Hygienic design prevents contamination risks

Washers that do more than just clean

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Not just a washing machine: a pharmaceutical washer is a thought through high-tech construction.

Quality and validation requirements for process equipment in the pharmaceutical industry are constantly increasing. The goal is to achieve highest product safety through validated, completely reproducible and monitored processes. Extensive measures must be taken against possible cross contamination and germ formation, but also for the protection of the operating staff, especially in the biotechnological production of active substances and in the area of highly active substances, parenterals and plasma products. The automated cleaning of all parts used for preparation and packaging that are in contact with the product such as format parts for filling plants, filling pump elements, filter housings, tablet stamps and dies, separators, trays, funnels, hoses, cans, drums and containers is particularly important. Even smallest amounts of adhering product residues must be removed efficiently, that is to say in shortest time with minimum energy and water consumption, by means of a validated, reproducible procedure.

But the washer also represents a potential risk of cross contamination and germ formation in the overall process, because of product residues or residual water which might remain in the plant after completion of the cleaning of a batch. An appropriate state-of-the-art hygienic design with modern constructional solutions allows reducing these risks to a minimum right from the outset.

Clean room standards compliant door systems

Usually, in pharmaceutical production, washers are operated as two-door lock systems with physical separation of clean and unclean sides in a clean room environment. Door construction and door sealing system must be adequately designed for clean room operation. Door drives operating without abrasion or pollution, which therefore do not emit particles in the clean room, are to be preferred. A very important point when cleaning toxic product residues are door systems with a door that does not enter a technical area or an equipment compartment when opening, but remains in the clean room. This allows, in case of an interruption of the washing process, to prevent unwanted contamination of non-classified and difficult to clean areas. Besides models with vertical door opening, models with horizontal door opening should also be available for integration in premises with limited ceiling height.

Glass doors allow the visual inspection of the washing process. Radially inflatable seals, which ensure tightness directly on the washing chamber wall, have minimal sealing surfaces and therefore optimal self-cleaning properties. Enhanced door seal designs allow easy seal replacement, without seal bonding and therefore without plant standstill while the adhesive is drying.

Radial door seal of a washer: minimal sealing surfaces, no seal bonding, optimal self-cleaning properties.

Hygienic washing chamber design

The state-of-the-art for preventing cross contamination between different cleaning batches is a washing chamber without gaps and dead spaces, with rounded corners, out of mirror-polished sheet metal (material 316L, Ra < 0.4 µm). All weld seams in contact with the product inside of the chamber should be ground and polished with weld seam surface finishes of Ra < 0.8 mm The smooth and rounded surfaces, combined with sufficient slopes in the bottom and the ceiling of the chamber, ensure almost complete self-draining of the chamber after individual washing steps and prevents product and detergent residues from remaining in the chamber. These optimal self-cleaning properties are essential for the compliant operation of a washer under GMP conditions.

Washing tank without fittings

In order to avoid spray shadows, which would impair the self-cleaning properties of the tank, the washing chamber, and in particular the tank in the washing chamber sump, should be free from any protective plates, filter plates or other fittings. For this reason, in compliance with the state-of-the-art, the water and the drying air are heated only by heat exchangers located in the piping of the plant instead of heating spirals located in the tank. The filling volume of the tank should be adjustable in order to adapt the required water quantity to the different items to be washed and take advantage of the water-saving potentials.

Direct dosage

Accurate and reproducible dosing of detergents, which is indispensable for process validation, will be best ensured with membrane dosing pumps. The entirely residue-free addition of the detergents in the washing tank can be achieved by direct dosage in the media supply of the plant. Another advantage of this technique in comparison with additional dosing openings in the washing chamber is the fact that the washing solution shows the required detergent concentration already at the first circulation. This allows preventing, e.g. when cleaning poorly water-soluble substances, agglutination or deposition effects that might appear in case of contact with pure washing water with an initially low detergent concentration. This dosing technique is also advisable for corrosion-sensitive tabletting tools, which should possibly not come into contact with pure washing water

Self-draining piping

Bacterial growth due to residual water stagnating in elements of the washer represents a great risk for process safety. This is why all piping should be routed with a minimum slope of two percent, to ensure complete self-draining. This is also why the use of membrane valves must be provided for in the piping system. Dead ends must be avoided or, at least, be designed according to the so-called “3D Rule”. The material (316L) and surface finish (Ra < 0.8 µm) of the piping in contact with the product and of the circulation pump should be identical to the quality of the washing chamber. With regard to the hygiene requirements, it is advantageous to use the same piping system for all process steps, i. e. washing, rinsing and drying. This way, the washing and drying system of the plant is entirely cleaned, rinsed, drained and dried after every cleaning cycle, ready for a new cycle.

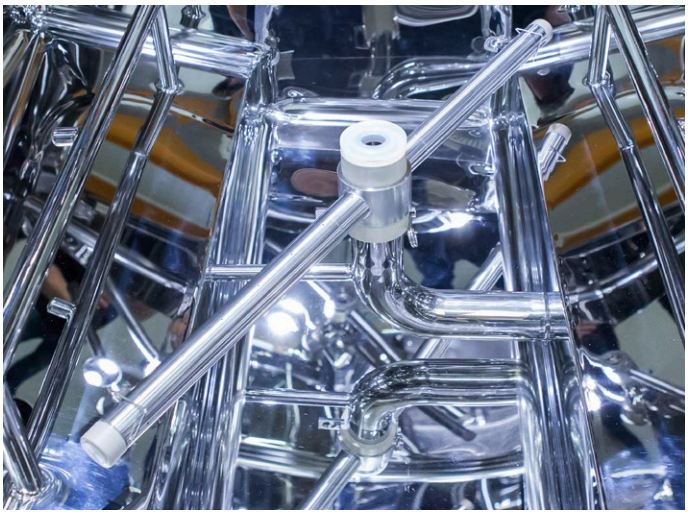
Bacterial growth due to residual water stagnating in elements of the washer is a great risk for process safety. To ensure total draining, all piping should be routed with a 2% slope.

Monitored nozzle system

The external cleaning of items to be washed in pharmaceutical washers is for most applications achieved with rotating nozzle arms, which also must show a design without gaps and dead spaces. So suitable nozzle arms are made of round material with incorporated nozzles and have removable end caps so as to allow, if necessary, the removal of any foreign matter. Since a slower rotation of the nozzle arms, due

for example to clogged nozzles, is almost not visible, even though it affects significantly the result of the washing process, monitoring the nozzle arms rotation is recommended for comprehensive process control.

In addition to the external cleaning system, most washers offer the possibility, for cleaning hollow items, to connect the piping system of the plant by means of an automatic connection coupling installed in the washing chamber to a flexibly designed nozzle system mounted on the wash rack. The latest technical development, compared to the spring-based or pneumatic docking couplings used until now, are water-hydraulically operated systems, which use the pressure provided by the washing pump for almost leakage-free docking, providing correspondingly higher washing nozzle pressure on the wash rack. A vertical arrangement ensures the complete draining of the coupling, without residue.



Hygienic washing chamber and tank design: shiny clean stainless steel.

Reduced ultrapure water consumption for final rinsing

Generally, in washing processes in pharmaceutical production, a final rinsing with ultrapure water is performed after completion of the various washing and rinsing steps, before drying. In a validated cleaning process, the goal of this “GMP Final Rinse” is to achieve the defined purity criterion, e.g. a determined conductivity of the final rinsing water. This clean rinse can be carried out either in a recirculation process or, if the absence of particles is required, in a direct rejection process. Direct rejection means that the rinsing water comes from the supply line and enters the washing chamber, and is then directly rejected in the drain. However, to be able to operate also in such conditions, the nozzle system of the washer requires a very high connected pressure, which is generally difficult to achieve for ultrapure water systems. A solution is provided by the pulsation rinse process, in which the final rinsing water is prepared in a special tank, which can then be suddenly emptied in the piping and nozzle system of the washer thanks to sterile compressed air. The high pressure thus provided allows the nozzle system to operate as efficiently as during the washing step, also without the corresponding water quantities, with accordingly reduced ultrapure water consumption.

High-performance drying

During the drying process, the drying air shall in no way transport particles inside of the washing chamber or on the washed items. This is why the drying unit should include a prefilter, a ventilator, a heating register and a HEPA filter. In order to validate the process, a differential pressure switch and a filter test device as accessible as possible, with scanning possibility through a DEHS fitting, must be provided. Shorter drying times and therefore better throughput can be achieved with special drying units, which generate overpressure in the piping system.

Conclusion

Highest product safety and efficiency of the cleaning process can be ensured already thanks to well elaborated design solutions. Modern pharmaceutical washers are technically more complex and therefore require higher investment costs, but they offer decisive advantages in terms of process safety, validation, energy and water consumption.

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