Clean in Place (C.I.P.) Technology

CIP Technology:

CIP (Clean in Place) technology is often used in the sanitary industries to clean equipment and vessels. For effective CIP cleaning to take place, the equipment must be designed to eliminate all cracks, crevices and areas that are shadowed from the CIP delivery device(s) (sprayballs or other devices designed to wet the areas to be cleaned). Many process vessels require agitators or mixers to either mix ingredients or to keep the product in the vessel in a uniform, homogenous state. There are many types and styles of mixers and mixing impellers. A very common mixer configuration is top entering, which features one or more impellers being driven from a motor located on top of the vessel. To clean the vessel and the agitator, single or multiple spray devices are furnished in the top. The spray devices in an agitated vessel normally spray in a 360 degree pattern to wet the shaft, impellers and any other appurtenances, such as steady bearings or baffles. Many factors pertaining to the cleaning cycle itself are important for proper cleaning, such as temperature, flow, pressure, type and concentration of chemical, and type and location of the spray devices. This article will focus on design of the mixer itself for effective cleaning of a top entering agitation system.

Impeller:

The primary element of a mixing system is the impeller. There are many styles and shapes of impellers that can be used. Every mixing process is different, and the impeller must be matched to the application. For low viscosity blending, mixing, or maintaining homogeneity, axial flow impellers are commonly used. An axial flow impeller is one in which the primary flow across the impeller blade is axial, or parallel, to the mixer shaft. Common types of axial flow impellers are 4-bladed 45 degree pitched turbines and hydrofoil impellers. These impellers are designed to optimize mixing performance, the cleaning characteristics of the blades not being a major consideration.

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Riboflavin Testing:

A common test for complete CIP coverage that is performed in the industries where sanitation is critical, such as the Pharmaceutical industry, is the Riboflavin test. To perform the test, a solution of Riboflavin is mixed with water and sprayed on the surfaces to be checked. Clean water is pumped through the spray devices, simulating the flow and pressure conditions of a CIP cycle, for a set period of time (normally in several intervals or bursts). After the allowing the vessel to drain, the surfaces under investigation are checked with a blacklight. Any surfaces that are shadowed, or did not have sufficient flow or velocity to remove the riboflavin solution, will become visible and fluoresce under a black light source. This is a stringent test, often performed by the vessel manufacturer. To assure repeatable results, the test is performed twice.

Pantented Sanifoil Impeller:

Several problem areas of traditional mixing impellers are the areas shadowed underneath the blade, especially at the point where the impeller blade attaches to the hub. Because the CIP devices are normally mounted at the top of the vessel, and the impellers are mounted well below the top, it is apparent that a potential shadow area exists underneath the impeller blades. Based on two years of research and repeated Riboflavin testing, JVNW has developed the “Sanifoil” impeller. As an impeller is normally rotating during CIP cleaning, a portion of the falling droplets of solution can be expected to strike underneath the leading edge of the blade. The leading edge of the Sanifoil blade is pitched vertically to catch the falling droplets of cleaning solution. The blade is radiused downward to provide axial pumping and free drainage. Nearest the hub, at the blade attachment, the cross sectional area of the blade is reduced and is near vertical. During testing of conventional impellers, this area was found to be difficult to clean because it is the area of lowest velocity relative to the CIP stream. The Sanifoil blade is gradually tapered back to the tip at a point roughly ¼ the blade length for a more even velocity distribution and better mixing performance. Our research determined that the surface finish of the impeller is an important factor in effective cleaning of the blade. All Sanifoil impellers are first mechanically polished, then

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electropolished to an average roughness height (Ra) of not more than 25 microinches.

Another area found to create cleaning problems is the hub of the impeller. The Sanifoil hub is tapered both on the top, to permit drainage on the top side, and on the bottom, to allow full flow along underside of the shaft. During development, it was determined the bottom corner must have a radius to permit solution flow to the shaft area directly underneath the hub. While most impellers are attached by welding the impeller to the shaft, it often desirable to have the impellers be removable, or adjustable along the length of the shaft. For non-sanitary applications, setscrews and keyways are commonly used. An effective solution for a sanitary adjustable hub has been developed by JVNW. A tapered keyless bushing attaches the hub to the shaft. The keyless bushing has been designed to carry the weight and transmit the torque of the impeller. The hub itself is sealed from the product by static 'O' ring seals around the shaft, effectively sealing the threads of the sanitary hub. The hub can be easily adjusted to accommodate varying batch sizes, and the keyless bushing will not mar or score the shaft as a setscrew might.

Steady Bearing:

Many sanitary vessels are equipped with a bottom steady bearing to prevent the large bending moments of an unsupported shaft, being transmitted to the mixer drive bearings. The JVNW steady bearing is designed for CIP cleaning. In the bottom of the vessel a tripod structure is welded and ground smooth. A plastic bushing, into which grooves are machined to match the tripod legs, is inserted from underneath the tripod. This design permits the bushing to be replaced without displacing the agitator shaft. An 'O'-ring, which fits in a slot around the bushing, secures the bushing in place. The end of the agitator shaft has milled flats, which allows the cleaning solution to flow into the bore of the bearing, and washes the inside surfaces. The outside of the bearing and the tripod is exposed to cleaning solution, as there is minimal contact area between the bushing and the tripod.

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Conclusion:

The Sanifoil impeller has successfully passed Riboflavin tests on mixers used on 200 liter vessels up to 14,000 liter vessels. It should be remembered that the riboflavin test is conducted with unheated water, without the aid of any cleaning chemicals, and for a much shorter time period than an actual CIP cycle. There have been many successful applications of conventional impellers that apparently do clean sufficiently during the longer CIP cycles with the benefit of heated cleaning chemicals, but there are also instances where additional spray devices are required underneath the blades. Installing additional spray cleaning devices is undesirable, as additional fittings in the tank are required. Sidewall, and especially bottom fittings, create pockets that are undesirable from a cleaning standpoint. Good sanitary design practice plays a large role in the CIP process.