Particle Counting

Particle Counting Offers Consistent Measurement

Engineering quality systems have determined that in-process part cleaning is a significant step in the manufacturing process. This is quite a change in attitude in some industries where cleaning is only considered an afterthought. There, the only goal is to prepare the finished part, cosmetically, immediately before it is shipped. Quality control specialists realize it is vital to wash each component during the entire build cycle if they are to achieve the desired end result.

For many industries, such as aerospace and automotive manufacturing, required cleanliness levels are specified for each component. They believe by taking each item to be assembled and cleaning it before it becomes a completed assembly, the internal workings of the finished part will function more smoothly, last longer with less service problems and generate greater customer satisfaction. Embracing the task of cleaning has translated into direct economic benefits such as improved production yields, lower service cost and reduced re-manufacturing time. These, in turn, have been able to make the manufacturer more competitive.

For too long parts cleaning systems have achieved results that could only be measured subjectively. Methods of determining how clean a part is, or needs to be, includes the “white glove” test, the oil finding “water break” test and the black light observation booth. Although these methods can determine whether a part has been cleaned or not, they cannot set a standard for cleanliness that can be objectively measured. Without this objective evidence there is no way to control the manufacturing process to the satisfaction of today’s customer driven, required quality system.

A more objective means of measuring the remaining contaminant on an individual part is the Millipore test. This procedure consists of:
1. Washing the part in an aqueous system
2. Taking the clean part and spraying it with a solvent
3. Funneling, via positive pressure, this solution through a filtered tube
4. Removing the filter from the tube and drying it
5. Weighing the dry filter
6. Subtracting the weight of the new filter from the weight of the dried filter- the contaminant level

This test will give a consistent measurement of the weight of the contaminant left on the part after washing. It is most appropriate for applications where oil, lubes or coolant are the contaminant to be washed off. This method also is able to measure cleanliness levels where there is grinding swarf, chips or residual weld spackle. Although Millipore tests are used in applications where particles are present, at the same time, the limitations of the test allow false assumptions to be made.

When weight of the contaminant is measured, the Millipore test can offer no indication of whether that weight is made up of 1 particle, 10 particles or 10,000 particles. Neither can it measure the size of any of those particles. This is vital information. Some components can operate effectively with 10,000 particles still on it as long as none of those 10,000 particles are over a certain size dimensionally. Although particles can be distinguished down to 1 micron, it is not practical to try and observe them as a way of measuring cleaning effectiveness. In order to bring this point into perspective, look at the following campaigns based on micron size:

- One inch equals 25,400 micron
- 1/10,000 of an inch is 2.54 microns
- One millimeter is 1000 microns
- A blood cell is about 10 microns across
- Humans cannot see anything smaller than 100 micron with the naked eye

- A human hair is 150 microns wide
- By scientific standards, any filtration system smaller than 100 microns is considered macro filtration.
- Most bacteria are between 1 and 15 microns in size
- The next unit of measurement on the metric scale is a nanometer and it is measured in light wavelengths.

Due to the limitations of the Millipore test, the most effective means of determining an objective level of cleanliness desired is by utilizing a particle counter. Sizing and counting particles with an optical particle counter gives the manufacturer a true reading of what is being washed off, what is still left on the parts after the wash process and what will be acceptable enough to the process. This method is becoming the method of choice for aerospace and the automotive industry due to the speed, simplicity and the repeatability of a typical particle counter.

A particle counter system is comprised of 3 components; a sampler, a sensor and a counter or computer. A sampler uses a positive pressure to bring a sample of the liquid to the sensor at a constant flow rate. This sample of solution is normally taken from the bath or is collected in the same way as we collect fluid for test when we use the Millipore testing method, by spraying the part down with a solvent after it is washed.

This fluid is then fed into the particle counter through the sensor, which is connected, to the counter/computer. A hard copy of the exact size in microns of the particles and the exact number of these particles is then emitted from the system.

Now the manufacturer has some data to work with that is relevant to his build process. If this sample were taken from solvent spraying washed parts, as is done in the Millipore test procedure, then from the example above he can see:

A. There are no particles left on the part that are over 400 micron in size. If that is an acceptable threshold, then he can proceed with what he has in place in regards to cleaning equipment.
B. The biggest differential in size is between the 50-micron and 100 micron level. This is where the most difference can be made with the least amount of modification.
C. The particles at the 5-micron level are significant in number. If this is the level that must be reached, then the filtering system to achieve this will need to be able to accommodate frequent changeovers in an easy, operator friendly manner.

Of course, depending on what needs to be achieved, the data can be used to make many cost justification and production design decisions.

More importantly, however, the quality of each part will be consistent. The manufacturer and his customer will enter into a contracted agreement, which will state objectively what is considered clean. (i.e. part must be free of particles over 200 micron in size.) The parts will be tested on a periodic basis, both scheduled and unscheduled, and the objective evidence given by the particle counter, will determine whether the conditions of the contract are being met.