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.

Vapour compression systems are fundamental for modern life. It is the most robust and cost efficient way to move energy from a low to a high temperature level or vice versa at the cost of certain amount of electricity. PFAS as defined in the the PFAS Restriction Proposal the five National Authorities submitted to ECHA on 13th January 2023 are applied in vapour compression refrigeration systems, which are widely used in various products, from small personal 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 system as base are serving heating, refrigeration and air conditioning applications.

These basic features are utilized for a lot of different applications from refrigeration to heat pumps with capacities ranging from below hundred watt to several megawatt. Systems are deployed globally with an electricity consumption around 20% of the overall electricity consumption.

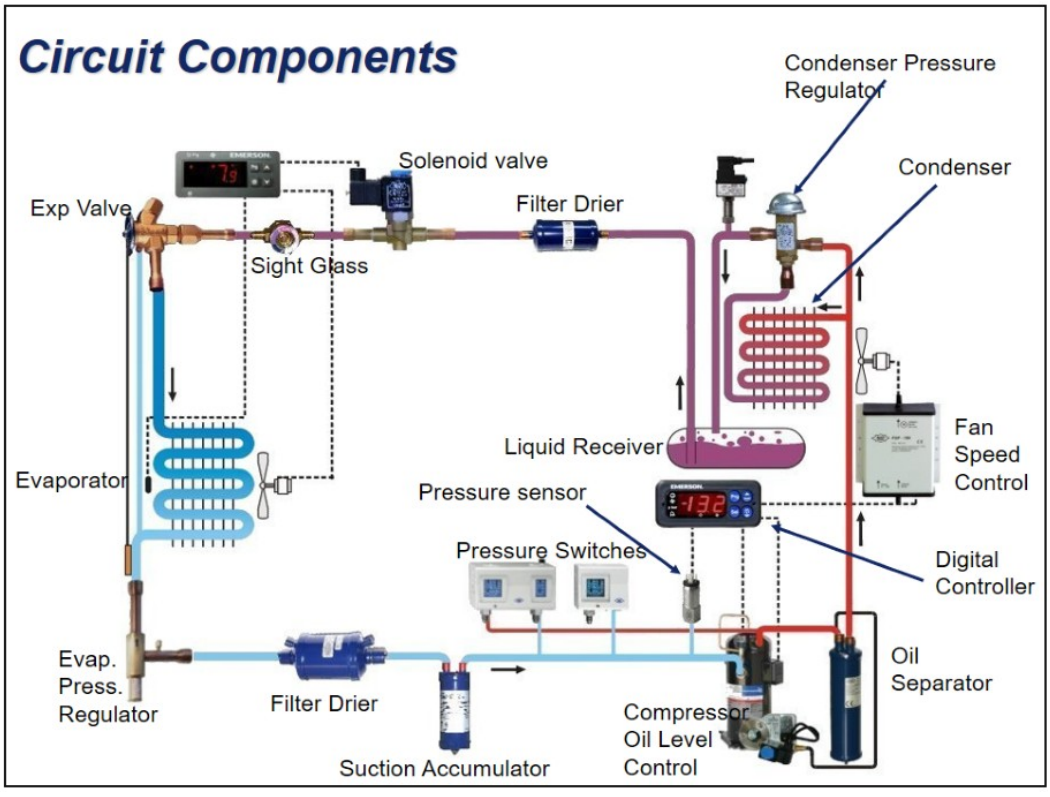

Figure of basic Vapor compression system

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 vapour compression systems.

In addition vapour compression systems are believed to be pivotal in decarbonising 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.

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 power plants PFAS substances 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.

Refrigerants used in vapour compression systems operate at high pressures and pressure gradients ranging from a few bars up to above 100 bar also giving rise to potential leakages. The high pressures, temperature fluctuations and pressure gradients in the system are fundamentally demanding very chemically persistent, temperature independent, low friction and wear resistant materials for the construction elements.

During the last 50 years components of the vapour 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 reasons for that innovative development and one of the most important is the development of materials and manufacturing processes. Besides efficiency, among the materials the fluoro-polymers have been outstanding contributors to long service life time, low leakage and reliability as demanded by the circular economy approach and are today seen as critical materials for several component and construction element types. For the application of the so called natural refrigerants especially CO2 (R744) or hydrocarbons (R290, R1290 etc.) an increased use of PFAS based polymers is necessary to secure safety and reliability of the products.

For some of these components so far no alternatives 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.

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

Vapour compression use examples:

- Heat pumps for domestic and industry applications
- Refrigeration for food production, storage and shops
- Industry process cooling and heating
- Heating and air conditioning in domestic areas, offices, factories, trains and public buildings

PFAS use examples in components:

- Gaskets and seals to outside and internally between different parts
- Emergency lubrication in hydrodynamic bearings

- Sliding coatings for other moving parts like pistons
- Electrical insulation for motor cables and safety relevant sensors

Even to identify PFAS in different materials applied in vapour compression cycles is not finished yet by all manufacturers, their suppliers and sub- suppliers.

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 detail information on use cases, amounts used and failed material examples.