TECHNICAL PAPER

Elastomers for CIP and SIP operations

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What are clean-in-place and steam-in-place operations?

Clean-in-place (CIP) operations are used to clean and sterilize surfaces in a manufacturing facility without the need to disassemble large components or manufacturing equipment. CIP is typically performed by forcing a solvent and cleaning agents into pipelines and equipment. The solvent's job is to dissolve away contaminants. Often, water is chosen as the solvent, and either a caustic, soap or other cleaning agent added to encapsulate and remove undissolved particles. While water is often used as a CIP solvent, the solvent is chosen based on the compositions of the contaminants and the equipment.

Steam-in-place (SIP) operations are similar, though they clean and sterilize through the use of high-pressure steam. The high pressure removes any stuck particulates at junctions or fittings, and the high temperature kills any bacteria, mold or fungi that could grow in the process equipment.

The real advantage of CIP or SIP operations is in the savings; it dramatically reduces the time used to disassemble process equipment and pipe lines for thorough cleaning. Disassembly requires the process to be stopped, temperatures and pressures to be dropped to safe levels, appropriate parts locked out and tagged out, all before the physical and chemical cleaning begins. Once the cleaning is completed, the equipment must be reassembled, leak tested and proven before production can be resumed.

Figure 1 — Dairy processing equipment with CIP tanks

By using CIP or SIP processes, there is also a reduced chance of worker chemical exposure. The cleaning solution or steam can be injected directly into the system — meaning no manual disassembly and scrubbing is required. If the system is designed for CIP or SIP, there may be no need for a worker to be near the cleaning solution or steam at all.
Furthermore, some components can be difficult to clean manually. For example, shell and tube heat exchangers have bundles of thin tubes, baffles and other flow paths that are difficult to clean. An anti-scaling caustic can be injected into the heat exchanger and clean the flow path without the need for complex brushes and time-consuming disassembly.

Elastomer seals for CIP or SIP

One particular challenge during CIP or SIP operations is seal maintenance. In the first instance, seals between pipe fixtures and process equipment must be sized correctly to prevent leaks at working fluid pressures, with the proper material resistance to guard against degradation and corrosion under specific operating conditions. To ensure a long service life, these seals must be resistant to chemical attack from any cleaners that are used during CIP, high temperatures and pressures experienced under SIP, and often hygienic enough to be used in food and beverage manufacturing. This balancing act can require the help of a specialist sealing engineer to get right.

CIP/SIP media	Temp	FFKM	FKM	HNBR	EPDM	NBR	VMQ
Caustic soda Sodium Hydroxide (4%)	60-85°C 140-185°F	Excellent	Average	Good	Excellent	Good	Average
Nitric Acid (0.5%)	55-65°C 130-150°F	Excellent	Excellent	Average	Good	Average	Poor
Phosphoric Acid	55-65°C 130-150°F	Excellent	Excellent	Average	Good	Poor	Average
Hypochlorite solutions	Ambient	Excellent	Excellent	Good	Good	Good	Good
Chlorine (Bleach)	Ambient	Excellent	Excellent	Average	Poor	Poor	Poor
Chlorine Dioxide	Ambient	Excellent	Excellent	Average	Poor	Poor	Poor
Peracetic Acid (PAA)	Ambient	Excellent	Average	Poor	Excellent	Poor	Good
Hydrogen Peroxide	Ambient	Excellent	Excellent	Average	Average	Average	Good
Acetic Acid	Ambient	Excellent	Excellent	Poor	Excellent	Good	Excellent
Hot Water	90-100°C 195-205°F	Excellent	Excellent	Average	Excellent	Poor	Average
Steam	120°C 250°F	Excellent	Excellent	Average	Excellent	Poor	Average

Table 1. Chemical resistance of common sealing materials. Source: Precision Polymer Engineering

Gaskets, O-rings, sanitary rings, hygienic pipe connectors and other elastomer seals are commonly used to prevent leaks in these systems. Determining the material chemistry that will have the longest service life depends on the conditions it will experience during use, including during the CIP or SIP process steps.

Commonly used O-ring materials

Different equipment and chemical processes require different chemical cleaning steps. Silicone rubbers (VMQ), nitrile rubbers (NBR), ethylene-propylene-diene rubbers (EPDM), hydrogenated NBR (HNBRs), fluoroelastomer (FKM) and perfluoroelastomer (FFKM) can all be used in CIP or SIP processes.

In terms of chemical resistivity, each of these materials is rated against common media used in the CIP or SIP process. Qualitative descriptions of each material's resistance to the various chemicals are shown in Table 1.

FFKM seals emerge as the most versatile sealing material, providing the best resistance to chemical attack, and maintaining this chemical resistance even at higher temperatures. Because of this, FFKM seals offer the longest service life.

Perlast® seals

Precision Polymer Engineering (PPE) specialize in manufacturing FFKM seals for industries including life sciences, chemical production, and food and beverage manufacturing. PPE's Perlast® range of O-rings are available in numerous standard styles, and rapid tooling available for making custom sizes. They also manufacture gaskets, valve seals and other profiles that meet international standards for food-contact applications. The Perlast® range includes several material grades that have been fine-tuned for specific temperature ranges and environments.

Perlast® seal advantages

When choosing a source for CIP- or SIP-ready O-rings, PPE offers several key advantages. Perlast® seals from PPE have some of the shortest lead times in the industry. Seals typically do not announce their failure dates, and a critical process can be down for months caused by a seal failure and long lead times for a replacement. Seals are available in many standard sizes, and non-standard sized components can be manufactured quickly. By purchasing components from PPE, processes can be up and running much quicker.

Figure 2. Various Perlast® perfluoroelastomer (FFKM) seals and gaskets used in food and dairy applications

Perlast® seals are also highly reliable and provide a low cost of ownership. The FFKM polymer chemistry used in Perlast® seals is resistant to chemical attack from all caustics and cleaners, ensuring a much longer service life than other elastomer materials. Furthermore, their thermal stability means they will not become brittle or degrade with repeated SIP cleanings.

Another major advantage is that PPE's Perlast® seals are manufactured with full traceability and certification to numerous international standards, such as FDA, U.S. Pharmacopeia (USP), 3A 18-03 (Dairy) and other standards for sanitary, pharmaceutical, and food and beverage use. Visit Precision Polymer Engineering's website for a full list of certificates; www.prepol.com

Precision Polymer Engineering

For more information about how Perlast® seals can improve the efficiency of CIP or SIP operations, contact Precision Polymer Engineering and the sealing experts who can assist in finding the perfect solutions for specific application challenges.

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