PFAS restriction and sealing devices

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On 07.02.23 ECHA (European Chemicals Agency) issued the PFAS Restriction Proposal. The ECHA committees will begin their scientific evaluation of the proposal and the six-month public consultation started on 22.03.23. How will this proposal effect the sealing industry, end users and producers of PFAS?

Sealing Devices are engineered products specifically designed to prevent gases or liquids escaping to atmosphere. They are used in processes which deliver water and electricity to your home, all forms of transport from bicycles to planes, in engines, washing machines, taps, throughout chemical plants, oil refineries, power stations to food processing plants. They utilise a range of fluoropolymers which are stable at high temperatures and are largely inert to aggressive chemicals. There is no alternative to the fluoropolymers used in Sealing Devices which can cater for such environments or work as effectively to prevent the release of process fluids or gases to the environment. To ban them would grind society to a halt, planes would not fly, water would not reach your home, gas and electricity supplies would stop and cars would fail. A proposed generic ban for all PFAS products as proposed by the EU and Federal bodies in the U.S. is necessary to prevent the bio accumulation of them throughout the world but for the Sealing Devices specifically it would have a wide-ranging negative impact on society and increase the level of emissions to atmosphere that the industry has fought to reduce over the last 70 years.

Here is the reason why

The use of fluoropolymer (fluoroplastics and fluoroelastomers) in the Sealing Industry

Sealing Devices retain media (powders, gas and liquids) inside hardware (process or storage equipment). Media within non-moving equipment are secured by “Static Seals” such as gaskets, whereas pistons and rotating equipment such as bearings and gearbox use “Dynamic Seals”.

Hazardous, toxic, flammable, corrosive and reactive chemicals are media found in different industries all of which require high performance seals to be used efficiently and safely. Seals are used in aggressive environments where they can be exposed to conditions, such as, wear, abrasion, radiation, and extremes of temperature.

Different types of materials; metals, Inorganics such as ceramics and graphite, and polymers (plastics and cross-linked elastomers) are used in industrial seals. In each case the seal material is selected based on the specific application requirements.

Seal materials must:

1. Withstand the environmental conditions of the application, including, media, temperature, pressure, speed, and abrasion
2. Not damage other equipment (hardware) in which the seal is housed
3. Be compliant with the counter surface to maximize sealing efficiency

Prevention of damage to hardware such as flanges, pipes, valves, and containers necessitates that contact seals are comprised of softer materials than the hardware into which they provide the seal. This prevents physical damage to hardware such as scoring or wear. For this reason, graphite, plastics, and elastomers are favored. Demanding applications, such as the prevention of fugitive emissions in the petrochemical industry or with toxic media and with high system pressures, require sealing materials with sufficient mechanical

strength to withstand the system pressure and that have extremely low permeability to the media. Fluoropolymers (fluoroplastics and fluoroelastomers) have unique importance for demanding industrial sealing due to their mechanical properties (strength and comparative softness) combined with chemical stability, thermal stability, low permeation, and low surface energy.

Polymers (plastics and elastomers) are manufactured from monomers which react together to from the repeating unit of the polymer. Fluoropolymers are manufactured from low molecular weight PFAS monomers and in some cases using PFAS process agents. It is an important consideration that a class ban on low molecular weight PFAS is in effect also a ban on fluoropolymers (Fluoroplastics & Fluoroelastomers).

The use of low molecular weight PFAS raw materials is limited to the manufacturing locations of the fluoropolymer and fluoroelastomer. It is therefore recommended that PFAS monomers in the polymer supply chain are exempted from any PFAS ban and that different controls are considered which enable their safe and continued use.

Use of fluoroplastics

Fluoroplastics (i.e., PTFE, PFA, …) are the only plastics that combine both the broadest chemical resistance with the highest operating temperature with an acceptable compliance to counter surface and therefore are used when other alternative plastics cannot offer the require chemical & thermal resistance combination for industrial applications. Many references are available in the public domain that highlight this:

	ETFE	FEP/TFE/FPA	FLPE	FLPP	HDPE	LDPE	PC	PETG	PP	PVC	TPE***
Acids, Dilute or Weak	E	E	E	E	E	E	E	G	E	E	G
Acids, **Strong/Concentrated	E	E	G	G	G	G	G	N	G	G	F
Alcohols, Aliphatic	E	E	E	E	E	E	G	G	E	G	E
Aldehydes	E	E	G	G	G	G	G	G	G	G	G
Bases/Alkali	E	E	F	E	E	E	N	N	E	E	F
Esters	G	E	G	G	G	G	N	G	G	N	N
Hydrocarbons, Aliphatic	E	E	E	G	G	F	G	G	G	G	E
Hydrocarbons, Aromatic	G	E	E	N	N	N	N	N	N	N	N
Hydrocarbons, Halogenated	G	E	G	F	N	N	N	N	N	N	F
Ketones, Aromatic	G	E	G	G	N	N	N	N	N	F	N
Oxidizing Agents, Strong	E	E	F	F	F	F	F	F	F	G	N

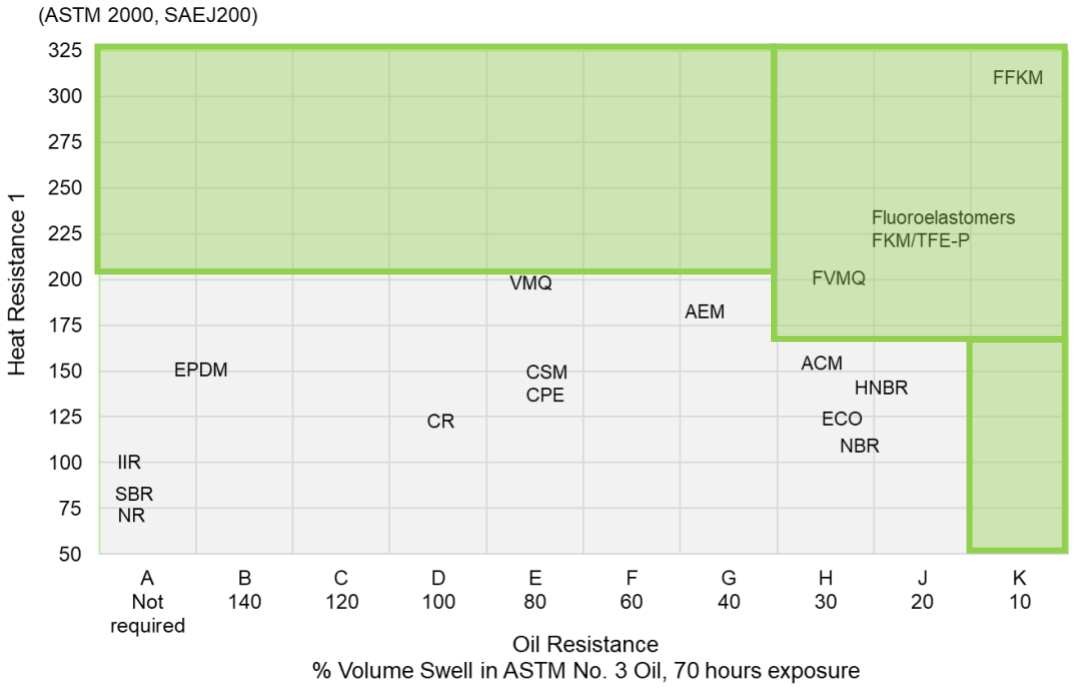
*Not for tubing chemical resistance (except PVC) **Except for oxidizing acids (See oxidizing agents, strong) ***TPE gaskets

EXCELLENT	GOOD	FAIR	NOT RECOMMENDED
30 days of constant exposure causes no damage. Plastic may tolerate for 30 years.	Little or no damage after 30 days of constant exposure to the reagent.	Some effect after 7 days of constant exposure to the reagent. The effect may be crazing, cracking, loss of strength or discoloration.	Immediate damage may occur. Depending on the plastic, the effect may be severe crazing, cracking, loss of strength or discoloration, deformation, dissolution or permeation loss.

Classes of Substances at 20° C, Chemical Compatibility Chart - LDPE, HDPE, PP, Teflon Resistance (calpaclab.com)

Use of fluoroelastomers

The well accepted ASTM D2000 chart below represents the elastomer families available on the market and rates them against heat and oil resistance. The green shaded area represents materials with the best chemical resistance and best thermal stability, all of which are fluorinated.



[1] Maximum temps at which vulcanizates can be aged for 70 hours with changes in tensile strength ≤ ±30%, elongation ≤ -50% and hardness ≤ ±15 points

Above 200°C only fluoroelastomers come into consideration for elastomeric sealing applications and at lower temperature, the drive for using fluoroelastomer is mostly linked to the broad chemical resistance.

Per- and Polyfluoroalkyl Substances (PFAS) is a broad "Class" of materials under scrutiny for health and environmental concerns. Governments and regions are seeking to regulate the use of PFAS, which could lead to restriction in their use, stringent control measures, or a ban of this entre class of materials. REACH (**R**egistration, **E**valuation, **A**uthorisation and Restriction of **Ch**emicals) in the EU are seeking to restrict the use of PFAS and the placing on the market of products containing PFAS in the EU as far as possible.

Controversially REACH scope for proposed PFAS regulation includes both small molecules and polymers. The inclusion of small molecules in the scope for PFAS is understandable; small molecules are subject to REACH registration, they each have a unique defined chemical structure, known physical properties, and their health and environmental impact can be assessed. Small molecular weight PFAS include surfactants, plasticisers, and chemical reagents used in the manufacture of other chemicals including monomers for PFAS polymers.

By comparison, when REACH was developed, requesting registration for polymers was deemed too difficult, because of the complexity of the polymer market, in terms of the size and variability of polymers on the market. For a polymer to be of Low Concern certain criteria had to be met, including;

- High number average molecular weight of the polymer
- Negligible presence of low molecular weight materials including oligomer and residual monomer content
- Resistance of the polymer to degradation
- No functional groups in the polymer that are known to be harmful

Polymeric PFAS, also called fluoropolymers, used in the sealing industry include fluoroplastics such as PTFE which are components of gaskets and compression packings, and cross-linked fluoroelastomers (rubbers) with application as O-rings and custom geometry seals.

Fluoropolymer seals which fall within scope of PFAS are irreplaceable in certain industries and a blanket ban or regulation of these polymeric PFAS will have a profound negative impact on society (health, welfare, and

standard of living). Larger molecular weight materials, such as polymers and cross-linked rubbers are non-bioavailable. PFAS polymers are considered to be Polymers of low Concern (PLC). They are critical to global development and pose no concern to public safety, yet the current REACH definition of PFAS groups these polymers together with low molecular weight PFAS of known concern such as PFOA and PFOS.

Conclusion

Linked to the high strength of the Carbon-Fluorine (C-F) bond, fluoropolymers (fluoroplastics and fluoroelastomers) uniquely offer chemical inertness vs aggressive media with thermal stability.

Many applications are enabled in our everyday life thanks to the use of fluoropolymers:

- Reduction of engine emissions both for planes (Increased efficiency allowed by higher operating temperature) and cars (higher thermal resistance allowing engine downsizing)
- Production of more powerful and more energy efficient computer processors which are now part of our everyday life (Smartphone, Datacenters, Artificial Intelligence)
- Reduction in fugitive emissions linked to lower permeation from valves and flanges in industry
- Reduced worker exposure linked to longer seal lifetime in the application. Every seal changed is a potential exposure for workers to the sealed media
- Sealing of drug production vessels to allow to production of the latest disease treatment thanks to their very low to no extractable materials

Banning the use of fluoropolymers components and the use of low molecular weight PFAS intermediates at the fluoroplastic manufacturing locations would step the science of sealing backward to the 1950s timeframe.

The ESA has commissioned a specific socio-economic analysis for the sealing industry which will be forwarded to ECHA to provide evidence that PFAS fluoropolymer (Fluoroplastic & Fluoroelastomer) materials should be exempted from the proposed regulation. A more detailed position paper, including case histories, regarding PFAS can be found on the ESA website.

Reference Documents:

ESA Fugitive Emissions Reduction Document, https://www.esaknowledgebase.com/wp-content/uploads/2019/11/ferd_5c_v2.pdf
ESA PFAS Position Paper, https://www.europeansealing.com/wp-content/uploads/2022/03/ESA-Position-Statement-on-proposed-PFAS-regulation-March-2022.pdf
BDI PFAS Position Paper, https://english.bdi.eu/publication/news/eu-chemicals-strategy-restriction-of-pfas/