ITCO

TG09
CASE STUDY

THE HEALTH AND SAFETY IMPACT ON THE TANK CONTAINER INDUSTRY IN THE EVENT OF A RESTRICTION TO THE MANUFACTURE OF PER FLUOROALKYL & POLY FLUOROALKYL SUBSTANCES (PFAS)

September 2022

ABOUT ITCO

ITCO is the trade association for companies engaged in the global transport of bulk liquids and liquified gases by intermodal tank container. Established in 1989 and with now over 170 registered members, it is estimated that the membership operates the majority of the **740,000 global fleet of tank containers**.

ITCO represents the tank container industry to chemical and liquid food producers, the public and government. It is engaged in regulatory processes, provides technical guidance, and arranges informative membership webinars, work groups and conferences.

MISSION STATEMENT

The ITCO mission is to promote and represent tank containers as safe, cost efficient and flexible means of transport. In doing so, we have a strong focus on enhancing technological and business developments for the sake of quality, health, safety, environment, and corporate responsibility in the tank container industry. We design the framework and platform for strengthening growth of our global business. With this we contribute to the competitiveness and success of the tank container industry.

SUSTAINABILITY

The tank container operates in a business world where safety and leak tightness of the tank is paramount and where the producers of chemicals and liquid foods are increasingly supporting environmental initiatives throughout the transport chain.

Tank containers are re-useable and operate for a projected life of at least 20 years. The tank is constructed with materials that, 95% by weight, are recycled. This provides industry a platform to strive towards its sustainability objective.

Over the past two years, ITCO has undertaken an active campaign to promote the environmental benefits of tank containers. In 2020, a video was produced to encourage the use of tank containers to achieve a sustainable mode of transport in place of single-use plastic flexi-bags used in shipping containers to transport liquids. In 2021, ITCO published its Technical Guidance document "TG- 08 Tank Sustainability Repurposing and Recycling" which provides sustainability guidance - from procurement to safe end-of-life repurposing and eventual recycling.

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Note:

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ABSTRACT

Governmental consultation processes are underway and are considering restricting the manufacture of PERFLUOROALKYL AND POLYFLUOROALKYL SUBSTANCES (PFAS) for reasons of potential waste material degradation which could adversely affect the environment and health. Such a restriction if enacted, would be detrimental to the tank container industry which mostly utilises the material in its solid form for the manufacture of sealing elements. This is because alternative materials are less effective and could potentially reduce safety and increase waste.

The tank container fleet of 740,000 units (also commonly referred to as ISO tanks) operates in the global trade, safely transporting liquids and liquified gases in bulk, most of which are classified as dangerous goods or are otherwise potentially hazardous.

These highly regulated tanks, defined as UN Portable Tanks in the IMO International Dangerous Goods Code, rely upon sealing elements within the valves, ancillaries and access hatches which are fitted to operational openings. For some special applications, the tank and valve might also be lined.

Sealing element materials must provide a range of technical properties that ensure the materials function as reliable and safe containment of liquids and liquified gases. PFAS, materials such as PTFE, are widely used because of the proven properties of chemical resistance, temperature range, durability, shrinkage, and vibration resistance, and cutting and machining qualities.

Because of the exceptional properties of existing sealing elements, the operational safety and leak tightness record of the tank container remains excellent.

Alternative sealing element materials have been researched and in some controlled applications have been trialled but there is an overwhelming technical need to continue the use of solid form PFAS. There is a risk to the environment and the public should access to the totally reliable existing sealing element material be restricted.

PFAS used for sealing elements are mostly in solid form. The material in this form does not shred or degrade into particles. Sealing elements have a long-life expectancy and are eventually safely disposed as licensed industrial waste. ITCO has initiated a programme to consolidate used materials and to seek recycling options.

For reasons of continued safety, ITCO call upon the regulators to designate solid PFAS sealing elements in tank containers as “materials of essential use”.

Tank containers are intermodal and used for transport of liquids and liquified gases by road, rail and sea. The photograph shows a consignment of standard liquid tank containers at a rail terminal and waiting for the cargo to be discharged directly to the chemical facility

FOREWORD - AIMS OF THIS CASE STUDY

The aim of this Case Study is to address the governmental consultation process that is investigating the potential restriction of the manufacture of PFAS and highlight the crucial contribution of PFAS which are used in the manufacture of sealing elements for the safe containment of liquids and liquified gases that are transported globally in a tank container.

Sealing elements (seals and gaskets) are fitted to the valves that control operational openings on the tank and have a proven compatibility and safety performance that has virtually eliminated containment risk to the environment, personnel, and the public.

The paper explains the tank container industry usage of solid state PFAS materials within the tank container and how the material is compatible with almost all substances transported in the tank along with its ability to remain effective in a wide range of temperatures and vibratory forces.

The materials that are in use, primarily PTFE and similar, are mostly used in solid milled and cut form. In this form, the material does not shred and degrade into particles and by so doing, detrimentally affect the environment. The estimated annual tonnage is about 230 metric tonnes

The lack of suitable alternative materials for seals and gaskets is explained in this Case Study and it shows how industry has made immense strides forward since the past times that the sealing industry, by necessity, employed asbestos.

ITCO is taking proactive steps to ensure used sealing elements are segregated and safely disposed by licensed industrial processes and in due course recycled.

The Case Study calls for sealing element materials to be ‘designated materials of essential use’.

1.0. INTRODUCTION TO THE TANK CONTAINER (ISOTANK) INDUSTRY

- Over the past 30 years, the tank container industry has grown from a niche sector of the intermodal transport of liquid and liquified gas, into a large global industry, operating an estimated 740,000 tank containers globally and with a predicted annual growth of 8%. This represents an investment amounting to over US$ 11 billion.

- The foundation of this high performance is the industry's record of safety; the containment of the substances transported, most of which is regulated as classified Dangerous Goods, and the efficiency of intermodal transport.

- Furthermore, the intermodal tank container, which transports approximately 30+/- metric tonnes in each transport event, is a sustainable package that demonstrates the practice of Reduce-Reuse-Recycle

- Tank containers are also commonly referred to as ISO tanks but are defined in the applicable regulations as UN Portable Tanks.

The industry comprises 7 main players:

- Shippers, the beneficial cargo owners, are the source of the substances transported in the tank container. They might operate the tanks (in-house logistics) or, more often outsource their logistics to tank operators.

- Tank container logistics operators provide 3rd party logistics services to shippers, transporting the shipper-owned substances door to door.

- Lease companies provide additional tank containers to shippers and operators on a contractual term basis, whereby the lessee takes quiet possession and operates the tank as if it were owned.

- Tank manufacturers design and construct tank containers and supply shippers, tank operators and lease companies.

- Component manufacturers, such as manufacturers of valves and fittings which are fitted to the openings in the tank to ensure the containment and sealing of the transported substance.

- Service providers that undertake tank container maintenance procedures and regulatory periodic safety inspections and tests.

- Carriers who provide transport services by sea, rail, and road.

Tank containers are intermodal and are handled in terminals and in transit with the same equipment and processes used for dry freight shipping containers. The photograph on the left shows tank containers in the port terminal being loaded onto the vessel by the overhead gantry crane. The photograph on the right shows a consignment of tanks on an ocean-going container vessel.

2.0 TANK CONTAINER OVERVIEW

A tank container is used to transport liquids and liquified gases in bulk. Most cargoes are regulated as dangerous goods, but other substances are transported too, including food grade and non-regulated substances. There are standard tanks suitable for a range of cargoes and specialist tanks dedicated to a given cargo e.g., food grade and liquified gas tanks.

The tank container comprises a cylindrical metallic pressure vessel mounted within an ISO frame to enable intermodal transport by land, sea, and rail.

Tank container construction and use is regulated by IMDG (International Maritime Dangerous Goods Code) where it is defined as a UN Portable Tank. The tank also conforms to the provisions of additional regulations such as RID-ADR (Agreement International Carriage Dangerous Goods, Europe) and CFR49 (Code of Federal Regulations, USA) and to Standards such as, e.g., ASTM Pressure Vessel Code and ISO Specifications. National regulations might also apply.

The operational openings within the tank vessel are fitted with valves, access hatch and ancillaries which incorporate sealing elements (seals and gaskets) at the interface with the metallic components. This provides for leak tightness of the tank container. For some special applications, such as a corrosive cargo, the tank and valves might be lined.

The seals and gaskets are manufactured of PTFE or similar PFAS materials and are crucial to the safe containment of the liquids and liquified gases that are transported.

The pictorial depicts a tank container that is typically used by tank operators for transporting liquids in bulk. The tank vessel is usually constructed of ASTM 316 stainless steel when transporting liquids. The vessel is a single compartment, but some tanks might be fitted with surge plates which, if fitted require the additional top access hatches shown in the pictorial.

The tank is secured within a carbon steel frame according to ISO intermodal container standard dimensions. The frame includes 8 corner fittings (red points shown on the pictorial) which allow lifting and securing of the tank during intermodal transportation by road, rail, or sea.

The tank is usually equipped with a heating system and insulated to control the cargo temperature.

Operational openings on the rear end and the top of the tank are fitted with valves and access hatches, each of which employ sealing elements.

The standard tank is used to transport a range of substances. Some tank containers dedicated to transport a specific substance, such as a liquified gas, a special chemical or liquid foodstuff and the tank vessel design and fittings are specified accordingly.

3.0 SEALING ELEMENTS (SEALS AND GASKETS)

Sealing elements are components within the metallic valves and equipment that are fitted to the tank operational openings and are crucial to the containment of the cargo of liquids and liquified gases, most of which are regulated as dangerous goods.

Sealing elements in use are elastomers (either solid or composite silicon core with an FEP or PFA outer) and solid virgin or filled PTFE’s for seals and wear sections.

3.1 Seals and gaskets

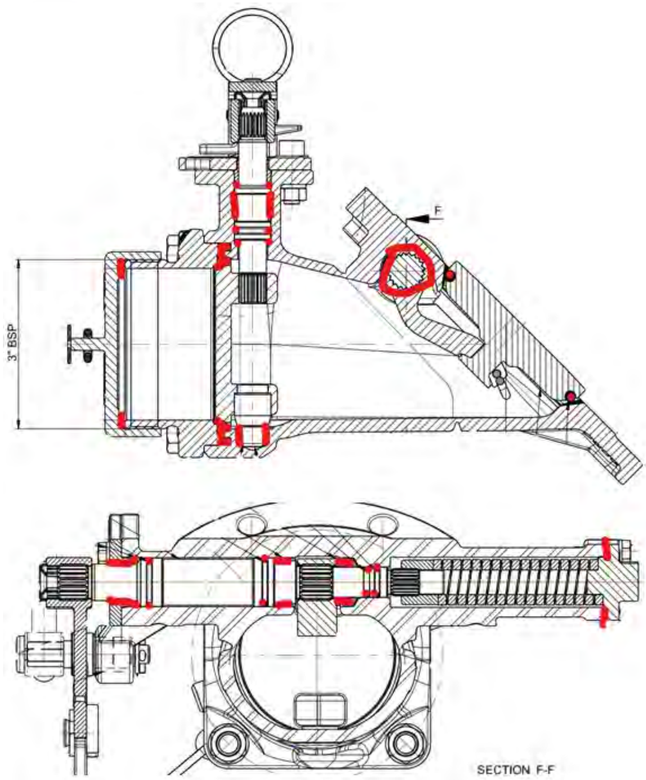
There are various types, designs and materials used for sealing elements depending on whether specified for use within the body of the valve or the interface between the valve and the tank.

Broadly, gaskets are manufactured of CNAF material and fitted with a PTFE envelope to align with the actual sealing face between the valve and tank.

Seals and O-rings are of PTFE, FEP, PFA and fitted within the body of the valve and access hatch.

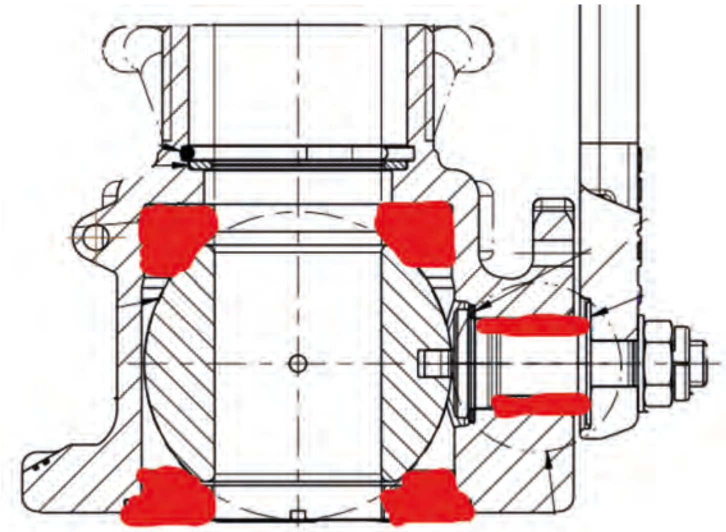
3.2 Bottom Valve Assembly

Highlighted in red, the main sealing elements of a typical bottom outlet assembly can be seen. These are elastomers (either solid or composite silicon core with an FEP or PFA outer) and solid virgin or filled PTFE’s for seals and wear sections. A gasket is sited at arrow F to permit sealing between the vessel and the assembly and is normally a PTFE envelope over a CNAF gasket.

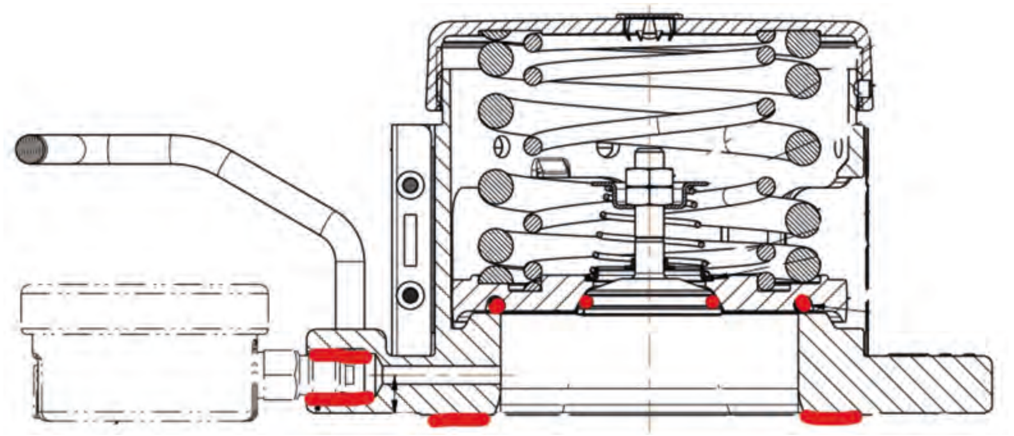


3.3 Airline assembly

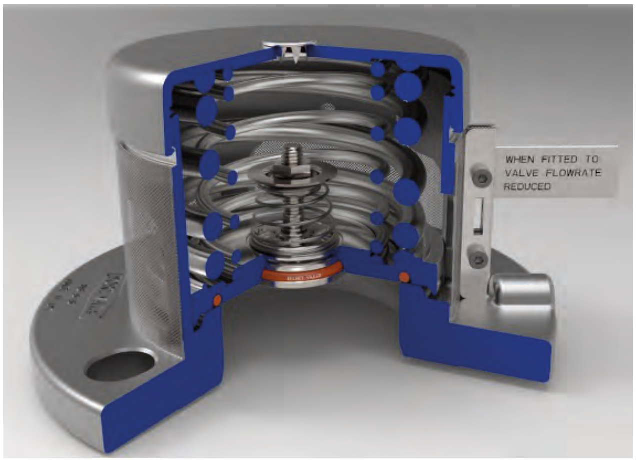
Highlighted in red, the main sealing elements of a typical airline inlet ball valve can be seen. These are elastomers (either solid or composite silicon core with an FEP or PFA outer) and solid virgin or filled PTFE's for seals and wear sections. A cap is normally fitted which contaIns a flat PTFE washer seal.



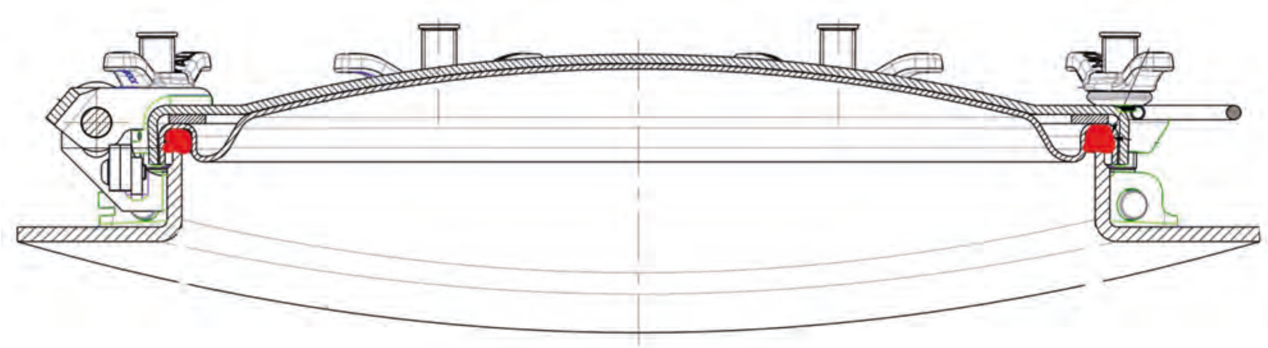
3.4 Pressure relief device



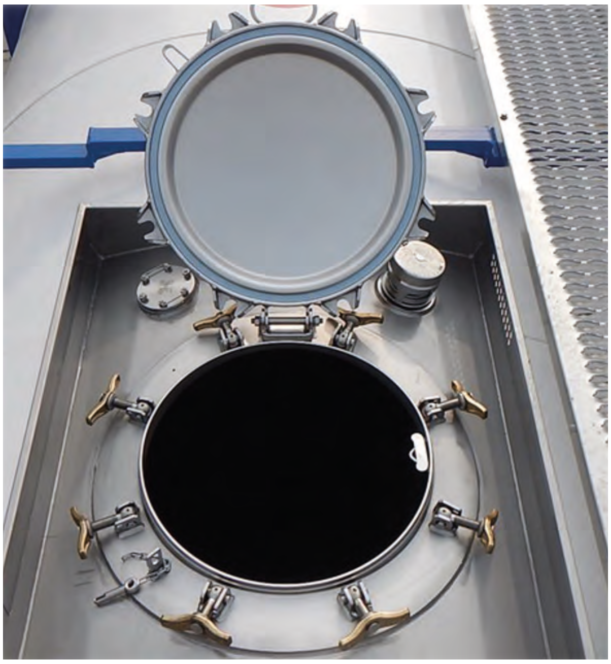
Highlighted in red, the main sealing elements of a typical relief valve can be seen. These are elastomers (either solid or composite silicon core with an FEP or PFA outer). PTFE tape or sealing compound is used on the gauge point. A gasket is sited on the bottom to permit sealing between the vessel and the assembly and is normally a PTFE envelope over a CNAF gasket.



3.5 Access hatch seals



Highlighted in red, the main sealing element of a typical access hatch. These are PTFE sheaf bonded to a nitrile core or PTFE impregnated braided polypropylene yarn, sometimes with a silicone core.



The photograph (left) shows a tank operator in a chemical works preparing to open the tank access hatch. The photograph (right) displays the access hatch fitted to the top of the tank. The hatch lid is open and shows the blue coloured sealing element.

4. SEALING ELEMENT PROPERTIES

Safe containment of cargo is the prime consideration of the manufacturer, certifying authority and the operator. This requires the use of sealing elements with a critical range of properties and attributes.

Essential operational properties of these materials include:

- Chemical resistance and compatibility
- Thermal stability
- Durable
- Shrinkage, elastic recovery, vibration and friction resistance
- Cutting, machining and extrusion capabilities

4.1 Chemical resistance and compatibility

Tank containers transport a wide range of chemicals which requires the sealing elements to be compatible over the range. This is achieved by currently manufactured PFAS sealing materials.

Whereas there are tanks dedicated to a specific cargo, most are in general trade and transport different substances according to demand.

The cost of labour, materials, and downtime to change sealing elements before each transport event, should the current universally compatible sealing elements not be available due to regulatory restriction, would be prohibitive. The need to change contaminated sealing elements would result in an added safety risk to maintenance personnel and increased waste disposal.

4.2 Thermal stability

Valves are manufactured to meet the general industrial required temperature range of -40°C to +200°C. Cryogenic tanks are design for temperatures below -150°C. Sealing elements must therefore equally perform at these temperatures.

Even if transporting cargo at ambient temperatures, -40°C in low temperature regions is possible and 60°C is not uncommon in the hold of an ocean container vessel. Furthermore, the tank must withstand high pressure water and cleaning fluid temperatures of up to 95°C and steam of about 160°C.

As cargoes might cool during transit, some might require heating prior to discharge. The tank integral steam heating system employs steam pressure up to 6 bar (165°C).

4.3 Durable

Sealing elements must be hard-wearing and be capable of withstanding a degree of handling damage.

Tank containers are routinely discharged through the bottom outlet assembly by gravity or pump and connected to the terminal pipe-lines by screw fittings. Access hatches are opened and used for filling and for cleaning equipment. Accordingly, materials need to be durable.

In addition, sealing materials should not absorb the substances transported. During maintenance programmes, absorbed substances which are often dangerous goods, are a safety risk to personnel undertaking works.

4.4 Shrinkage, elastic recovery, vibration and friction resistance

Tank containers are transported globally over long distances and unlike static tanks have no access for frequent inspection in transit as might be possible with land static tanks. Sealing elements once secure in the valve assembly and tightened to the specified torque, must remain reliably leak tight. This means that the material properties are required to resist any compressive set which would allow vibratory forces to act on the fixings and consequently risk leakage. When used within moving parts such as the valve spindle, low friction is required.

4.5 Cutting, machining and extrusion capabilities

As may be seen from the depictions of valves in this case study, many of the sealing elements are precisely engineered components that must fit exactly.

Manufacturers are required to produce these components in quantity and quality. Being able to utilise the the most economic and efficient productive process ensures the minimum of waste.

5.0 SAFE CONTAINMENT, LEAK-TIGHTNESS

ITCO considers the danger and risks of the transportation of chemical substances (flammable, toxic, corrosive dangerous goods) more hazardous than containment in static plant equipment.

Chemical plant valve sealing requirements are for mostly static operations and are within a controlled environment. The substances within a chemical plant would normally feature a bund to contain any leakage should this occur. It is possible to predict with greater accuracy the maintenance and emergency procedures because of the known environment.

The consequences of leakages from tank containers can be significantly higher than leakages from valves in a controlled environment. A leakage from portable tank containers in transit could result in dangerous and potential lethal chemicals affecting the environment and the public with potentially serious consequences and a risk to life.

Currently, and historically, the leak tightness record for portable tank containers operations is exceptional with very few reports of leakage due to design of the tank and its sealing elements.

PFAS are a key component for the manufacture of safe sealing elements. The materials ensure a high level of sealing integrity, and a chemical compatibility, across a wide range of transported substances at temperatures which exceed that of available alternative sealing materials.

Moving away from PFAS based materials without an equivalent alternative will significantly increase the risk of leakage either by reduction in the material's sealing performance or significantly reducing the substance range of chemical compatibility. Alternative sealing elements could require to be chemical substance specific and require a lower safety margin for acceptable usages.

With reference to the Appendix item A, a report following the meeting of the United Nation Working Party on the Transport of Dangerous Goods, highlights the potential serious consequences for the safe transportation of dangerous goods presented by any restriction on the PFAS materials used in sealing.

This reinforces ITCO's concerns that restrictions in PFAS will result in a higher risk than currently prevails.

5.1 Sealing element life expectancy

In addition to the excellent sealing performance, existing materials have an extended life expectancy which benefits industry, its personnel, and the environment.

5.2 Personnel Health and Safety

Because of the life expectancy, inherent durability, compatibility with almost all substances transported and in-situ cleanability, PFAS sealing elements do not require frequent maintenance. This means that personnel are not required to frequently strip and change valve seals and handle used and contaminated materials.

To the contrary, the use of alternative materials for sealing elements such as compressed fibrous gaskets, could requiring changing after each transport event, causing considerable handling of contaminated materials and an increase in the quantity of waste disposal.

Connecting a discharge hose to the tank container bottom valve

5.3 Environment

It follows that the benefit of existing sealing element materials which have a long-life expectancy and wide chemical compatibility is that it reduces the frequency of sealing element maintenance replacement and therefore the quantity of new seals manufactured per annum and the quantity disposed.

New material from manufacturing off-cuts and machining and drillings can be recycled.

Used material recycling is currently problematic due to potential contaminants and the lack of a viable economic quantity of material. Work continues to develop a viable process. However, a trial recycling of tank container sealing elements is underway in the Netherlands.

Used tank container sealing element materials are currently safely disposed of through licensed industrial waste collection systems, but the aim is to increase recycling processes.

ITCO's programme to safely dispose of sealing materials and to work with recyclers to develop processes to use the materials in a re-manufacture is ongoing.

6.0 QUANTITY AND FORM OF SEALING ELEMENT MATERIAL

PFA material is an essential component of the sealing element. However, the tank container industry minimises the use of this essential material by designing seal elements with an outer skin of PFA material and inner part of made of silicon or, for gaskets, envelop PTFE and compressed fibre.

As a result of the engineering design initiatives to minimise the use of PFAS only for essential components and outer surfaces, the available data indicates that materials used in the manufacture of sealing elements for the tank container industry averages about 82% non PFAS, 18% PFAS.

The percentage of PFAS material vs. non PFAS material is subject to the seal type. ITCO estimate that about 22 metric tons of PFAS material is used per annum in valve sets of which 3.6 tons is used in the manufacture of gaskets.

Access hatch seal elements are more frequently replaced due to vulnerability and operational damage. ITCO estimate 230 metric tons of PFAS material is used per annum in hatch seals of which 112 tons is solid or composite type and 118 tons is the braided style.

ITCO promote procedures to minimise the need for replacing sealing elements and for safe disposal and recycling where the need for replacement of the sealing element is unavoidable.

6.1 Form of PFAs used for sealing elements

Solid state, non-shredding material is mostly used for tank container sealing elements. When considering the main scope defined by ECHA in the PFAS webinar (29th October 2020 – Peter Simpson) we see that ECHA consider the main detrimental uses of PFAS materials include:

- Fire-fighting foam
- Textile treatment e.g. clothing
- Food contact materials e.g. food packaging

These industries use the material in vast quantities and their method of application is mobile and dispersible. The life expectancy is much shorter, and materials are disposed of in domestic waste systems.

The form of material utilised for tank container sealing in the solid form and manufactured from rods of material. These materials do not shred into particles and do not cause the environmental issues cited in the scope of the ECHA document.

There is one sealing element is use, a man-lid braided PTFE seals, which is now recognised as a potential environmental risk and ITCO is currently advocating the removal of this seal from the list of acceptable seal elements. Even so, braided PTFE seals do not shed PFAS in the same manner as the items cited by ECHA and the production quantity is infinitesimal by comparison.

ITCO recognise the importance and support the work of the governmental authorities but believe that the mobility, frequency, and degradability of sealing element materials, in the form that they are utilised within the tank container industry, is extremely low risk to the environment, compared to the material form cited by governmental research. Furthermore, by utilising the most appropriate materials for sealing elements, it prevents leakage of dangerous goods and protects the public and the environment.

7.0 ALTERNATIVE SEALING ELEMENT MATERIALS

There are no alternative materials that provide the crucial performance range achieved by existing specified solid state PFAS sealing elements.

Some of the non-PFAS alternatives researched could be economically beneficial except that the operational cost resulting from risk of leakage from an inferior material would by far exceed any saving. Furthermore, alternative materials are technically unsuitable in many required applications and therefore are not feasible alternatives.

7.1 Range of essential properties

The alternatives suggested in the call for evidence as replacement PFAS sealing materials do not possess the universal range of properties to be a suitable replacement, especially that mechanical properties and their function differ depending upon their location and purpose within the sealing arrangement.

However, there are certain situations where some alternative sealing elements might be usable with some of the substances being carried and in specific equipment applications, but alternative materials present risks.

For example, a fibrous material might be used as a gasket to seal the face between two flanges, but the material cannot be used in the manufacture of an "O" ring. In addition to being less reliable as a sealing gasket, fibrous material may become saturated with the dangerous substance transported in the tank e.g., a toxic chemical. The gasket would need to be handled by personnel undertaking maintenance, thus adding a health and safety issue along with an additional environmental disposal risk.

7.2 Restriction of PFAs for essential use increases waste

The loss of PFAS for manufacturing sealing materials would require a significant increase in the number of seals and gasket manufactured for maintenance replacements parts because alternative materials will not achieve the same range of substance compatibility and durable life expectancy.

This would inherently raise the risk of leakages caused by inadvertently fitting incompatible sealing material to different tanks but would also significantly increase the waste streams produced by frequent repurposing the tank sealing element. If a PFAS sealing element is fitted abroad it might need to be replaced and adding to waste.

Fundamentally, the chemical transportation industry is not able to cope with this dramatic change. It might cause a reduction in available cargo carrying capacity and an increase in costs. Some transportation may stop entirely due to the leakage risks of alternative materials.

7.3 PTFE, ETFE, PVDF, PFA, FEP, FKM, FFKM, PEEK

Although there are alternative non-PFAS materials each with capabilities of temperature and chemical compatibility, none has the unique combination of temperature range and chemical compatibility of PTFE and similar PFAS materials.

To restrict the entire range of PFAS materials irrespective of its solid form and use, would severely disrupt the global chemical and liquified gas transportation industry and curtail some operations.

The alterative materials are incompatible with some applications such as the transport of Cryogenic liquified gases, Chlorine, Anhydrous Hydrogen Fluoride, Hydrofluoric Acid Solutions, Hydrochloric Acid and Sulfuric Acid, to name a few. See Appendix for a general guide to compatibility.

7.4 Ultra-High-Molecular-Weight Polyethylene "UHMW-PE"

Ultra-High-Molecular-Weight Polyethylene "UHMW-PE" has been researched as an alternative sealing material. It is currently used within prosthetics of knee and hip replacements. The material is considered, in medical implant terms, "low friction, high wear resistance, good toughness, high impact strength, highly resistant to corrosive chemicals, excellent biocompatibility with low cost".

It is also available, with additives, to achieve continuous use temperatures of 135°C under the brand name "Tivar H.O.T.". These additions still permit the polymer to achieve FDA compliance although may reduce corrosion resistance at lower temperatures where normal temperature UHMW-PE is higher performing.

Unfortunately, the temperature, chemical resistance range and rigidity UHMW-PE (particularly at elevated temperature) is insufficient as direct replacement sealing material for tank containers.

The material is not a viable like-for-like replacement because, as with all alternative materials, it is required by the tank approval regulations to undergo extensive type testing and field testing.

7.5 Polypropylene, Silicone, PVC (tank lining suggested alternatives)

PVC-U has a temperature range of 0°C to +60°C which is too low for service in tank containers, not least ambient temperatures range (-40°C to +60°C) is a requirement of the regulations.

PVC-U is also not resistant to many chemicals including aromatic and chlorinated hydrocarbons or chlorine for example. Additionally, PVC-U may not be suitable due to the potential to emit corrosive chlorine gas which can cause chloride stress corrosion cracking in austenitic stainless steels, which is the material used for the tank and valve construction. PVC also contains SVHC which is likely to be restricted by environmental regulations.

7.6 Polypropylene

Polypropylene has a slightly wider temperature range of -10°C to +80°C but still not sufficient to satisfy most of our industry applications. Polypropylene has a wide chemical resistance at ambient temperature, but its chemical resistance reduces with increased temperature particularly with strong inorganic acids.

7.7 Elastomeric compounds

Some Silicone grades have a temperature range of -55°C to +300°C and can be used within sealing elements in certain applications but are not resistant to many of the chemicals transported including most solvents and Hydrochloric or Hydrofluoric acids. The lack of hardness also restricts the use of these material for some sealing elements. Elastomeric compounds such as silicone, nitrile, and neoprene, can also be regarded as bio-accumulative and toxic to the environment.

7.8 Natural Rubber

Natural rubber compounds provide elastic recovery properties and resist vibration. The material is water-resistant as well as being tolerant to alcohols, acids and alkalis. There are limited applications for the material.

8.0 CONCLUSIONS

Safety and the environment

ITCO support safety and environmental initiatives. Indeed, a key feature of the tank container is its excellent safety record and its sustainability, 95% by weight recycled after a 20-year life of reuse.

Safety is a prime consideration and not least because tank containers transport a wide range of classified dangerous goods in liquid and liquified gas form. Containment of these substances requires tank operational opening to be fitted with highly engineered valves, ancillaries, and access hatches, each requiring sealing elements between the metallic interfaces of the tank and valve.

Sealing elements use PFAS components mostly in the solid form, primarily PTFE but similar materials too e.g., FEP, PFA, FFKM, FKM. The solid materials form does not allow for the materials to shred or degrade to particles as is the case with some other industries such as food packaging, clothing, and fire-fighting foams.

The eventual waste of used sealing elements are disposed at licensed industrial waste sites. New material from manufacture cut-offs and drilling are recycled. Initiatives to develop recycling of used materials are in progress in the Netherlands.

Sealing element material

Solid form PFAS that are used in tank container sealing elements are essential materials with a long history of excellent safety performance that prevent leakage of liquids and liquified gases, many of which are regulated as dangerous goods.

PTFE provides for chemical resistance and temperature range and other properties that cannot be replicated by alternative materials. These properties are essential to ensure safe containment of dangerous goods in transit.

Sealing elements of PTFE are of high cost to industry but are employed to procedures that ensure a long-life expectancy which is achieved by the sealing elements being compatible with almost all chemical substances. Therefore, the sealing elements do not require frequent maintenance replacement. If less durable materials were in use, frequent replacement might be necessary because each transport event invariably carries a different substance. This would therefore increase waste.

Alternative sealing element materials

The tank container industry is receptive to new materials and manufacturers constantly research options which might afford increased performance, lower cost, improved availability or are better suited for their intended application.

As a result, some alternatives to PFAS have been introduced because of technical suitability for some limited applications. Generally, non-PFAS alternative materials are lower cost than PFAS and hence might be economically beneficial to new manufacture except that the risks to safety in service and ongoing maintenance exceeds any saving.

However, many alternative materials are technically unsuitable in most of our industry applications and therefore not a feasible option.

Chemical resistance

Existing use solid PTFE and similar materials afford excellent chemical resistance over a wide range and are standard use for virtually all cargoes transported. Alternative materials do not provide equal resistance and compatibility which if used would risk leakages.

The Appendix to this case study provides examples of the limited and inferior compatibility of alternative sealing materials.

Thermal stability

Thermal qualities are also unique to PTFE and similar sold PFAS in use for sealing element manufacture. It is essential to maintain the temperature range.

Valves are manufactured to meet the general industrial required temperature range of -40°C to +200°C. Cryogenic tanks are design for temperatures below -150°C . Sealing elements must therefore equally perform at these temperatures.

Even if transporting cargo at ambient temperatures, -40°C in low temperature regions is possible and 60°C is not uncommon in the hold of an ocean container vessel. Furthermore, the tank must withstand high pressure water and cleaning fluid temperatures of up to 95°C and, also steam of about 160°C.

Alternative sealing element material replacement process

All valves and equipment must undergo rigorous testing processes which are witnessed and signed off by an authorized industry inspector, acting for the governmental administration. This type-approval testing can take months to carry out and must be repeated if subsequently there is a variance in design or materials.

A restriction on PFAS would require, firstly to find technically suitable alternatives as detailed above; and, secondly, to manufacture and test these alternatives and then re-apply for industry approval.

The tank container life expectancy exceeds 20 years and there are thousands of valve designs that are in continued use. To re-approve all this equipment would take many years at significant cost; some valves designs might not achieve re-approval using non-PFAS alternatives. And achieving approval does not mean they will necessarily satisfy the customer’s end needs.

Economic impact

Disruption to global supply chains would be severe. An economic impact will be felt by consumers due to increased shipping timeframes and cost and availability until suitable alternatives sealing materials are developed. Some chemicals may no longer be transportable until there are viable alternative sealing materials.

The risk of leakage, risk to life and risk to the environment will be increased with the restriction of PFAS materials due to inherent risk associated with reduced specification alternative sealing materials.

Alternative sealing element materials have a reduced life expectancy. This increases the frequency of in-service sealing element replacement because the lack of compatibility with the range of chemical cargoes that are loaded on each transport event. This results in added costs for the sealing element replacement, labour, downtime, and waste material disposal, some of which will be contaminated with dangerous goods.

Recommendation

For reasons of safety, ITCO call upon the regulators to designate sealing elements in tank containers as “materials of essential use”.

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10.0 GLOSSARY

CNAF	Compressed Non-Asbestos Fibre
ETFE	Ethylene tetrafluoroethylene
FEP	Fluorinated ethylene propylene
FKM	Fluorocarbon-based fluoro-elastomer materials
FFKM	Fluorocarbon-based fluoro-elastomer materials (increased fluorine)
PE	Polyethylene
PEEK	Polyether ether ketone
PFAS	Perfluoroalkyl and Polyfluoroalkyl Substances
PTFE	Polytetrafluoroethylene
PVDF	Polyvinylidene difluoride
UHMW-PE	Ultra-High-Molecular-Weight Polyethylene

11.0 ACKNOWLEDGEMENTS:

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APPENDIX

Item A:
Report of the Joint Meeting of the RID committee of Experts and the Working Party on the Transport of Dangerous Goods – Economic Commission for Europe, United Nations Economic and Social Council.

United Nations ECE/TRANS/WP.15/AC.1/164/Add.1

Economic and Social Council

Distr.: General
25 April 2022

Original: English

Economic Commission for Europe

Inland Transport Committee

Working Party on the Transport of Dangerous Goods

Joint Meeting of the RID Committee of Experts and the Working Party on the Transport of Dangerous Goods

Report of the Joint Meeting of the RID Committee of Experts and the Working Party on the Transport of Dangerous Goods on its spring 2022 session

held in Bern, on 14 - 18 March 2022

Item 10 – Potential environmental restriction of polytetrafluoroethylene (PTFE) used for the manufacture of tank service equipment seals and gaskets

Informal document: INF 6 (ITCO)

28. It was brought to the attention that The European Chemicals Agency (ECHA) consultation process is considering the REACH proposal to limit risks to the environment and human health that might result from the manufacture and use of perfluoroalkyl and polyfluoroalkyl substances (PFAS). ECHA estimate that 4700 substances are within the scope of PFAS which includes PTFE.

29. A ban on the use of PTFE and other similar materials would have serious consequences for the safe transport of dangerous goods. The material is used due to its superior properties in providing a tight seal and chemical resistance, performs better than the asbestos seals that it is replacing, as no equivalent alternative exists.

30. It was strongly advised that concerned parties should respond to the consultation that would close around June/July 2022. Environmentally sound recycling was also to be encouraged.

Item B:
Overview of Chemical Resistance to Chemicals at 20 Degrees C
https://www.calpaclab.com/chemical-charts/

Overview Of Chemical Resistance Of Resins To Chemicals At 20°C:

E	30 Days of constant exposure causes no damage. Plastic may tolerate for years.
G	Little or no damage after 30 days of constant exposure to the reagent.
F	Some effect after 7 days to the reagent. The effect may be crazing, cracking, loss of strength or discoloration.
N	Not recommended. Immediate damage may occur. Depending on the plastic, the effect may be severe crazing, cracking, loss of strength, discoloration deformation, dissolution or permeation loss.

	ETFE	FEP/ TFE / PFA	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 oxiding acids (see Oxidizing Agents, strong)
*** TPE gaskets

Item C:
Overview of Thermal Resistance of Engineering Plastic
http://www.stug.com.au/materials/engineering-plastics-properties/min-max-operating-temperatures.php

Material	Minimum operating temp. for short periods	Minimum operating temperature continuous	Maximum operating temp. for short periods	Maximum operating temperature continuous
PTFE (Virgin)	-280	-250	290	260
High Perform. Mats	-60 to -20	-30 to -10	160 to 310	150 to 250
Polypropylene	-15	-10	145	130
Polycarbonate	-60	-30	135	121
PETP	-30	-20	160	110
Acetal (C)	-50	-40	140	110
Nylon 66SA	-40	-30	180	95
Bakelite	-120	-100	105	90
UHMWPE	-280	-260	110	90
Polyurethane	-60	-45	100	85
HMWPE	-120	-100	100	80
HDPE	-65	-50	100	80
Acrylic	-200	-150	70	60
PVC	-15	0	80	50