

Impingement vs. Ultrasonic Cleaning

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Impingement cleaning vs. ultrasonics

The challenge is given to a program engineer. A manufactured part is made of a hard substrate that includes stainless steel as well as mild steel, bronze and other grades of steel. It is designed with one deep blind hole, 3 threaded small (1/16" diameter) through holes and a series of threaded shallow blind holes. This part must meet an objective cleanliness level and process 2,800 parts per full 8 hour shift.

The objective cleanliness level includes multiple specifications. First, the part must be oil free upon exit from the wash system over a specific (98%) area of the part's surface. This can be measured using phase imaging. Phase imaging is a surface-mapping technique that utilizes an oscillating probe brought into soft contact with a surface. The amplitude of the signal varies with changes in the surface topography and thus illustrates where surface contamination remains.

The cleanliness specification also includes a maximum weight. This can be measured using the Millipore gravimetric method. This method uses a solvent to flush a part down until all the remaining particles are funneled through left on a filter screen. The screen is then weighed. This part's filtered contaminant weight cannot be more than .5 milligrams per part.

Finally, these parts cannot exit the washer with a particle that is greater than 20 microns in size as measured in a standard approved brand of particle counter.

Meeting that cleanliness specification will be challenging. Since this specification must be met and the part contains blind and deep holes, along with narrow through holes, the assumption by many program managers is to clean this part with ultrasonic waves. Meaning, use the mechanical action of agitation created by way of electrically powered transducers, which convert electricity to intense, high frequency ultrasound vibrations within a cleaning bath.

Although this conventional wisdom has merit, the entire scope of the project prohibits ultrasonics from being the most effective method of choice.

Ultrasonic cleaning is cleaning via cavitation, which occurs when ultrasonic waves cause pressure gradient within the cleaning fluid, forming bubbles within low-pressure areas. These bubbles burst at the surface of the part being cleaned. This energy loosens the contaminant from the surface. Thus, the perfect agitation for hard to reach places where spray from nozzles cannot be directed.

Perfect as long as there is enough ultrasonic energy to attack the entire part surface. Perfect as long as no part surface area is shielded by other parts or by transferring baskets. And perfect as long as the time is adequate to allow the cavitation to perform its work.

Energy

The industry standard, as cited in the Cleaning Technology handbook released in the December 1998 issue of Part Cleaning Magazine says, " ..as a rule of thumb, the sum of the part's cross-sectional areas should not be greater than 70% of the ultrasonic tank's cross-sectional area. In addition, the workload mass to volume ratio should be no greater than 30% in parts cleaning and no greater than 15% in precision cleaning applications."

In short, ultrasonics will not perform unless there is enough juice to attack all surface areas to be cleaned.

So where does that leave you? With either a small tank to do a few parts at a time or a large tank to perform

mass cleaning of many parts.

Production Rate

The production rate cannot be met using ultrasonics to clean 1 or 2 or even 10 parts at a time. Time of transfer, dip, process time, retrieval and subsequent transfer to the next stage is too time consuming. That leaves only one way to use ultrasonics and meet the production rate desired. Load a large number of parts into a large container and transfer the entire batch together from stage to stage. When this method is employed, however, hidden problems arise to prove this way of cleaning is ineffective.

1. Transfer basket surface areas waste cleaning energy
2. Parts stacked on parts shield each other from the cleaning action.
3. Recontamination of parts when removed from the tank
4. Particles sized less than 25 micron cannot be removed.

The first two objections are self-explanatory. All exposed substrate surfaces are cleaned in the ultrasonic tank, which includes the frame of the transfer basket. Also, the more parts that need to be processed, the larger the basket needs to be. Any surfaces that are not exposed do not become clean. Parts stacked together or even touching themselves or the basket frame avoid cavitation at those contact points.

The third objection is the hidden risk of all dip tank applications. The cleaning action takes place with cavitation opening and collapsing at the substrate surface. The energy releases the oils, and the particulate held to the part by the oils, into the tank. As this happens, oils with a specific gravity lighter than water rise to the tank surface. When the cleaning action is completed, the basket of parts are removed by being drawn up through that soil laden surface. Thus, the parts are made dirty as they are moved from the bath. Finally, particles less than 25 micron in size are not effectively removed via ultrasonics. This is confirmed in that same article found in the December 1998 issue of Parts Cleaning Magazine.

The most effective cleaning method for this specific part is an indexing conveyor with the following sequence of operations:

1. Part is manually or robotically loaded onto a specifically designed nest or fixture to hold the part in place for transfer from stage to stage.
2. Fixtured part indexes to the point where a pneumatically activated, manifold with a rubber gasket is energized and moved down onto the fixture swallowing up the part.
3. Heated, chemically blended solution floods the part by being pumped through the manifold. This solution drains out the bottom of the fixture.
4. Gasketed manifold is then lifted while solution continues to spray over the part. Sheer force of fluid combines with temperature and the chemical to flush oil and particulate from all crevices, holes, threads and surfaces.
5. Part is indexed to next fluid stage for corrosion protection if necessary.
6. Part is then indexed to the next stage where the part is vacuum dried. Here the part is engulfed with a rubber gasketed manifold that creates a vacuum that allows the mechanism to lower the boiling point of water so that all liquid is evaporated before the manifold is released.
7. Part is then indexed to the unload stage where the robot or operator is able to remove a clean, dry part that is neither too hot or too cold.

This sequence of operations can be timed to meet the production rates necessary. Pumps, vacuum dryer, manifolds and pneumatic activators all can be sized to achieve the necessary action to adequately flush the part and evaporate the moisture.

Of course, all washer fluid management, filtration, in-process treatment options and devices that are available on a standard belt washer can be installed on this system as well.

With this option available, cleanliness levels and production rates can both be satisfied. Satisfied even with a part that has hard to reach areas and particles that are less than 25 micron in size.