Pneurop PN14 - Air Treatment

Draft PN14 position paper on the proposed REACH restriction of PFAS

Table of content

Pneurop PN14 - Air Treatment

1. Executive Summary

Pneurop is the European association of manufacturers of compressors, vacuum pumps, pneumatic tools and related equipment. Pneurop members are national associations, representing more than 200 manufacturers in 7 EU Member States, the United Kingdom and Turkey. The European market turnover of the represented company exceeds 20 billion euros.

Pneurop agrees that PFAS should only be used where strictly necessary and fully supports the restriction of PFAS into the environment. However, as there are no alternatives available today and in the foreseeable future for critical applications, the use of those PFAS containing applications should remain possible in a controlled way (collection, recycling, appropriate disposal).

We must avoid regrettable substitutions for our customers in the medical, food and beverage, energy and many other sectors.

Even though the amount of PFAS in our products is very small (<< 0,1% by weight), there are PFAS containing parts in all of them. The impact of a ban in Europe will imply a closure of the European factories of our members with 100% loss of employment (>>10.000 people) and revenues (>20b€).

Pneurop is submitting four papers to elaborate in more detail the use, value, and challenges of our major product types.

In this paper we describe the impact of the planned restriction of PFAS on the European compressed air treatment industry, with a specific focus on the application which would be most affected by the proposed PFAS restriction – compressed air refrigeration drying.

F-Gases ("refrigerant media" = fluids/gases = Hydrofluorocarbons (HFCs), Hydrofluoroolefins (HFOs), Hydrochlorofluoroolefins (HCFOs)) are adopted in all compressed air refrigerated dryer equipment used in the treatment of compressed air across many industry/market sectors and have been under constant EU legislative acts of limiting the total amount, banning the use and preventing emissions from 2015.

Alternative "natural" refrigerants exist on the market (Ammonia-NH_3, Hydrocarbons-HC, Carbon dioxide-CO_2) and are largely adopted in applications like refrigerated or HVAC, but they aren't necessarily a good fit for compressed air refrigerated dryer equipment due to the following reasons:

a) Safety →(toxic, flammable, high pressure)
b) Performance/Efficiency →(operating conditions of refrigerant are different from HVAC & Refrigerated)
c) Economic →(severe system redesign with related severe product cost increase)

Most compressed air refrigerated dryer equipment is intended for indoor use only, consequently safety aspect is the biggest concern for using currently available alternatives. This aspect represents big differentiation compared to HVAC industry since most HVAC units are intended for outdoor installation.

2. Importance of refrigerated dryers in industry, society

Compressed air refrigerated dryers as an indispensable component of industrial compressed air systems.

Pneurop PN14 - Air Treatment

Compressed air is required as a cross-sectional technology in almost all industrial sectors (e.g. food, pharmaceutical, automotive, mechanical engineering or chemical industries), is saturated with water vapour after compression and must therefore generally be dried to ensure process quality and to avoid damage to the piping network and compressed air consumers caused by condensate and corrosion. Principle sketches of compressed air systems with compressed air refrigerated dryers can be found in the appendix.

The importance of compressed air for industry is reflected in the high share of estimated electricity consumption for compressors at approx. 85 TWh for EU-28 (Ecodesign studies Los31) and at 7% (16 TWh) of industrially required electrical energy in Germany (Arbeitsgemeinschaft Energiebilanzen). It is estimated that more than 60,000 companies in Germany and 320,000 for the whole of Europe operate compressed air systems, primarily protected from the weather and frost in central compressor stations as well as indoors in production facilities. It is roughly estimated that at least 90% of the compressed air used in industry is dried with compressed air refrigerated dryers: The compressed air flows as a secondary medium through the evaporator of a refrigerated circuit and is cooled to +3 to +10 °C; the moisture that condenses out is discharged as condensate. The cooled compressed air flow is reheated in counterflow with the warm and humid inlet compressed air and is thus ready for further applications in a highly undersaturated or dried state.

The current dominance of compressed air refrigerated dryers in this area of application is explained by the favourable life cycle costs (favourable investment and operating costs, the latter due to high energy efficiency and low maintenance requirements), the small footprint and the simple installation or optional integrability into compressors, in each case in combination with a drying of the compressed air that is completely sufficient for most applications.

Alternative technologies with a justifiable cost-benefit ratio are lacking and currently not available.

Alternative technologies

Alternative processes for compressed air drying exist: Membrane dryers, cold and hot regenerated adsorption dryers, special designs such as Heat Of Compression (HOC) dryers. However, these do not cover the entire range of applications, are partly designed for much more demanding drying tasks (i.e. extremely low residual moisture), have significantly higher acquisition and operating costs (compressed air consumption, pressure loss, partly energy requirement for fans, maintenance costs, etc.), usually require larger footprints and are partly more complex to install. The energy consumption and investment costs of alternative processes are on average several times higher. Due to the current numerical dominance of compressed air refrigerated dryers, alternatives would not be available as a replacement in the required quantities at short notice.

Alternative refrigerants

In contrast to other refrigerated equipment, e.g. heat pumps, a conversion of compressed air refrigerated dryers to natural refrigerants raises extreme, especially safety related problems and would if at all possible be associated with serious cost increases (investment, installation, operation).

a) Seemingly obvious: HC refrigerant, e.g. propane (R-290)

A conversion to HC refrigerants, e.g. R-290 (propane), in flammability class 3 or safety class A3, i.e. with high fire and explosion risks, is made more difficult by the following circum-stances:

- Today's compressed air refrigerated dryers are almost exclusively air-cooled and designed for indoor installation in confined spaces, are often installed in central compressed air stations near compressors (simple piping), optionally integrated into compressors or installed decentrally in manufacturing areas, i.e. generally near numerous ignition sources and usually in rooms with strong and highly variable ventilation (e.g. due to air cooling of the compressors).
- Compressed air refrigerated dryers are thus typically installed in access areas of cate-gory b (supervised access area, e.g. ... "rooms for general manufacturing and work purposes") and in installation locations of class I ("mechanical equipment in the area where people stay") as defined in EN 378-1.
- The permissible refrigerant filling quantities according to EN 378-1 Table C.2 are very small and at best sufficient for small compressed air refrigerated dryers. Even with small refrigerated dryers, in addition to avoiding ignition sources in the unit, surrounding areas would also have to be kept free of ignition sources, which are not available in the required size in today's installation situations.
- Due to the highly variable ventilation of the installation sites, the determination of the po-tentially flammable area required according to EN 378-2 subclause 6.2.14 to determine the potentially flammable area (e.g. by leakage simulation test according to Annex I), which must be kept free of ignition sources, is very problematic.
- Constructive measures to reduce the filling quantity, which are possible with water-to-water heat pumps, for example, are severely restricted by requirements on the heat ex-changers (low pressure loss, low temperature differences) for the secondary media "compressed air" and "cooling air", especially for the evaporator through which the compressed air flows.
- In case of outdoor installation (installation site class III according to EN 378-1 clause 5.3), higher filling quantities would be permissible due to lower fire and explosion risks. Due to the complex compressed air piping and due to the risks of freezing condensate in winter (leakage and refrigerant leakage due to damage to the compressed air-refrigerant heat exchanger), this is not a suitable alternative. Countermeasures (insulation of on-site piping, electrical heaters on components of the compressed air refrigerated dryer, more complex design of the refrigerated circuit) would be expensive and very disadvantageous for energy consumption.
- Ventilated enclosures according to EN 378-1 subclause 3.2.10 would also allow larger filling quantities as a Class IV installation location, but are prohibitively expensive due to the on-site measures for the large cooling air flows of air-cooled compressed-air refrigeration dryers to be extracted (especially with negative pressure in the room due to cooling air systems for the compressors) and for safety in the event of a power failure.
- In case of damage to the evaporator, a transfer of refrigerant into the compressed air (warm evaporator at standstill under high refrigerant pressure) and of compressed air into the refrigerated circuit (cold evaporator in operation under low refrigerant pressure) is possible. The former is to be considered analogous to indirect systems in the sense of EN 378-1 chapter 5.4 because of the risk of distribution of the refrigerant with the compressed air into other areas where people are present with ignition sources. The exclusion of the associated risks through safety heat exchangers would not only be expensive, but also associated with increased energy consumption due to the greater temperature differences.
- By interconnecting circuits with refrigerant fluid, it might be possible to install all refrigera-tion components outdoors, but this would result in significantly poorer energy efficiency and

considerable additional costs on site (wall openings, additional pumps, piping, etc.) compared to current solutions with direct evaporation.

b) Other natural refrigerant Carbon dioxide CO2 (R-744)

- In refrigerated technology, compressed air refrigerated dryers are only niche products in terms of quantities and therefore depend on the availability of refrigerated components (refrigerant compressors, heat exchangers, control valves, sensors, etc.) that are developed and offered for mass applications. These components are not yet available for CO2 in the range relevant to compressed air refrigerated dryers in the required breadth (size and power ranges, electrical networks, designs...).
- The following characteristics are even more serious: very high pressures (well above 100 bar), transcritical operation and/or complex refrigerated circuits for subcritical process control

c) Hardly relevant example Ammonia (R-717)

As it is a B2L refrigerant, problems due to toxicity have to be considered in addition to problems of flammability. Ammonia is essentially suitable for "large refrigeration" plants with considerable safety measures and operator requirements, but not at all for compressed air refrigeration dryers.

3. Essential functionalities in refrigerated dryer

In Refrigerated Dryers for compressed air, PFAS are contained in almost all currently available refrigerants with low GWP suitable for the application.

PFAS are included in single component refrigerants like R125, R134a, R143a and in HFOs like R1234yf and R1234ze.

R134a is no longer employed as a single component in new refrigerated air dryers manufactured in Europe and its use in chillers is disappearing under pressure from the F-gas regulations, while HFOs R1234yf and R1234ze(E), along with R1233zd(E) (also included on the list), are also currently being offered as single refrigerant options in Refrigerated dryers and chillers by a number of leading manufacturers.

R134a, R1234yf, R1234ze refrigerants are the main ingredients for refrigerants series 400 (R407x, R410x, R448x, R452a, etc) and series 500 (R513x, R514x, etc). 93 of 106 current ASHRAE-listed blends Refrigerants series 400 are impacted by PFAS and those 13 outside of the scope are predominantly hydrocarbon blends (Flammable or slightly flammable). Similarly, on the 500 series blends, only two, both hydrocarbon blends, are outside of the scope.

The advantages of refrigerants series 400 and 500 are

- Low GWP
- Low atmospheric residence time: decomposition products (TFA) possibly persistent, but high background level of natural origin
- Not toxic, not explosive, not high pressure
- According to F-Gas regulation 517/2014 refrigerant is not released but largely recovered and recycled

4. Conclusion

Pneurop PN14 supports regulations to prevent F-Gas from entering the environment. However, in refrigerant applications the use of F-Gas remains essential due to safety, efficiency and functionality.

PN14 proposed position is to ask for **regulation of F-Gas to be the exclusive arena of the F-Gas Regulation (EU 517/2014).**

F-Gas Regulation (EU 517/2014) is already in place and is to be revised with more stringent requirements. To prevent any possible double regulation, PN14 would ask for the F-Gas Regulation to be the only mechanism used in order to manage the future restriction of refrigerant gas media. F-Gas Regulation already aligns with the intention of the REACH Restriction of PFAS restriction and incorporates the desired outcomes of the proposed actions.

There follow some robust arguments to support the above stated position:

a) Alternative with safe, efficient, economic solution currently not available.
b) Possibility that any alternative solution could be significantly more harmful to the environment through increased energy consumption and resulting in increased CO_2 emissions.
c) In addition, alternative solutions will typically demand larger volumes of refrigerant gas which could result in a higher CO_2 emission.
d) Transitional period needed for development of alternative solutions would require complete product design change, validation, testing, certification and regulatory approvals. Estimated timeline to conduct all required steps is at least 10 years.
e) Responsible recycling and re-use of F-gases is already a regulated approach to avoid unnecessary waste and it is critical for Circular Economy and Life Cycle Cost considerations.
f) Processes and supply chain to be developed.
g) Early decommissioning of legacy products containing F-Gases will lead to unnecessary waste and negative environmental and economic impact.

The compressed air industry is situated in the middle of a supply chain function (consumer of products and supplier to many diverse industries). As such we would be reliant on our component suppliers to develop and supply alternative products, with PFAS removed, which could have severe implications on the design of existing products. Our customers use compressed air for a diverse range of applications (e.g. treatment of drinking water and waste water, semi-conductor production, food & beverage processing and packaging, chemical and pharmaceutical production and packaging, and the majority of typical industrial manufacturing and assembly processes) and could be severely impacted by any change in the products supplied.

In addition to the »***primary***« impact of the proposed REACH restriction of PFAS (to the referigeration drying application), we also wish to point out that there are many other applications / products which would be impacted. For example, compressed air treatment products commonly contain components which would be impacted, such as:

- Oils and Lubricants (greases)
- Treatments to Paper Filter Media (PFHxA)
- Seals and Gaskets (including on proprietary products such as Solenoid and check valves)
- Membranes and Diaphragms
- Electronic Control Devices (containing semiconductors)

- Electrical Cables / Wires
- Hoses
- Coatings (for corrossion and friction resistance)

To manage the potential release of PFAS containing products, PN14 support approaches that aim for information requirements on the presence and quantities of the substances of concern.

On behalf of Pneurop PN14
Tim Preece (Secretary)
Janez Jakop (Chair)