EUROPEAN ASSOCIATION OF PUMP MANUFACTURERS
ASSOCIATION EUROPÉENNE DES CONSTRUCTEURS DE POMPES
EUROPÄISCHE VEREINIGUNG DER PUMPENHERSTELLER

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Europump position on the restriction of PFAS

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1. Executive summary

Europump is the European Association of Pump Manufacturers. It represents 16 National Associations in 12 EU Member States, the United Kingdom, Turkey, Russia & Switzerland. Europump members represent more than 450 companies with a collective production worth more than €10 billion and employing 100,000 people in Europe.
Pumps are essential for many applications in daily life, such as

- transport of drinking water and wastewater,
- production and packaging of food and beverage,
- production processes within chemical and pharmaceutical industry,
- heating, ventilation, and air conditioning (HVAC) applications
- and further.

PFAS materials are used in many of the listed and further applications, mainly as sealings, bearings, cable sheaths, coatings, pump inserts and membranes, due to their extraordinary behaviour. As the PFAS materials, which are up to 100 times more expensive compared to standard materials, are only used in those cases, where no alternative is available, Europump rejects the broad restriction of PFAS, as many vital applications will not work without PFAS materials.
A substitution with other (less or even not suitable) materials would lead to quick failures, and leakages, which would, for example, lead to release of aggressive (hot) media or steam, which could cause harm to humans and environment.
Europump fully supports the restriction of the release of PFAS into the environment, but the use of PFAS materials should remain possible for those applications, where no alternatives are available and are not foreseeable in the next years. A marking of PFAS containing products, could be the initial step for the collection, recycling and appropriate disposal, and should be adapted to ensure safe handling.

2. Importance of pumps for health and society

Pumping liquids is fundamental to the smooth operation of life in all aspects. From the central heating and water supply in our homes, sewage and wastewater treatment in our cities, through extraction and processing raw materials to manufacture finished products – pumps and pumping systems play a fundamental role. Industrial applications can range from water treatment, food processing, chemical industry, oil & gas, mining, paper mills, fire-fighting, dredging, waste removal and many more. Future applications to help the green transition would include transportation of hydrogen, geo-thermal, and green gases.

Their unmatched chemical resistance, temperature resistance, unique tribological properties and the combination of these characteristics, make PFAS containing materials irreplaceable. No currently available alternative material guarantees the same performance, safety and lifetime.

For example, due to exceptional properties at cryogenic temperatures, PFAS (PTFE, PFA, PCTFE) are also critical for equipment that import, handle and store liquefied gas, such as liquefied natural gas or liquified hydrogen. The former is critical for supplying gas with LNG tankers to replace Russian gas, and the latter is a potential future energy supply solution. At these cryogenic temperatures (-161°C for liquid methane gas, -253°C for liquid Hydrogen) no other elastomeric materials are adequate. Other

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materials such as PVDF are critical in applications where aggressive chemicals are dosed and handled. Due to the combination of temperature resistance, low coefficient of friction and sealing properties, PFAS are essential for guaranteeing equipment safety and integrity, preventing gas emissions, and ensuring adequate lifetime and performance.

The challenge of lack of PFAS-free alternatives for essential use is not limited to pump applications It equally applies to other equipment like valves, compressors and downstream industries like pharma, chemicals, petrochemicals, and aerospace. Furthermore, electronic components are also critical for pumps and some electronic applications require the use of PFAS materials to ensure safety. Pumps cannot function without these electronics.

PFAS in pumping applications

Due to their unique properties and performance – thermal and chemical resistance, abrasion and wear resistance – PFAS materials are used in pumps to improve functionality and achieve higher performance and safety. Service life of components and products has been increased and maintenance intervals reduced which improve overall resource efficiency.

The price of PFAS materials varies from 2,5 times to nearly 100 times of standard material prices. Thereby there is a commercial regulatory mechanism that means PFAS materials are generally only used in pump applications when absolutely necessary, for either safety or performance.

Europump supports regulations that prevent PFAS from entering the natural environment or impact human health – however a general PFAS ban would increase environmental pollution through emissions and result in reduced performance (meaning reduced energy efficiency), durability and safety and decreased resource efficiency.
Regulations should be proportionate and reflect a risk-based approach instead of a hazard-based approach.

3. Essential functionalities in pumps

3.2 Sealing

In pumps, PFAS materials are used primarily in sealing applications, specifically in seals, O-rings, and gaskets. Because of their extreme cost, which varies from 2.5 times to nearly 100 times those of other natural or synthetic elastomers, the use of PFAS materials is limited a very small percentage of all pump applications. They are used only when absolutely necessary when there is no other suitable elastomeric substitute. The primary advantage of PFAS elastomers is that they have excellent chemical resistance to many highly aggressive liquids where standard elastomers will quickly fail. Furthermore, they can maintain their elasticity and sealing properties at temperatures where other standard elastomers will harden, often within a few hours or days of use, and become totally incapable of sealing.
PFAS seals are primarily, but not exclusively, used in the chemical and petrochemical industries where pump seal leakage can lead to exposure of operating personnel, equipment and environment

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to hazardous, corrosive, or toxic chemicals. They are also used in industries (such as pharmaceutical) where elastomeric seal residue contaminating the process liquid can lead to process upsets and final product safety issues. Moreover, in addition to leakage issues, attempting to use non PFAS materials when PFAS is needed will lead significantly increased service (disassembly and seal or component replacement) requirements. This will result in additional exposure of maintenance personnel to hazardous/corrosive/toxic process liquids.

Much more in depth technical information can be found in a position paper produced by the European Sealing Association (ESA)1 – “European Sealing Association (ESA) position statement relative to the European proposal for PFAS regulation in relation with the Sealing Industry.” This position paper can be found and downloaded from the ESA website: https://www.europeansealing.com/about-us/position-statements/.

3.3 Bearings

The majority of PFAS based bearings are made from PTFE and are used in applications where standard metal bearings cannot be employed due to high coefficients of friction and where other polymer bearings fail due to high loads or temperatures. Unlike other fluoropolymers, PTFE does not melt, has an exceptionally low coefficient of friction and high self-lubricating characteristics, resistance to attack by almost any chemical, and an ability to operate under a wide temperature range. These properties make PTFE an ideal material in applications with starved lubrication, aggressive chemicals, and high temperatures.

In many bearing applications, PTFE isn’t used as a plain material, but is filled with glass fibre, graphite, or other inert materials to increase its application range. While unmodified PTFE can be used to a PV value of only 1,000, filled PTFE can be used at PV values up to 10,000 or more, exceeding the capabilities of most common bearing materials.

PTFE bushing type bearings offer dry-running capability for applications where limited lubrication-free behaviour is required. This makes them an ideal choice in areas where constant lubrication with oil-based lubricants is not possible, due to environmental or hygienic reasons, and when heat build-up due to friction is an issue. Examples are vertical pumps with product lubricated line shaft bearings in water and food processing, where the non-immersed bearings suffer from dry running upon start-up and shut down of the pump.

Due to the very low coefficient of friction of PTFE against all kind of metallic shaft material, the application of PTFE containing bearings contributes to the reduction of friction losses and thereby to saving of energy.

Due to their chemical inertness, PTFE based bearings are crucial in applications, where metal bearings may suffer from corrosion and non-PFAS polymers are prone to swell, leading to a derogation of their mechanical and tribological properties.

PTFE does not require processing aids such as stabilizers, which are generally used to protect against thermal degradation, or plasticizers used to improve overall elasticity. Its stability and lack of

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additives means that there is no leaching of foreign substance into the fluid that is flowing through the bearing. For these reasons PTFE based bearings are also chosen for applications in food and drink processing plants, where other materials will progressively break down and leach potentially harmful substances to the process.

Due to the very low coefficient of friction, which leads to a low wear rate and a high service life, the environmental impact of PFAS based bearings in pump applications can be rated as very low. A complete substitution based on the current state of the technology is not possible or may lead to other concerns related to environmental impact and public health.

3.4 Cable sheath

Some cables used within the pump industry are specially designed for use with heavy duty submersible products – one example being the HCR (Heat and Chemical Resistant) cable. HCR cables have an outer sheath and conductor insulation made of fluorinated ethylene propylene (FEP) and control wire insulation made of ethylenetetrafluorethylene (ETFE). The HCR cable is designed for use in severe conditions. It is resistant to chemicals and solvents (petrol, strong acids and bases), high temperature and mechanical stress, that often cause rapid deterioration of other cables. An HCR cable is used in hot liquid applications where temperatures exceed 70°C and at lower temperatures where superior chemical resistance is required.

Even though, they are used in demanding environment they can still retain mechanical and electrical properties over a long period of time. They also have excellent electrical insulation properties and are oil resistant for use in many types of liquids. If there is a need for a cable that can handle difficult temperatures > 70°C) and that also must be chemically resistant, there is today no alternative to these specialised cables with PFAS sheath, at least not if you want the cables to have a long life and assure stable processes and safe applications.

A silicone cable cannot replace the HCR cable since it does not have the tear strength and cannot handle the same mechanical stress as HCR. There are regular rubber cables often used for pumps and mixers, but these cannot replace the HCR because they neither handle the higher temperatures nor contaminated water (oil/acids/bases). Even though an HCR cable has many very good qualities, it is only used when needed due to high cost. In addition, it is hard to work with it due to its stiffness and smooth/slippery surface. In other words, pump manufacturers already apply use “restrictions”.

To use of these cable makes the product more durable and, is in some cases, the only alternative for the products to even be used in certain environments. Longer lifetime of the product also gives less waste and less environmental risk as any cable failure may result in dangerous process consequences, such as a pump that does not pump anymore and results in a tank overflow. Since the HCR cable can be used in very contaminated water, it is a necessary application to pumps and mixers cleaning and preventing contaminated water reaching the environment.

3.5 Inserts for pumps

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Certain pumps, for slurry and/or chemical applications, require elastomer inserts (liners) in the volute. The impeller may also be covered with elastomer in many applications.

Virtually all slurry pumps will be constructed with removable volute liners. This is due to the fact that they experience rapid wear and it is much more cost effective, as well as safer, to replace liners when they wear out, rather than to replace the whole volute. (Also, the first indication that the volute is worn may be catastrophic failure.) Depending on the application, an elastomer liner can be much more suitable for wear resistance than a metal liner.

Likewise, in certain chemical applications the use of a suitably resistant volute liner, either as an elastomer or as a polymer coating, can be a much better and more economical solution than to make the entire volute from a corrosion resistant metal. In most chemical applications the volute liner will be fixed to the volute with a suitable adhesive, rather than be removable.

As is the case with pump sealing applications, only a small minority of pump liners are required to be made from PFAS materials. In most situations standard (non PFAS) elastomers or polymer coatings work perfectly well. PFAS materials are never used where they are not required because of their high price. Depending on the composition involved, components produced from PFAS materials can cost between 2.5 and 100 times those produced using other technical elastomers.

The advantages of PFAS liners are their resistance to most chemicals as well as to higher temperatures than standard elastomers. Of particular importance is their resistance to swelling. For efficiency considerations it is important to have minimal clearance between the rotating impeller and stationary volute. When elastomer swelling is expected, this clearance must increase to allow free operation without rubbing, resulting in higher energy consumption.

One important point to note is that there is a fundamental difference with liners as compared to items used in sealing. In the case of seals, there is absolutely no way to practically replace PFAS materials, when they are required, with metals. In the case of liners, there can be, depending on the wear conditions, the possibility to eliminate the liner and use a suitably corrosion resistant metal casing. However, the disadvantages of doing this can be quite significant. Replacement of the whole casing due to corrosion and/or wear, instead of relatively thin liner or insert, will be required. Wear in the thick casing will mean greater degradation of performance and increase in energy consumption. Both of these circumstances are certainly contrary to the philosophy of a circular economy and will always require an increased carbon footprint over the life of the product.

3.6 Coatings for fasteners

Pumps require a multitude of fasteners with defined mechanical strength and corrosion resistance, to ensure tightness and safe operation. For high pressure pumps and axially split pumps, the cost of fasteners is a substantial part of the overall costs.

Usually, high strength fasteners are protected from corrosion by means of cathodic protection, either achieved by hot dip galvanizing or electrodeposition of zinc / zinc-nickel alloys. Further protection can be achieved by adding conversion layers based on chromium VI or chromium III. For applications in

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seawater and specific environments in the O&G industry this protection level is however frequently not sufficient. In this case the fasteners need to be made from costly stainless steel or even nickel base alloys, which are, with some exotic exceptions, limited by their mechanical strength. Furthermore, the usage of stainless-steel fasteners bears the risk of galling / seizing, requiring the application of leachable lubricants, which may be detrimental to the environment. Risk of emissions from PFAS coated fasteners is lower than from using lubricants.

An appropriate method to overcome these problems is applying a PFAS based coating (Xylan) on high strength carbon steel fasteners. This provides a corrosion protection almost equal to stainless steel in aerated environment (seawater) and even superior in non-aerated environment like hot soil or aggressive chemicals. The wide range of operating temperature from cryogenic to + 290°C makes them applicable in a multitude of environments. Due to the low coefficient of friction, the application of lubricants is not required.

Further applications, where PFAS based fastener coatings provide a solution that is difficult to achieve with full metal fasteners, are in the assembly of dissimilar materials, where galvanic corrosion is a concern. Due to the insulating properties of the coating, a separation of the dissimilar components can be easily achieved.

In comparison to zinc coated fasteners, where the zinc starts to corrode immediately when exposed to the environment, which makes it difficult to reuse them after a certain period, PFAS coated fasteners can be reused, as long as the coating is not mechanically damaged.

The ban of PFAS based fastener coatings would lead to a reduced lifetime of fasteners and in specific cases technical restrictions, which cannot be overcome with standard fasteners. In addition, costs would increase due to required replacement by high alloyed nickel containing materials, which require a lot of energy and resources to produce.

3.7 Membranes and PTFE diaphragms[2]

In addition to static and dynamic seals, PFAS materials are widely used in positive displacement pumps as flexible pumping elements. The parts include vanes, tubes, stators, and diaphragms.

• Air operated diaphragm pumps and controlled volume metering pumps use a reciprocating diaphragm for pumping. The diaphragm materials used are PFAS elastomers.

• Progressing cavity pumps also use PFAS elastomers for their stators. Due to the eccentric rotation of the rotor, a flexible material with good friction behaviour is typically required for these pumps. These materials provide tightness guarantee and reduce energy consumption.

• In peristaltic (flexible tube) pumps, the tube material is often a PFAS elastomer.

• In flexible vane pumps, the vane material is often a PFAS elastomer.

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In many cases the PFAS elastomers used are treated to increase their hardness (shore rating) for durability but require the flexible properties of an elastomer. Their low friction characteristics allow higher efficiency and resilience to wear. PFAS plastics and elastomers are required in these pumps for their broad chemical compatibility and temperature range. In particular fluoroplastics and fluoroelastomers are the types that combine both the broadest chemical resistance with the highest operating temperature range. No other plastic or elastomer type are a substitute at temperature above 200°C, and/or for aggressive chemicals.

In addition, low surface energy of these materials prevents fouling and the deposition of foreign materials on the surface. These pump types are used broadly across commercial, industrial and municipal pumping applications, and they would not be able to serve the application requirements without PFAS materials.

4. Conclusions

Europump, representing Europe's pump manufacturers, supports regulations to prevent PFAS from entering the environment. However, in some pump applications the use of PFAS remains essential due to safety, efficiency and functionality concerns when pumping hazardous liquids. As no substitutes for these applications are currently available, the use of PFAS for these described applications should remain possible, so the pollution of environment by other acutely hazardous substances can be prevented.

References:
[1]European Sealing Association (ESA) position statement relative to the European proposal for PFAS regulation in relation with the Sealing Industry.
[2]https://www.calpaclab.com/chemical-charts/ (Section 2.6)
[2]https://www.researchgate.net/publication/329250308_Design_and_Manufacturing_of_Micro-Turbomachinery_Components_with_Application_of_Heat_Resistant_Plastics

[2]Choosing the right elastomer for the right application Stahl W, World Pumps, 2006, 481, 2006 Oct, pp 30-33
[3]Metering Pumps (Illustrations of Components Containing PFAS and Discussion of Chemical Compatibility WRT Process Applications) – P. Berdos 11/8/2022

Other references:
Orgalim Position Paper on the restriction of PFAS, 27 January 2022

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Annex I. Illustration of PFAS used in the hydraulics of a complete pump[3]

A metering pump is used as an example, however similar representation of PFAS would be found in other pump types.

Figure 1 below represents an example of a metering pump assembly, highlighting the head assembly (liquid end).

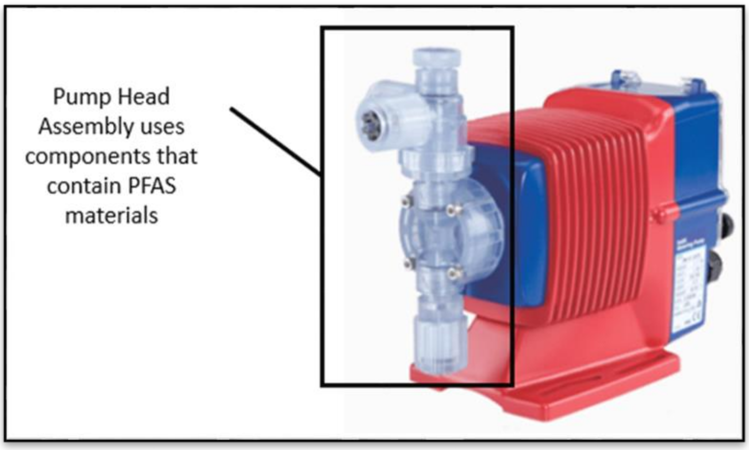

Figure 2 represents an exploded view of the above head assembly, in depth technical information can be found in a position paper produced by the European Sealing Association (ESA)[1] – "European Sealing Association (ESA) position statement relative to the European proposal for PFAS regulation in relation with the Sealing Industry.", that highlights various PFAS materials used.

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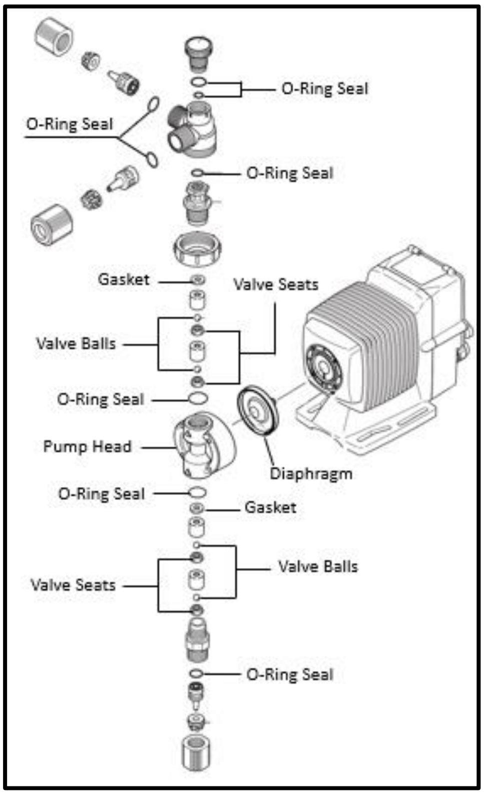

This metering pump example, along with several other models of similar construction, are used in a wide variety of applications – each with unique material requirements. These applications include chemical manufacturing, chemical toting + packaging, chemical blending, water treatment, plating, metal finishing, metal pickling, mining, bio-fuels, desalination, paper mill, ethanol – bulk metering, chlorination plants, refineries, fume scrubbers, semiconductors, bio-diesel generators, sodium hypochlorite generators, kidney dialysis, precision cleaning systems, circulation, chillers and battery manufacturing.

For some process fluids, there are ”PFAS-free” metering pump versions available. However, there are many cases where non-PFAS materials (EPDM, GFRPP, PVC) are not chemically compatible with the process fluid and therefore have no substitutes (or ”PFAS-free” versions) available. Some examples of such process fluid applications are discussed below.

The data from Table 1 below is taken from a compatibility chart, showing which non-PFAS materials are not compatible with certain chemicals and what applications use these chemicals.

Chemical (% Concentration)	Example of Application	Pump Head Materials				Gasket / Valve Ball Material	O-Ring / Seat Materials				Diaphragm Material
		PVC (2)	GFRPP	PVDF	316SS	PTFE	FKM	EPDM	AFLAS	PCTFE	EPDM
Chromic Acid (50)	Metal Finishing	N/R	N/R	A	N/R	A	A	N/R	A	A	N/R
Cyclohexylamine	Chemical Blending	N/R	N/R	NO DATA	A	A	N/R	N/R	NO DATA	NO DATA	N/R
Dibutyl Amine (Pure)	Chemical Blending	N/R	N/R	B	A	A	N/R	N/R	N/R	A	N/R
Nitric Acid (70)	Metal Pickling	N/R	N/R	A	B	A	B	N/R	B	A	N/R
Nitric Acid (98)	Chemical Blending	N/R	N/R	A	A	A	N/R	N/R	N/R	A	N/R
Sulfuric Acid (90)	Paper Mill	N/R	N/R	A	N/R	A	A	N/R	A	A	N/R
Sulfuric Acid (98)	Water Treatment	N/R	N/R	A	B	A	A	N/R	B	A	N/R

Table 1 shows that when metering pump components made from EPDM, PVC and GFRPP (non-PFAS) are not compatible with certain chemicals, the only options remaining are PVDF, PFTE, FKM, AFLAS or PCTFE (PFAS). In this table, “A” represents the best material suited for that chemical; “B” is the next best material, though swelling will occur sooner and

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require regular replacing of these materials when placed into these applications. “N/R” means “not recommended”, or not compatible. Some materials have “no data” accounted for in these applications.

The purpose of this section is to help educate and give perspective on how components are used in metering pumps that contain both PFAS and non-PFAS materials. Through the study of a chemical compatibility chart, this section also elaborates on the reasons for selecting one over the other and emphasizes the importance of selecting the proper materials for certain applications. In summary, the absence of PFAS materials would make certain chemical process applications impossible in a variety of critical industries - especially the pump industry.

Safe handling of essential PFAS components in pump applications

For the above demonstrated applications, currently there are no PFAS free alternatives that can fulfil the same safety, performance and functionality requirements. From our point of view, PFAS emissions into the environment from pump applications can be controlled easily, as the assembly, maintenance and repair of pumps is usually carried out by professionals. The processes for the later collection, recycling and appropriate disposal of these PFAS containing materials should clearly be defined. As already implemented in other industries, the different market actors should have a shared responsibility in securing that PFAS emissions from the production, usage, maintenance and disposal of pumps and pump components are eliminated.
Producers of PFAS containing pumps and pump spare parts, must ensure appropriate labelling and traceability of the respective products containing such components. Furthermore, a proper installation, maintenance and end-of-life documentation for these products is mandatory, so a robust infrastructure for PFAS handling can be built. Existing infrastructure of take-back and recycling schemes, SCIP and the planned infrastructure for the digital product passport could be leveraged to secure zero emissions from non-consumer (meaning installation and maintenance by professionals) use. Manufacturer responsibility should include the securing of the identification of PFAS containing products and ensuring that needed data is passed on in the value chain to enable the collection, recycling or appropriate disposal of PFAS.