Brussels, September 2023

ASERCOM, the Association of European Refrigeration Component Manufacturers, represents the platform for dealing with scientific and technical topics and their challenges, promoting standards for performance rating, methods of testing and product safety, focusing on improved environmental protection, serving the refrigeration, air conditioning and heat pump industry and its customers.

The HVACR industry has manufacturing sites and R&D facilities throughout the EU. Equipment manufacturers within the industry realize a turnover of over 30 billion euros and employ more than 200,000 people in Europe alone. These employment numbers do not count the vast network of small- and medium-sized enterprises such as contractors who install, service, and maintain refrigeration, air conditioning, and heat pump equipment. It is estimated that those small- and medium- sized enterprises would bring the total count of HVACR-related companies in the EU to 15,000+. (Source: *EPEE Members. epeeglobal.org. (2021)*. https://epeeglobal.org/members)

Introduction

PFAS as defined in the PFAS Restriction Proposal the five National Authorities submitted to ECHA on 13th January 2023 are applied in vapor compression refrigeration systems, which are widely used in various products, from small equipment like household refrigerators or small air conditioning (AC) systems up to cooling systems for power stations and large AC systems for high-rise buildings. Industries as well as many small SMEs which are using vapor compression systems as base are serving heating, refrigeration and air conditioning applications.

We would like to emphasize the role of some of those molecules listed on the PFAS in our sector, which are making our systems affordable, durable, and effective from a decarbonization standpoint.

Some of those molecules refer to refrigerants, some others to fundamental components refrigerant-independent (polymers), which make them even more important for the next years of transitions.

Vapor compression refrigerating systems

HVACR is dominated by vapor compression systems because of their high efficiency and reliability. The vapor compression system is the most robust and cost efficient way to transfer heat from a low temperature to a high temperature level by compressing vapor to high pressure.

These basic features are utilized for a lot of different applications with capacities ranging from below hundred watts to several megawatts. Systems are deployed globally with an electricity consumption around 20% of the overall electricity consumption (Source: IIR, International Institute of Refrigeration).

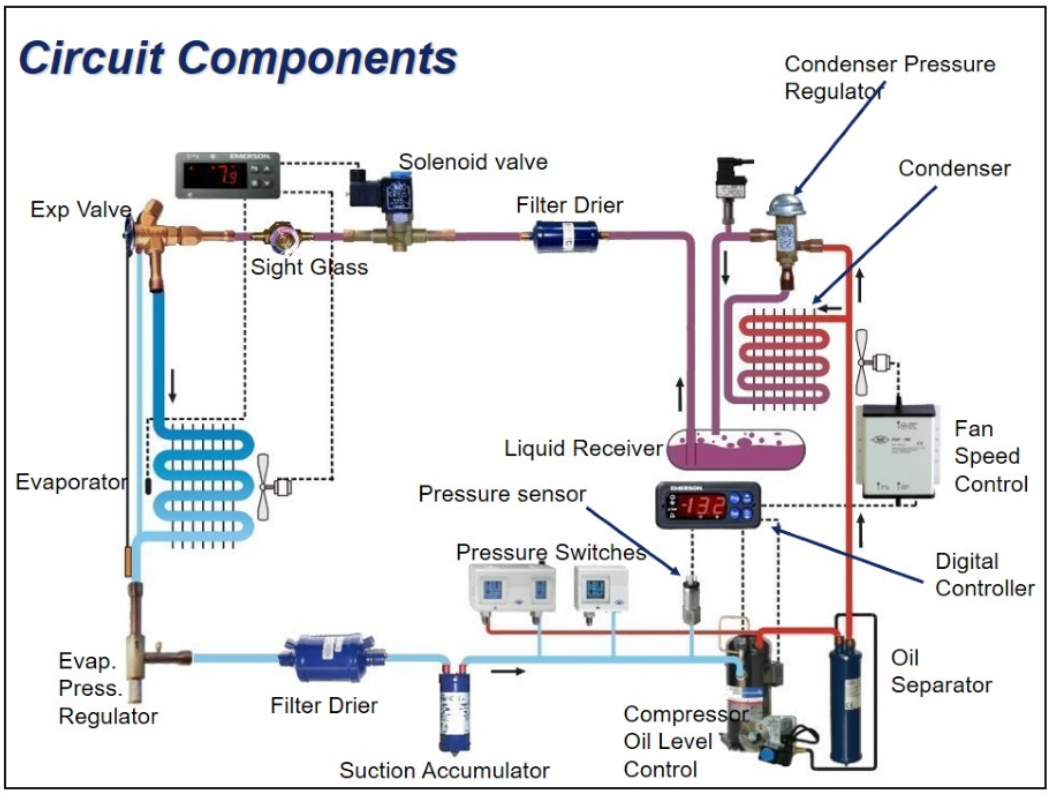


Figure of basic Vapor compression refrigerating system

Nowadays the complete cold chain of for example foods or pharmaceuticals starting in the production, via transport, storage in warehouses, supermarkets or pharmacies and the consumers at least is based on vapor compression systems.
In addition, vapor compression systems are believed to be pivotal in decarbonizing the heating sector via heat pumps for space heating. Especially the industrial sector is relying on the development of industrial high-temperature heat pumps to elevate the available waste heat to a temperature level that can be used for their processes. Thus the demand for higher temperature compatible components and materials increases.
Even for converting waste or geothermal heat into electric power utilized by the Organic Rankine Cycle (ORC) which is quite similar to the cycle in electrical power plants, fluorinated refrigerants are used as working fluids.
All these systems are operated using fluids (refrigerants) as energy carriers, lubricants to keep the moving parts running and other construction or design elements like sealings or coatings that may contain PFAS.

<u>Examples of use in vapor compression systems:</u>

Mobile and stationary applications:

- Heat pumps and air conditioning for domestic commercial and industrial applications (offices, hospitals, factories, public transport and public buildings)
- Refrigeration for food production, transport storage and shops (Cold chain)
- Industrial process cooling and heating

PFAS Refrigerants

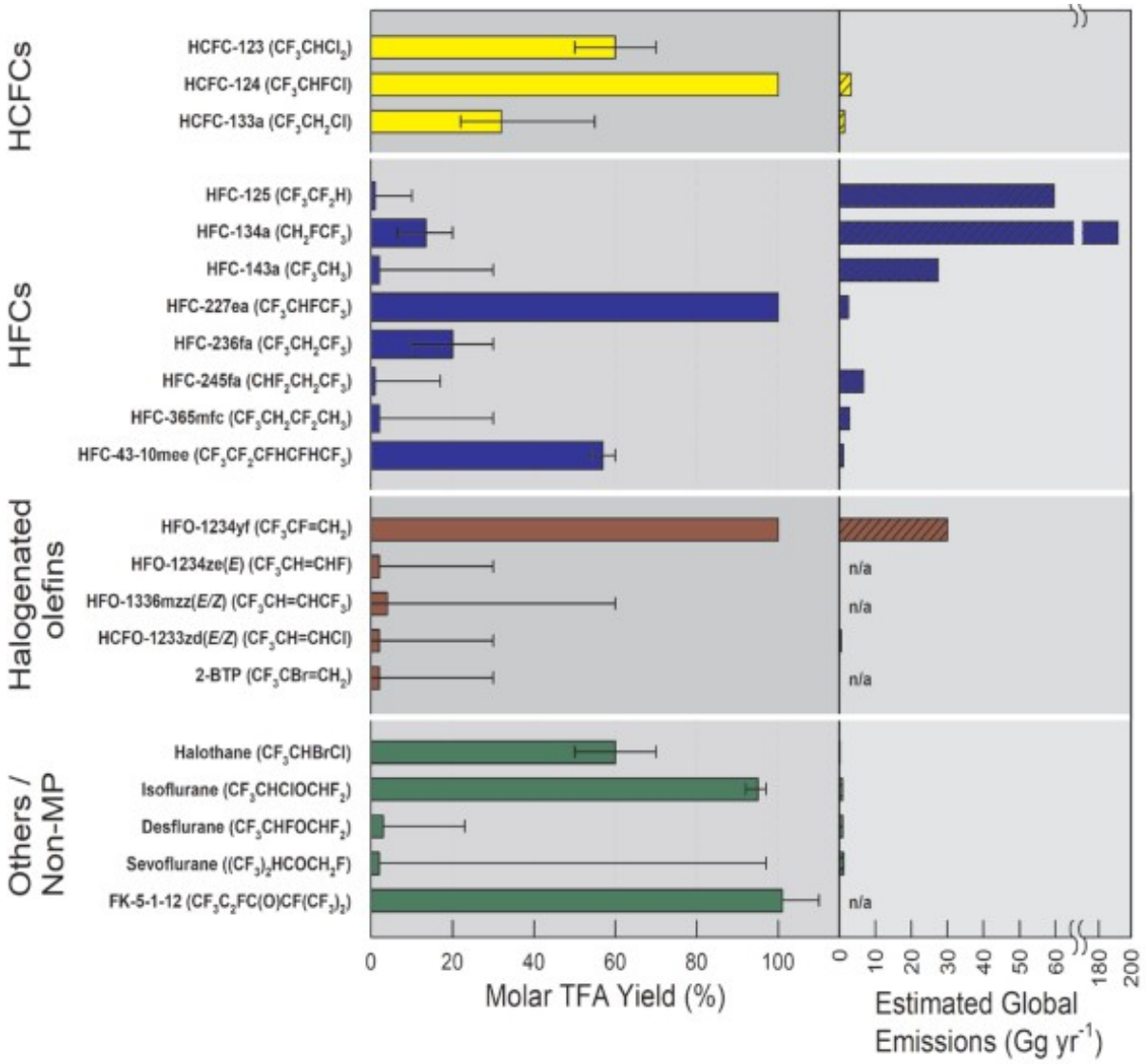
The system relies on a ‘refrigerant’ fluid, which for some types – the F-gases called HFCs or HFOs – are mostly classified as PFASs as well as their breakdown products known as TFA (Trifluoroacetic acid).

Not all F-gases are PFAS-classified as they break down to HF (no CF_3 part). Some of the PFAS-classified HFOs have very small TFA yields from breakdown, while others have 100 % TFA formation.

Refrigerants can also be non-PFAS substances, e.g., naturally occurring gases like CO_2, ammonia, or propane. Component manufacturers deliver products for natural refrigerants as well as for F-gases.

The main reason for using F-gases in the past and nowadays was safety. Safety is a concern if the gases are toxic or flammable and usage is regulated through complex safety standards.
Components use minor amounts of F-gases directly (thermostatic valves), but many more are designed to contain F-gases in the use phase.

The newly applied HFO gases like R1234ze and R1336zd have a low amount of TFA formation [Environmental Effects of Stratospheric Ozone Depletion, UV Radiation, and Interactions with Climate Change; UNEP 2022 Assessment Report of the Environmental Effects Assessment Panel], and, they are important substances to reduce global warming impact of refrigerants and support the green transition by saving energy and emissions from fossil fuel heating. See figure below:



PFAS Fluoropolymer material in components

During the last 50 years components of the vapor compression process have become increasingly driven by various regulations like Ecodesign, demanding higher energy efficiency while at the same time being more affordable. There are multiple drivers for that innovative development and one of the most important is the development of materials and manufacturing processes.

Besides efficiency, among the materials the fluoropolymers have been outstanding contributors to long service lifetime, low leakage and reliability as demanded and are today seen as critical materials for several component and construction element types. For the application of the so-called natural refrigerants especially CO_2 (R744) or hydrocarbons (R290, R600a etc.) an increased use of fluoropolymers is necessary to secure safety and reliability of the products.

Already today, the typical operating temperatures of vapor compression systems range down to -60 °C, in special cases around -100 °C, and up to 150 °C or more at the discharge side of compressors. Development of more heat reclaim units and industrial high temperature heat pumps will elevate the discharge temperature to around 200 °C, the electric motor temperature up to

approximately 180 °C, pressures can range from near a vacuum up to 45 bar and up to 135 bar in CO_2 systems. Sealing, flexibility and safe electric insulation shall be ensured at these temperature and pressure ranges, in refrigerant and oil atmosphere, for the full lifetime (up to 45 years). For some of these components so far no alternative substances are known providing same or similar properties or qualities. For the substitution of many of those substances long-time tests have to be carried out to identify and prove the suitability of new materials.

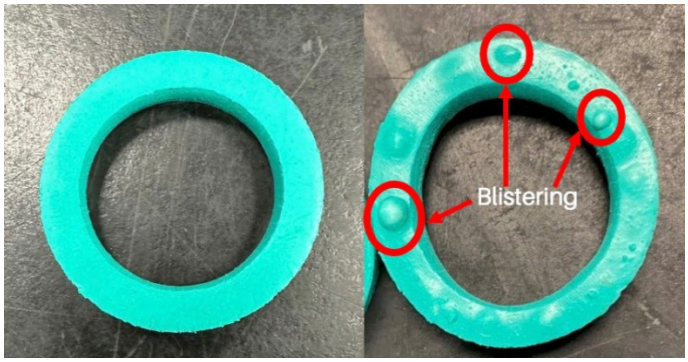
The substitution of PFAS elements might in many cases cause a significant redesign of the complete components, especially in the light that so far many components are released for more than one refrigerant. Alternative substances which are just suitable for a specific fluid would multiply the number of components to handle in production, whole sale and installation site and increase the danger of failure and damages due to wrong choice.

Usually these kind of components are installed and disposed of by qualified personnel. In this light a containment and recycling strategy for these polymeric parts could be an alternative to a ban or restriction.

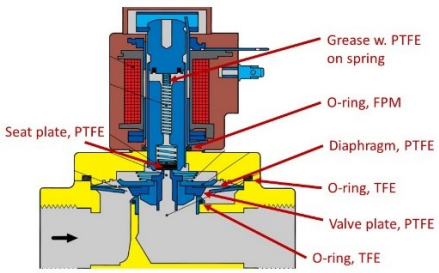
Example of PFAS use in components:

- Gaskets and seals to atmosphere and internally between different parts
- internal seals for compartments' tightness.
- Boundary lubrication protection for hydrodynamic bearings
- Sliding coatings surface of moving parts like pistons or bearings
- Electrical insulation for cables, motor windings, control boards and PTC relevant sensors
- Part of a compound to achieve special properties, such as friction reduction, flame retardance, reliability under extreme conditions, …

Example: Before and after pictures of an elastomer that underwent rapid gas decompression



Example: solenoid valve



The identification of PFASs in different materials used in vapor compression systems has not yet been completed by all manufacturers, their suppliers and subcontractors.

The attached tables show some use examples from different member companies, partly with details on the use cases and reasons for material selection.

Member companies might additionally individually deliver detailed information on use cases, amounts used and failed material examples.

Proposal

ASERCOM proposes to introduce

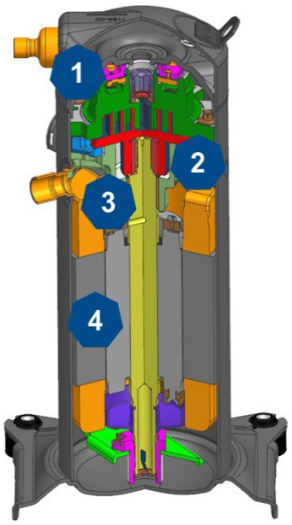
- An exemption for the RACHP applications for:
  - F-gases as their consumption and use is controlled under the F-gas regulation. Their properties are essential for energy efficiency and carbon dioxide emission reductions.
  - Fluoropolymers since they have unique properties that cannot be substituted.
- Threshold values for PFAS contents in other materials in a range that is easier possible to operationalize or control in standard laboratories, e.g. in a 2 to 3 digit ppm-range.

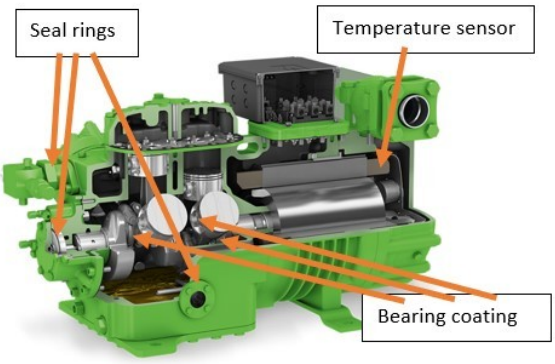
- A review clause to be included.

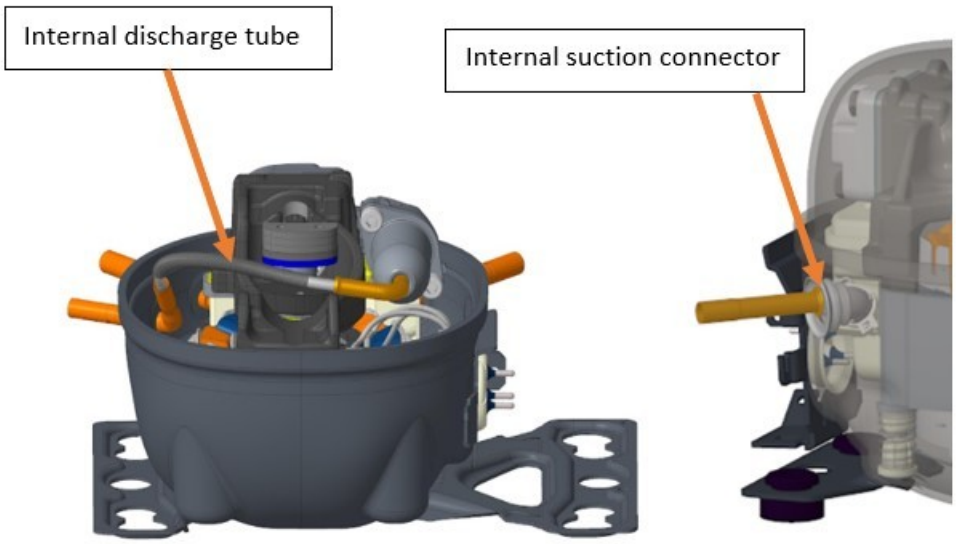
To get an overview of the main and state of art usage of fluoropolymers inside components please look at the figure and cut away drawings of compressors.

Parts in a compressor containing fluoropolymers:

1. Floating lip seal assembly
2. Upper drive sleeve bearing
3. Main sleeve bearing (some models)
4. Motor electronic components and wire insulation




Seal rings
Temperature sensor
Bearing coating


Internal discharge tube
Internal suction connector