greenhouse warming effect. The main disadvantage is that they are highly flammable substances and must be handled with caution. Also, blends or mixtures of some refrigerants can be considered as substitutes or alternatives to existing refrigerants [4].

These provide the possibility of a zero ozone depletion potential, low toxicity, chemical stability, together with suitable thermodynamic, physical and chemical properties. It is possible to mix hydrocarbon refrigerants with other alternative refrigerants, such as HFC, to replace R134a in domestic refrigerators. Alternative refrigerants should have stable thermodynamics, physical and chemical properties, low in-flammability and good miscibility with lubricants[5]. The only disadvantage of HCs relative to other refrigerants is flammability. The reduction in flammability can be achieved by mixing HCs and HFCs together. This process reduces the amount of flammable substance, consequently, flammability risk will be reduced. The global warming potential will be at least two-thirds less than when HFCs are used alone and also decreases the cost of such mixture. The proposed ternary mixture of HFC/HC used in this study has saturation properties matching very closely with those of R134a.

CONCLUSIONS

The research on alternative refrigerants should be continued with focus on Hydro Carbon blends as the flammability issue seems to be minimised when they are blended with other refrigerants and the performance also is encouraging.

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