# A Brief Review on Uses of Refrigerant Used In Various Refrigeration System

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***ABSTRACT: This article examines the evolution of refrigerants from their early uses to the present, before addressing future paths and prospects. The article divides the history of refrigerants into four decades based on specifying selection criteria. It addresses the displacement of previous working fluids using consecutive criteria, as well as how curiosity in some older refrigerants resurfaced, such as increased interest for those currently designated are natural refrigerants. The research analyses the prospects for current choices in the framework of current trade conventions, such as the Montreal and Kyoto Protocols, which aim to prevent stratospheric anthropogenic factors and global warming, respectively. It also looks at other environmental issues as well as other domestic and international regulatory measures. The debate demonstrates how focused emphasis on specific environmental concerns or regulatory requirements, as opposed to coordinated solutions to multiple issues at once, can result in unintentional environmental harm that almost always necessitates subsequent reversals.***

***KEYWORDS: Global Warming, Heat, Refrigerants, Refrigeration, Water.***

## 1. INTRODUCTION

In ancient times, refrigeration relied on ice storage, evaporation of water, and other evaporative methods. Phase change physics was investigated by a large number of scientists in the 1600s and 1700s, and their conclusions laid the groundwork for "artificial" refrigeration (man-made refrigeration). Water can be frozen into ice by using a volatile fluid in a closed cycle, which was first proposed by Oliver Evans in the 1800s. This involved the use of vacuum-sealed ether to produce refrigeration, which was then piped through a water-cooled heat exchanger where it was condensed for re-use. In spite of the lack of documentation, his theories probably had an impact on both Jacob Perkins and Richard Trevithick. In 1828, he proposed an air-cycle swamp cooler, but he never built one[1]. He is credited with identifying the Perkins Cycle, which is a thermal vapor technique, as an important contribution to the refrigeration industry.

Although the original design called for sulfuric ethyl ether as a refrigerant, the early testing used an industrial solution that Perkins had on hand as a printer. First generation of coolants, which included anything that worked and was available at the time of the invention [2]. They were combustible, poisonous, or both, and some of them were extremely reactive as well. Without human interference, natural refrigerants occur naturally in nature's biological and chemical cycles Among the natural refrigerants used in refrigerators are ammonia, carbon dioxide and sulphur dioxide, as well as water, air and ethers. Between 1800 and 1930, natural refrigerants dominated the HVAC (Heating, ventilation, and air conditioning) business until the advent of high-performance synthetic refrigerants [3].

After ozone depletion and climate change were caused by synthetic coolants and fossil fuels, scientists and manufacturing businesses were pushed to abandon the use of halogenated compounds and fossil fuel extraction in favor of natural refrigerants or alternative fuels [4]. There's plenty of water on the Earth that's non-toxic, non-flammable, and accessible everywhere. When compared to CFCs, R-718 has a far higher refrigeration effect. However, it needs ten times greater flow rate for a similar refrigeration capability. For safety reasons, refrigerators are often required to have their doors removed before disposal[5]. A phenomena known as refrigerator death has seen boys running hide-and-seek asphyxiated while lurking inside discarded refrigerators, particularly older models with latching doors. Since August 2, 1956, refrigerator doors in the United States are no longer allowed to latch, and they can be opened from the inside per federal law. These days, modern units include an internal magnetized door seal, which prevents the door from closing but allows it to be pulled open from within.

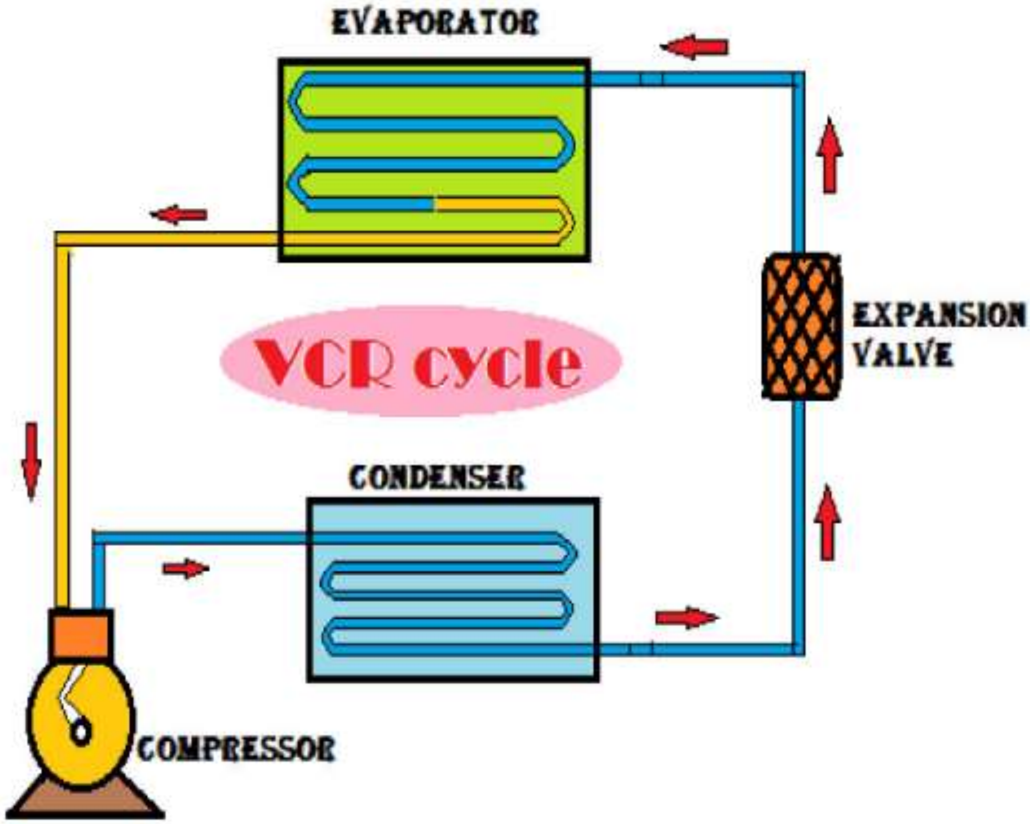


**Fig. 1: Illustrates the working of vapor compression refrigeration cycle, used in most of the refrigeration system showing all its part[6].**

Fig. 1, Illustrates the working of vapor compression refrigeration cycle, used in most of the refrigeration system showing all its part. It is a closed system that employs liquid refrigerant and compresses and expands the refrigerant in four steps, converting it from liquid to vapor. Due to heat being absorbed or released by the system throughout this process, surrounding air that passes over the unit's components will have a different temperature than it had before. As a result of this cycle, nearly all of the chillers we use today achieve cooling. Evaporator, condensing unit, compressor, and expansion valve make up the VCRS (vapor compression refrigeration system) system. In both the evaporator and the condenser, coils are used to increase the surface area of the refrigerant. When it comes to mechanical units that manage temperature and pressure changes, compressors and expansion valves come to mind.

Located at opposing ends of a system, the evaporator and condenser handle the heat exchange within and outside of the system. In the beginning, the VCRS is charged with a liquid refrigerant until it achieves the necessary working pressure. A high-pressure/high-temperature vapor is created as soon as the system is turned on. After that, it goes through a coil that allows air to escape to the outside. Outside air blows through the condenser coils, removing the heat, which in turn cools down and condenses the vapor into a liquid. As a result of this, liquid is pumped to the expansion valve, where it is swiftly expanded back into low-pressure vapor again. Because of this, the refrigerant also experiences a fast pressure drop. There has been a lot of interest in two-phase ejectors as an energy efficient expansion device since the introduction of trans critical air conditioners in the late 1980s. Research has been done on vapor-ejector refrigeration systems that use ecologically benign refrigerants by several researchers.

**Table 1: Illustrates the various types of refrigerant used for cooling a space according to need and available space[7]**

| Refrigerant | Boiling Point (°F) | Specific Heat @ 86°F (Btu/lb. °F) | ODP | GWP | Atmospheric life (years) |
|---|---|---|---|---|---|
| R-11 | 74.7 | 0.21 | 1.000 | 4600 | 45 |
| R-12 | -21.6 | 0.24 | .82 | 10600 | 100 |
| R-22 | -41.4 | 0.31 | 0.034 | 1900 | 11.8 |
| R-123 | 82.0 | 0.21 | 0.012 | 120 | 1.4 |
| R-134a | -15.0 | 0.36 | 0 | 1600 | 13.6 |
| R-404A | -51.9 | 0.37 | 0 | 4540 | (13.6-53.5) |
| R-410A | -60.9 | 0.41 | 0 | 2340 | (5.6-32.6) |
| R-502 | -49.5 | 0.30 | 0.221 | 6200 | (11.8-1700) |
| R-507 | -52.8 | 0.35 | 0 | 4600 | (32.6-53.5) |

Refrigeration systems and heat pumps use refrigerants, which are working fluids that undergo repeated phase transitions from liquid to gas and back again. Compounds used as refrigerants might be either liquid or gaseous. When paired with other components such as compressors and evaporators, it could provide refrigerated or climate control. Refrigeration and freezing would be impossible without refrigerant. Outside, a fan blasts hot air over coils, which then exhausts the refrigerant to the outside. As a result, the refrigerant is reduced in temperature and becomes a low-pressure gas. As a result, a second fan situated within the home circulates cold air throughout the whole. The cycle continues itself repeatedly to perform the process of refrigeration to a fixed space. In air conditioners, refrigerants play a crucial function. Liquid or gaseous forms are common. Refrigerators are used to cool a place. Numerous refrigerants function to remove heat from one location and transfer it to another. Various appliances such as air conditioners, cooling machines, etc., employ these refrigerants. To transform a gas into a liquid, they often exploit the thermodynamic occurrence of phase shifts. Table 1 illustrates the various types of refrigerant used for cooling a space according to need and available space.

## DISCUSSION

Air conditioners use refrigerants, which absorb fluid and release heat. In addition, refrigerants rely on thermodynamic phenomena of phase shift. This aids in the conversion of liquid to gas and gases to liquid. The evaporator subsystem is where the refrigerant process begins. Under low pressure, the refrigerant liquid can transfer energy and turn into vapor. The vapor travels towards the system's compressor.

*2.1 First generation:*

Solvents and other volatile fluids were the most frequent refrigerants for the first 100 years. They were the first generation of refrigerants, which included anything that worked and was available. They were combustible, poisonous, or both, and some of them were extremely reactive as well. Unfortunately, accidents were commonplace. As an example, a number of companies promoted propane over ammonia as the odorless safety refrigerant".

"Propane is a non-corrosive, non-obnoxious, and non-destructive substance," according to an old advertising**.** "Propane is a non-corrosive chemical, therefore there's no corrosive activity according to an old commercial. It's neither obnoxious nor harmful, so the engineer can work in it without discomfort." Despite the fact that ammonia continues to be preferred over hydrocarbons in industrial applications, the high flammability of big systems has been and remains a bigger worry as a result of this methodical search, the first refrigerant with a feasible design and increased performance was discovered. Fig. 2, Illustrates the progress of evolving refrigerant used in various refrigeration unit to cool down the space with the flow of time, the evolution of refrigerant not took place in one day it took many centuries for the refrigerant to take modern evolution.

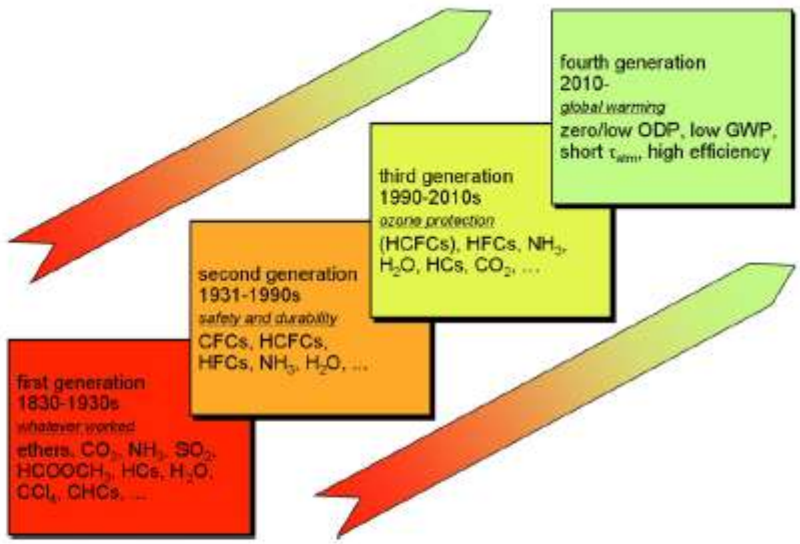


**Fig. 2: Illustrates the progress of evolving refrigerant used in various refrigeration unit to cool down the space with the flow of time[8]**

*2.2 Second generation of refrigerant:*

In the second gen, flour chemicals were used for safety and durability. Early efforts to market residential freezers to replace iceboxes were hampered by leakage of methyl format and Sulphur dioxide. A new refrigerant is needed for the refrigeration sector, if it is ever going to succeed. It was decided to limit the search to substances that were known to be stable, but not hazardous or combustible. However, organic fluorides accurately suspected that the real boiling temperature was substantially lower than that recorded for carbon tetrafluoride. Medley swiftly eliminated those elements from the periodic table that had inadequate volatility. On the basis of their low boiling temperatures, he then eliminated those resulting in unstable and hazardous chemicals, as well as inert gases. Carbon, nitrogen, oxygen, Sulphur, hydrogen, fluorine, chlorine, and bromine were the only eight elements left. Increment temperature from 1860 to 2000 that shows a phenomena of global warming is effecting the world's temperature as illustrated in Fig. 3.

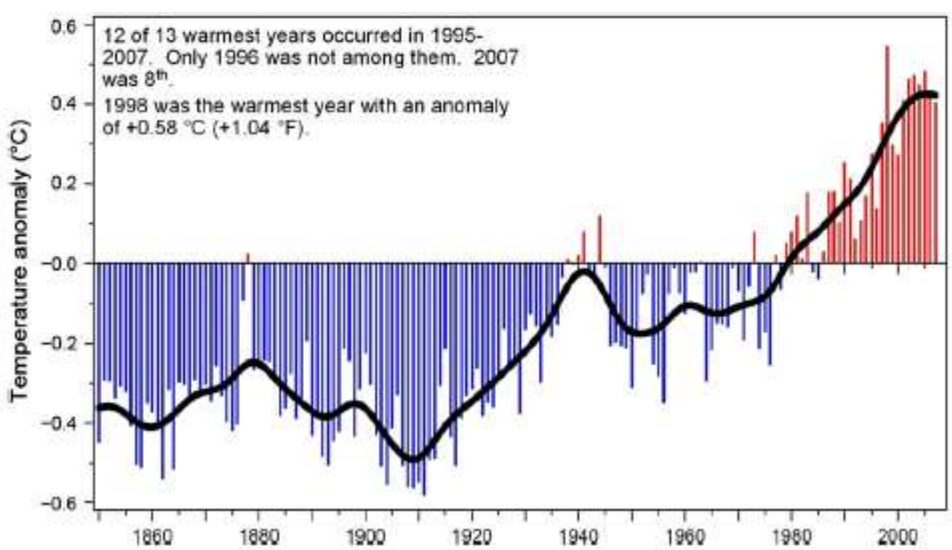


**Fig. 3: Illustrates the rise in temperature from 1860 to 2000, that shows a phenomena of global warming is effecting the worlds temperature[9]**

*2.3 Refrigerant related to third generation:*

When CFCs (chloro fluorine carbon), particularly CFC refrigerants, were released and linked to the loss of protective ozone, third-generation technology was developed with an emphasis on stratospheric protection from CFCs. Ozone-depleting compounds had to be phased out as a result of the Vienna Convention and Montreal Protocol Hydrofluorocarbons (HFCs) for the long term and HCFCs for interim (transitional) use remained the main focus of fluoro chemicals. Ammonia, carbon dioxide, hydrocarbons, and water are among the natural refrigerants that have resurfaced as a result of these alterations. Both formal and informal research programmers studied a wide range of non-fluoro chemical and hydro fluoro ether (HFE) possibilities, but only a small number of them showed promise. Fig. 4 illustrates the versatile application of refrigerant in different type of industries for completing different purposes. Fig. 5 illustrates the refrigeration cycle working.

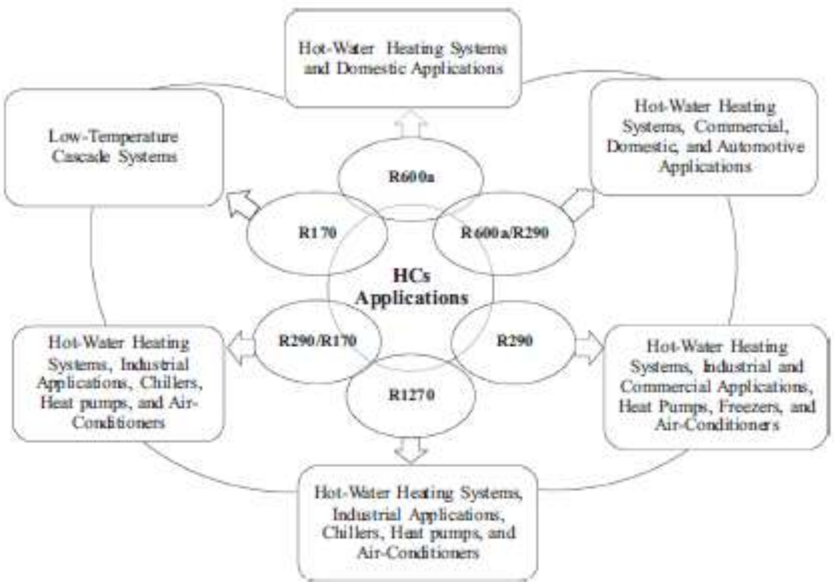


**Fig. 4: Illustrates the versatile application of refrigerant in different type of industries for completing different purposes[10].**

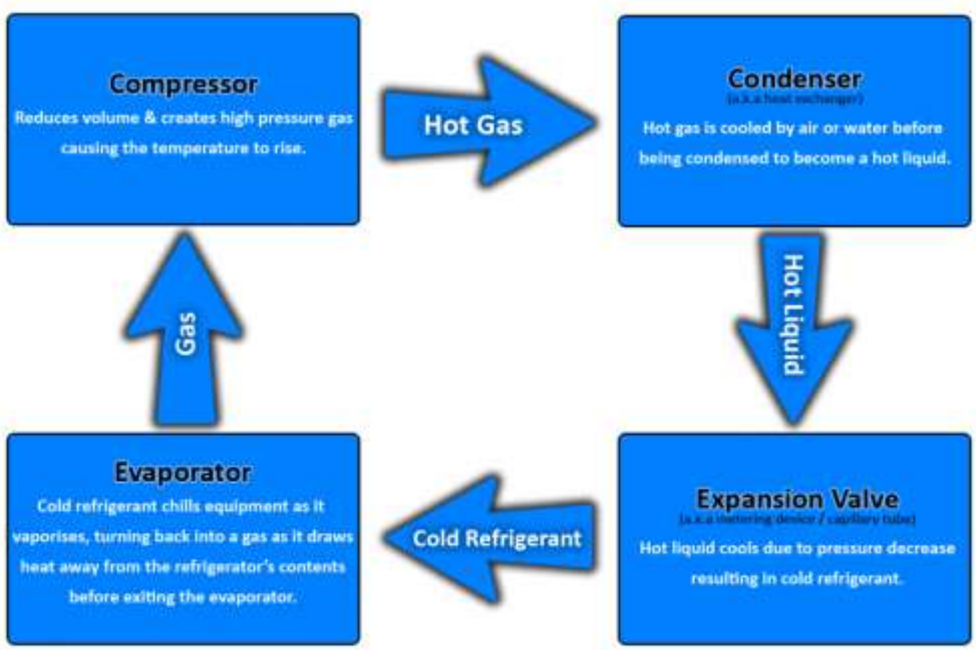


**Fig. 5: Illustrates the refrigeration cycle working [Fridge Freezer Direct].**

## CONCLUSION AND IMPLICATION

It has a significant impact on the refrigeration and air conditioning industry. An in-depth look into eco-friendly refrigerant and nano refrigerant applications is presented in this research paper. Refrigeration and air conditioning companies can benefit from scientific research on ecologically friendly refrigerants as they make the shift to sustainability. Despite the fact that the deadline is rapidly approaching, many countries remain unsure or ignorant. Permission to use HFCs for a limited period of time is a temporary solution, not a reason. It's almost clear that future regulatory constraints will extend beyond mobile air conditioners. Numerous refrigerants, including many HFCs that are today seen as new alternatives could soon become old rejects. Future refrigerant selections should be based on a comprehensive review of all environmental issues, rather than a piecemeal approach that risks eliminating good overall solutions because of modest or even indiscernible impacts on particular issues. Using a parametric quantification model of natural and synthetic refrigerants, this work aims at optimizing the decision-making process. A refrigerant's techno-economic data can be used in a parametric quantification to make a better choice. Although there has been conducted extensive research in the sector refrigerant but this domain is not limited and more research is demanded to explore the full potential many material as refrigerant.

**REFERENCES**

[1] B. O. Bolaji, I. O. Abiala, S. O. Ismaila, and F. O. Borokinni, “A theoretical comparison of two eco-friendly refrigerants as alternatives to R22 using a simple vapour compression refrigeration system,” *Trans. Famena*, 2014.

[2] S. Benhadid-Dib and A. Benzaoui, “Refrigerants and their environmental impact substitution of hydro chlorofluorocarbon HCFC and HFC hydro fluorocarbon. Search for an adequate refrigerant,” 2012, doi: 10.1016/j.egypro.2012.05.096.

[3] G. Li, “Comprehensive investigations of life cycle climate performance of packaged air source heat pumps for residential application,” *Renewable and Sustainable Energy Reviews*. 2015, doi: 10.1016/j.rser.2014.11.078.

[4] H. Averfalk, P. Ingvarsson, U. Persson, M. Gong, and S. Werner, “Large heat pumps in Swedish district heating systems,” *Renewable and Sustainable Energy Reviews*. 2017, doi: 10.1016/j.rser.2017.05.135.

[5] K. A. AIKINS, S.-H. LEE, and J. M. CHOI, “TECHNOLOGY REVIEW OF TWO-STAGE VAPOR COMPRESSION HEAT PUMP SYSTEM,” *Int. J. Air-Conditioning Refrig.*, 2013, doi: 10.1142/s2010132513300024.

[6] M. Mohanraj, S. Jayaraj, and C. Muraleedharan, “Environment friendly alternatives to halogenated refrigerants-A review,” *International Journal of Greenhouse Gas Control*. 2009, doi: 10.1016/j.ijggc.2008.07.003.

[7] S. Paul, A. Sarkar, and B. K. Mandal, “ENVIRONMENTAL IMPACTS OF HALOGENATED REFRIGERANTS AND THEIR ALTERNATIVES: RECENT DEVELOPMENTS,” *Int. J. Emerg. Technol. Adv. Eng. An ISO Certif. Int. J.*, 2013.

[8] J. M. Calm, “The next generation of refrigerants - Historical review, considerations, and outlook,” *International Journal of Refrigeration*. 2008, doi: 10.1016/j.ijrefrig.2008.01.013.

[9] X. Fan, F. Wang, H. Zheng, X. Zhang, and D. Xu, “Behavior and performance of refrigerant mixture HFC125/HC290 in heat pumps,” 2013, doi: 10.1115/IMECE2013-63552.

[10] V. W. Bhatkar, V. M. Kriplani, and G. K. Awari, “Alternative refrigerants in vapour compression refrigeration cycle for sustainable environment: A review of recent research,” *International Journal of Environmental Science and Technology*. 2013, doi: 10.1007/s13762-013-0202-7.