PC PUMPS PROVIDE SOLUTIONS FOR CLEAN-IN-PLACE SYSTEMS

BY ERIC D. GRAY AND
ROBERT L. MCNEELY

MOYNO

Always the Right Solution™

MOYNO

Always the Right Solution™

PC PUMPS PROVIDE SOLUTIONS FOR CLEAN-IN-PLACE SYSTEMS

High labor costs and sizable, complex process equipment and operating methods demand that processing plants make the best use of their resources. Lengthy periods of downtime dismantling, cleaning and reassembling process equipment are not economical. These unproductive intervals are minimized if cleaning is done from a central position rather than by having an operator move from one area to another performing a series of manual functions. Progressing cavity pumps with clean-in-place capabilities can eliminate labor-intensive manual cleaning and prevent costly downtime.

Many industries have replaced manual cleaning with "cleaning in place," a process that circulates detergents and chemical sterilants. In the dairy industry, where clean-in-place (CIP) systems were first used in the early 1950s, automated CIP systems have almost completely replaced manual cleaning. Processors of various food products including fruit juices, salad dressings, egg products, puddings, mustard, and meat packing are widely using CIP systems as an alternative to manual cleaning. CIP is gaining acceptance in wine processing, brewing, pharmaceutical and chemical process industries.

The benefits of CIP systems include:

(1) Minimal manual effort - Manual operations can be reduced or eliminated

(2) Increased production - Equipment can be cleaned as soon as it is empty and refilled immediately after cleaning

(3) Cost savings - Recirculation of water, detergent, and sterilants

(4) Improved hygiene - Each cleaning cycle is the same as the previous for repeatable, reliable performance. CIP makes it easier to meet both FDA and ISO 9000 requirements.

(5) Improved safety - The risk of falling on slippery surfaces is eliminated.

Operation

CIP is accomplished by circulating water and various chemical solutions through process piping and equipment in the assembled state. The combined effects of solution turbulence and chemical action remove debris and micro-organisms from equipment surfaces. It is essential that the cleaning solutions reach every part of the system that has been in contact with the process fluid. Therefore, all equipment subject to CIP must be free from inaccessible crevices and pockets.

For closed equipment such as pipelines, heat exchangers, valves, and pumps, CIP solutions must circulate with sufficient velocity and turbulence to remove the soil load completely. This fluid velocity should be about 3.5 ft/sec. (1 m/s) for straight pipe and up to 7 ft./sec. (2 m/s) for obstructions in valves and pumps. With PC pumps, these flow velocities typically are achieved at flow rates three-to-five times the process flow rate. CIP solution temperatures can reach 180° F.

Among its component parts, a typical process system consists of completely enclosed pipework, storage vessels, pumps, automatic valves, and sensors which operate in a number of modes, one of which is clean-in-place. Since product and CIP liquids traverse the same route through the process system at different times, safeguards must be provided to prevent any possibility of intermixing. Automated systems are invaluable in this respect and in providing minimal non-productive process time. In CIP systems, a microprocessor or computer control system operates valves, assuring they maintain their position by continuously monitoring valve feedback and flow switches. The system might also ensure that cleaning solutions are of the correct chemical strength and temperature and that sufficient quantities of solution are available.

A typical CIP sequence is as follows:

(1) Water pre-rinse to remove gross soil

(2) Detergent circulation to remove residual adhering debris

(3) Intermediate water rinse to clear detergent from the system

(4) Sterilant circulation to destroy any residual organisms

(5) Final water rinse to remove any traces of sterilant solution

Cleanability Requirements

There is much confusion over the cleanability requirements for equipment meeting 3A, FDA, USDA, and other sanitary standards related to two methods of cleaning — clean-in-place or mechanical cleaning and manual cleaning. The 3A standards define mechanical cleaning as "...cleaning, solely by circulation and/or flowing chemical detergent solutions and water rinses onto and over the surfaces to be cleaned, by mechanical means." Currently, only silo tanks and permanently installed sanitary pipelines are recognized by most sanitarians as acceptable for CIP cleaning.

Most sanitarians also recognize differences between CIP and mechanical cleaning. The difference is that CIP systems and equipment never have to be disassembled to be cleaned or inspected for cleanliness, whereas mechanically cleaned systems and equipment need periodic inspections and possibly periodic manual cleaning. Under these circumstances, process equipment or systems must be evaluated for design and installation, as well as by field observations to determine whether it can be CIP, mechanically, or manually cleaned. It ultimately becomes the user's responsibility to make this determination and to verify the decision by field inspections and experience.

Cleanability is another factor that affects installation. Even though equipment is designed for CIP or mechanical cleaning, that does not always mean it will be cleaned following the prescribed cleaning process. It is important to note that the use of the term "CIP" is strictly for identification, and most manufacturers do not imply that manual cleaning or inspection is unnecessary in all applications.

CIP Design in Progressing Cavity Pumps

In the past, the CIP design relied largely on using standard hardware items adapted to existing pump equipment. Such modifications have been adapted to centrifugal and positive displacement pumps.

The centrifugal pump design works extremely well for CIP applications with minimal modifications necessary. However, by nature, positive displacement pumps are slightly more complicated and require a different approach when it comes to CIP. A common CIP design used with positive displacement pumps is to install a bypass loop around the pump connected at the suction and discharge ports or piping with pipe "T"s. In contrast, some progressing cavity pumps are designed especially to accommodate CIP modifications.

A progressing cavity pump such as the Moyno® Sanitary Pump, has a specially designed CIP option with a bypass port in the suction housing. The bypass port is located in the suction housing so that high-velocity CIP solutions remove debris from the mechanical seal, pin joints, and other surfaces inside the suction housing before exiting through a bypass port located just ahead of the stator. Wiping action of the rotor inside the stator, combined with flushing and the mechanics of the CIP solution, remove debris from the pump element.

During the in-place cleaning cycle, the pump operates as during normal pumping at the process flow rate. CIP pumps, usually centrifugal, supply CIP solutions to the systems at rates three-to-five times the process flow rate. The excess volume not passing through the pump element passes through a bypass loop. Figure 1 shows a typical plumbing arrangement for the bypass loop.

Two close-coupled valves suitable for CIP should be installed to close off each end of the loop. In the event either of the valves would leak resulting in a pipe full of product, one of the valves should be a three-way type so that one port is open to the atmosphere when closed. This allows drainage and detection of the leak. Figure 2 shows the valves in the open position, closing off the drain port and allowing CIP solution bypass.

A less expensive configuration, eliminating the valves and using sealed caps during processing, can be utilized in some cases. When cleaning is required, remove the caps and attach a flexible hose for bypass flow.

Selection Guidelines

When selecting a progressing cavity pump to be operated in a CIP mode, take the following factors into consideration:

(1) CIP is difficult, if not impossible, using an open throat suction hopper with many progressing cavity pumps in food applications. It is difficult to obtain the high-velocity flow necessary to generate a mechanical scouring action to dislodge debris from all surfaces within the open throat hopper.

(2) Select a pump with a single mechanical seal. Compression packing cannot be cleaned in place.

(3) Stator and sealing elastomers must not only be capable of withstanding contact with process fluid, they also must withstand detergents and disinfectants at the cleaning temperature. Most detergents contain caustic soda (NaOH) which can be used with Nitrile elastomers. Commonly used disinfectants include sodium hypochlorite (NaOCI) which requires a fluoroelastomer. Carefully choose compatible stator and sealing elastomer materials.

(4) A process might involve a product temperature of 70° F, a CIP solution temperature of 180° F and a cleaning cycle that lasts one hour each day. Since CIP solution temperatures could be as high as 180° F, this temperature must be considered when calculating driver horsepower. Select a sanitary pump with a standard size rotor and driver horsepower based on a standard size rotor at 180° F.

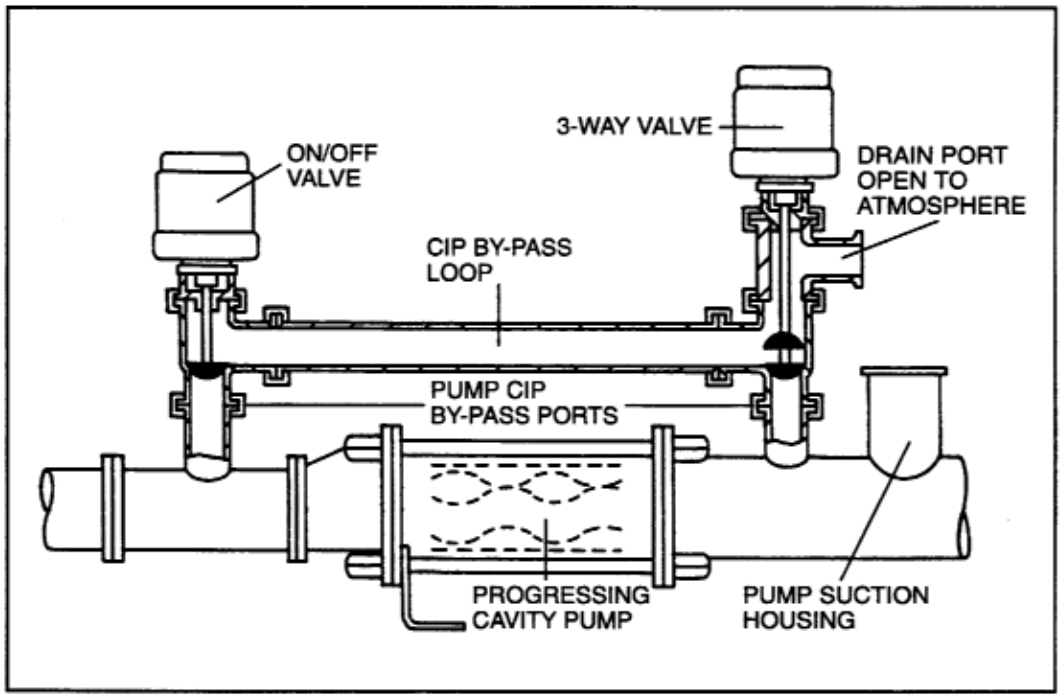

Figure 1. Process cycle with valves in closed position

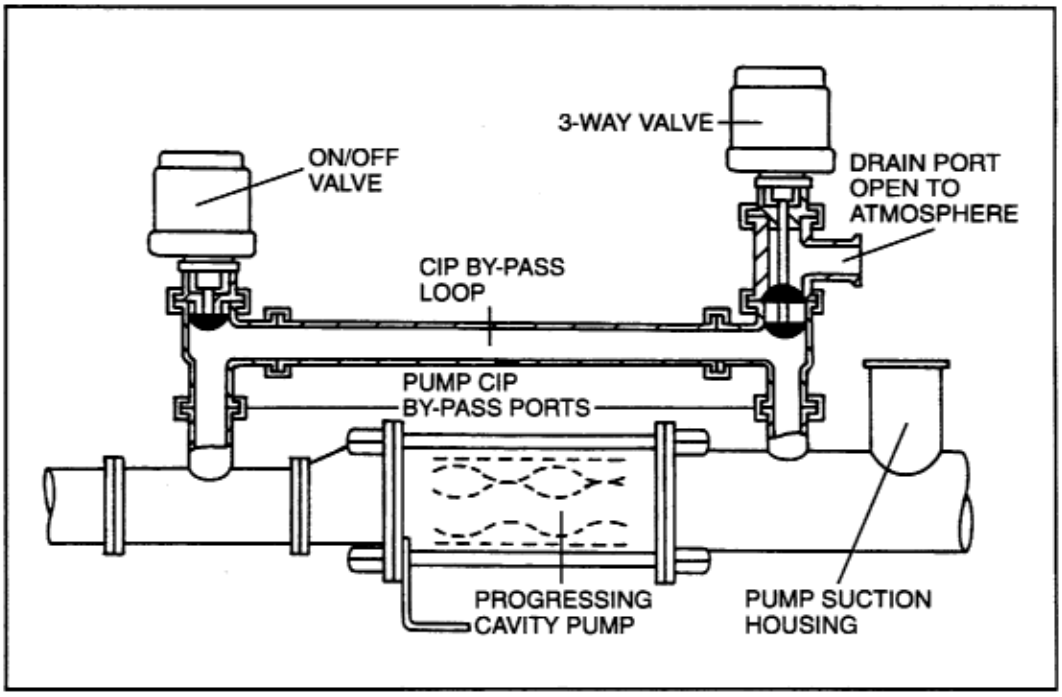

Figure 2. In-place cleaning cycle with valves in open position

Conclusion

Clean-in-place systems provide numerous benefits including increased production, decreased downtime, improved hygiene, and cost savings. The CIP process of circulating water and cleaning solutions through assembled process equipment has replaced manual cleaning in various industry facilities — most notably, the dairy industry. The PC pump is compatible with CIP applications. CIP can be accomplished by installing a bypass loop around the progressing cavity pumping element. This loop prevents excess volume of cleaning fluid from damaging the pump and interfering with the cleaning process.

Progressing cavity pumps with clean-in-place capabilities offer highly efficient, cost-effective solutions to help processors maximize their productivity and meet industry sanitary requirements.