Tech Sheet #S 603

Requirements and Approvals for Soft Seals for Sanitary Valves

There are three basic approvals that govern the acceptability of soft seals for sanitary service. The most well-known are the regulations published by the US Food and Drug Administration (FDA). These regulations are specified in 21 CFR Part 177.2600 which lists allowable rubber like materials and plastic like materials in 21 CFR Part 177.2400 separately. The other regulations are published by the 3A Symbol Council and the US Pharmacopeia.

The following provides a summary of requirements from the regulations for acceptability of soft seals for sanitary service:

Section 177.2400 Perfluorocarbon Cured Elastomers

Section 177.2400 establishes the requirements for indirect food additives and perfluorocarbon cured elastomers. Repeated use for perfluorocarbon base polymers is permitted only when in contact with nonacid foods with a pH above 5.0. The section sets limitations of chemical composition, identification and lastly extractive limitations.

I. Chemical Requirements

The polymer shall not contain less than 40 weight-percent of polymer units derived from tetrafluoroethylene, perfluoromethyl vinyl ether and no more than 5 weight-percent polymer units derived from perfluoro-2-phenoxy-propyl vinyl ether. In conjunction with the above, requirements for optional adjuvant substances are permitted in the composition such as, substances generally recognized as safe in food or food packaging, any substances used in accordance with a prior sanction and substances that fall under applicable specifications determined in Part 175 and Part 178.

II. Identification

Infrared identification is used to determine perfluorocarbon cured elastomers. The product is broken down by thermal decomposition. This is accomplished by using the method titled "Qualitative Identification of Kalrez by Infrared Examination of Pyrolysate."

III. Extractive Limitations

Requirements are established for perfluorocarbon cured elastomers to meet certain extractability limits. The sample must have a minimal thickness of at least 0.039 inch when extracted and must be extracted at reflux temperatures for 2 hours separated with distilled water, 50% ethanol, and n -heptane. Total extractives must not exceed .2 milligrams per square inch. Fluoride extractives calculated as fluorine not to exceed 0.03 milligram per square inch.

Section 177.2600 Rubber Articles Intended for Repeated Use

Rubber articles intended for repeated use in production, manufacturing, packing, processing, preparing, treating, packaging, transporting, and or holding food all fall under the requirements specified in Section 177.2600. The quantity of a substance required for producing any rubber article intended for repeated use shall not surpass the amount necessary to achieve the intended effect in the rubber and should not achieve any effect in food.

The use of rubber articles is dependent on the compounds used to create such polymers and or copolymers. The chemical composition of such rubbers affects their requirements, respectively. In extension of the chemical requirements, Section 177.2600 breaks down the intended use of the rubber articles by the state at which the food is in when contact is made. The following states are dry food contact, aqueous food contact, as well as contact with fatty foods. Rubbers intended for use with dry food are to be formulated and cured with good manufacturing practices that are suitable for repeated use. Rubber articles being in repeated contact with aqueous food shall meet the following specifications: The food-contact surface of the material, in the finished form in which is in contact with food, when extracted with distilled water at reflux temperature, shall not yield total extractives that exceed 20 milligrams per square inch during the first 7 hours. The succeeding 2 hours of extraction shall present a yield no more than 1 milligram per square inch. Rubber articles intended for repeated use in contact with fatty foods shall meet the same as stated above, except the yield total extractives shall not exceed 175 milligrams per square inch during the first 7 hours of extractions. The succeeding 2 hours of extraction shall present a yield no more than 4 milligrams per square inch.

3A Symbol Council (3A)

Sanitary and pharmaceutical operators rely on the standards published by the 3A Symbol Council (3A) since 3A is recognized as the authority for milk and dairy processing. The 3A general sanitary standards have been used in the industry for many years. The 3A standards for sanitary seals are somewhat unique as they are absorption based as opposed to extraction based. This means they are more concerned about the process being absorbed into the material and becoming stale rather than compounds of the seal itself being leached out of the seal and into the process. Seals are precision weighed, then soaked for a predetermined time in milk, and precision weighed again. The allowable net change in weight is specified in the standard. Standard 18-03 covers Rubber and Rubber Like materials. Standard 20-27 covers multiple use plastic-like materials. In an effort to expand their influence, the 3A Symbol Council officially entered the pharmaceutical realm by introducing their new P3-A Standards. The relatively new P3-A 002 sets the requirements for materials to be used in Sanitary/Hygienic Process Equipment. Manufacturers must submit sample parts directly to the 3a Symbol Council for testing and approval.

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US Pharmacopeia (USP)

As the worldwide pharmaceutical industry became more and more advanced, the industry began to use standards developed by the US Pharmacopeia (USP). There are two USP standards that are applied to sanitary seals: USP <87> *Biological Reactivity Tests, In Vitro*, and USP <88> *Biological Reactivity Tests, In Vivo*.

USP <87> prescribes testing for In-Vitro Biological Reactivity by examining the effects of the material being tested to cause death of cells in a culture or to prevent their multiplication. There are three tests to be conducted with a sample of the test material – the Agar Test, the Direct Contact Test, and the Elution Test. These tests are conducted with cells extracted from a pre-prepared culture of L-929 mouse fibroblast cells.

I. The Agar Test

Cell samples are exposed to the material being tested that are separated by a thin layer of Agar which is intended to protect the cells from physical damage but allow for leachable extracts from the material being tested to reach the cells. The cells are evaluated and the effects of the leachables on the cells is graded on scale of zero to four to categorize the effects observed in the cell culture. The sample meets the requirements of the test if the rating is not greater than grade 2 – *mildly reactive*.

II. The Direct Contact Test

This test is like the Agar Diffusion test except the test material is applied directly to a pre-incubated cell sample coated with fresh cell culture medium. The pass criteria is the same as the Agar Diffusion Test. This test cannot be used with low density or high density polymers.

III. The Elution Test

This test is designed specifically to test the extracts of polymers. The procedure allows for the extraction of leachables, usually at higher temperatures, for varying time intervals. Sodium Chloride solution is mixed with the test product and heated in an incubator to extract any potentially harmful product derivatives. This mixture is then added to the mammalian cell culture and incubated for 48 hours. Results are also based on a scale of 0-4, but unlike the previous tests they are evaluated based on the appearance of distinct breakdown of the membrane of the cells when viewed under a microscope. The test requires a "passing score" for which no more than 50% are round and devoid of intracytoplasmic granules and that no cellular membrane degradation (referred to as "cell lysis") is present.

USP <88> prescribes testing for In-Vivo Biological Reactivity by examining the effects of the material being tested when leachable extractions or physical pieces of the material are injected or implanted in a live animal. Elastomers are tested by Systemic Injection and Intracutaneous Injection. The extracts are prepared at one of three standard temperatures, with 121°C being the most often used. There are six classes of tests for polymers depending on how the material will be used. For most components in pharmaceutical use, Class VI is required.

I. The Systemic Injection Test
Extract solutions are injected into the bloodstream of the test animals (mice and rabbits) and the reactions are scored for two different types of reactions on a scale of 0 to 4.

II. The Intracutaneous Test
Extract solutions are injected into the skin layers of the test animals (mice and rabbits) and the reactions are scored for two different types of reactions on a scale of 0 to 4.

NSF – National Sanitation Foundation
The National Sanitation Foundation was founded in 1944 and is now known simply as the NSF. The two primary standards for consideration when selecting soft seals are NSF/ANSI 51 covering materials for Food Equipment, and NSF/ANSI 61 covering Drinking Water Components.

NSF/ANSI 51: Food Equipment Materials
This standard covers plastic and rubber like materials used for gaskets and seals, as well as other components and sealing compounds commonly used on valves and other types of process equipment. The requirements that must be met are based on US FDA Regulations. The evaluation method is like a "Formulary Review" of 21 CFR Part 177.2600 for elastomeric and rubber like materials, and 21 CFR Part 177.1520 for polymeric and plastic like materials. A review of the FDA regulations for elastomers and polymers should be performed by personnel familiar with the regulations and the chemical formulations as the specifications can be quite specific and complex.

NSF/ANSI 61: Drinking Water System Components
This standard is a far-reaching document that covers materials and finished products that may come into contact with drinking water. Items covered include protective coatings, joining and sealing materials (gaskets, O-rings, adhesives, lubricants, thread sealing compounds, and thread lockers). Finish products covered include valves, filters, strainers, connection fittings, pipe, tubing, and hoses whether metallic or non-metallic. Compliance with this standard is determined

by third party verification (like the process used by the 3A Symbol Council). The NSF website describes the certification program as a seven-step process:

1. Application and Information Submission
2. Product Evaluation
3. Product testing in lab
4. Manufacturing facility inspection, product confirmation, and product sampling
5. Review of test results and acceptance
6. Contracts signed, products listed as approved
7. Annual plant inspection and retesting

Holders of an NSF certification can have their name listed on the NSF website, like holders of a 3A Certificate can have their name listed on the 3A Symbol Council website.

ADI/TSE Free Certification

When ordering seals of any type, an ADI/TSE Free certification should be requested at time of order. This is to prevent the transmission of PRION diseases, such as Bovine Spongiform Encephalopathy and Transmissible Spongiform Encephalopathy. Common ADI's are: Glycerine, Casein, Squalene, Guanine, and Oleic Acid.