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1 Scope

This document provides guidance for PFAS-related substantive changes to polymeric seal materials for subsea oil & gas equipment. It is intended to supplement product validations found in API specifications, such as API 17D and API 6A. It details the process for determining whether a change to an existing material is substantive. This is intended to cover situations such as the substitution away from a fluorosurfactant polymer to a PFAS-surfactant-free equivalent polymer. It is not intended to justify transitions to entirely separate ASTM D1418 material class designation.

2 Terms, Definitions and Abbreviations

2.1 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

2.1.1 Elastomer

Polymeric material mechanically mixed with other constituents to form a compound, which is then shaped by flow into articles by means of the manufacturing processes of molding or extrusion, and then (invariably) cured at elevated temperature to form an elastic insoluble material.

2.1.2 End user

The individual, company, or entity that ultimately uses the finished sealing system in its intended application, rather than for further manufacturing or processing.

2.1.3 Equipment manufacturer

A company that designs, develops, and produces tools, machines, and systems used for exploration, extraction, and production of oil, gas, geothermal energy, or other subsurface resources.

2.1.4 Material manufacturer

A company that is responsible for the formulation and production of polymer-based engineered materials—such as elastomers, thermoplastics, or thermosets

2.1.5 PFAS

A group of synthetic chemicals that have multiple fluorine atoms attached to an alkyl chain. PFAS are known for their persistence in the environment and their resistance to heat, water, and oil, which is why they are often referred to as "forever chemicals".

2.1.6 Polymer

A substance composed of macromolecules characterized by the repetition of one or more types of monomeric units.

2.1.7 Thermoplastics

Material that is capable of being repeatedly softened by heating and hardened by cooling through a temperature range characteristic of the material and, in the softened state, of being shaped by flow into articles by molding, extrusion, or forming.

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2.1.8 Thermoset plastics

Polymeric materials that irreversibly harden when cured by heat, chemical reaction, or irradiation, forming a crosslinked molecular structure that cannot be remelted or reshaped without degrading.

Abbreviations

API American petroleum institute
NFS non-fluorosurfactant
OEM original equipment manufacture
PFAS per- and polyfluoroalkyl substances
PTFE pertetrafluoroethylene
RGD rapid gas decompression

3 Discussion

Per- and polyfluoroalkyl substances (PFAS) are a class of synthetic chemicals that have been incorporated into industrial processes and goods since the 1940s due to their advantageous characteristics. As human health and environmental risks are better understood there continue to be changes in the availability of such products in the market.

API codes often contain clauses which allow for substantive changes in a validated design to be justified without revalidating. One example is API 6A 21st edition F1.2.2.3, which states “a change in nonmetallic materials might not require new design validation if the suitability of the new material can be substantiated by other means.” This document aims to clarify the documentation required to satisfy such clauses for seals in the cases of PFAS market changes.

4 Determination of a Substantive Change

4.1 General

Any changes to the material that lead to a change in the ASTM D1418 material class designation shall be considered a change which requires revalidation or justification outside of this document. To determine if any other change in polymer production process made due to a PFAS market change is suitable without new design validation, the following testing shall be performed and documented with the changed material:

- tensile strength at break, according to the same standard it had previously been tested to (typically ASTM D412 for elastomers, ASTM D638 for plastics, and ASTM D1708 for PTFE);
- tensile stress at a specified elongation, according to the same standard it had previously been tested to (typically ASTM D412 for elastomers);
- modulus of elasticity, according to the same standard it had previously been tested to (typically ASTM D638) for those plastic materials where there is proportionality of stress to strain;
- elongation at break, according to the same standard it had previously been tested to (typically ASTM D412 for elastomers, ASTM D638 for plastics, and ASTM D1708 for PTFE);
- compression set at the maximum stated operating temperature and for at least 22 hours, according to the same standard it had previously been tested to (typically ASTM D395 for elastomers);
- either TR-10 or glass transition temperature, according to the same standard it had previously been tested to (typically ASTM D1329 or other international test method standards for elastomers);

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- chemical resistance/compatibility, according to the same standard it had previously been tested to (typically API 6A, F.1.13, API 17D annex K, or similar).

The results of this testing shall be compared to results performed and documented with the unchanged material. If the changed material results are either within the material manufacturer's historical measured output for the unchanged material or within the equipment manufacturer's specified limit, then the change is suitable without new design validation.

If a changed elastomer is to be used in applications that require rapid gas decompression (RGD) damage resistance, then ISO 23936-2, Annex B testing shall be performed and documented with the changed material. If the changed material results have results comparable to the unchanged material, as determined by the equipment manufacturer for their designs and applications, then the change is suitable without new design validation.

NOTE Material manufacturers willing to divulge the details of their material recipes may forgo performance of chemical resistance and RGD damage resistance testing if both material and equipment manufacturers agree and document that the change is suitable without new design validation.