Ask the Experts

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What type of cleaner method is preferred for lead-free stencils?

What type of stencil cleaner is preferred: ultrasonic or high pressure jet? The application is in lead free cleaning of stencils after screen printing.

Ask the Experts Comments:

This is a good opportunity to let everyone know that the IPC has been working on a Handbook for Stencil and Misprinted Board Cleaning. The final draft was submitted in early June and hopefully the document (IPC-7526) will be released soon.

The decision process for selecting a system for cleaning lead-free is the same for lead/tin solder paste.

There are several factors to consider when selecting a stencil cleaner. Most experts will agree that the most important factor is the chemistry. The machine used to apply the chemistry is secondary. Washing greasy hands is a good analogy. Using a facial soap is usually not very effective, even with hard scrubbing and hot water. However, if a good hand cleaner is used, mild scrubbing is only required. The 'soap' = the chemistry and the 'scrubbing' = the machine.

Aside from cleaning efficiency, other factors to consider include:

Can the process potentially damage the stencil?
Is the process also used for cleaning misprinted PCBs?
What is the environmental impact?
User safety?
Versatility?

The best article I have seen written on the subject is "SMT Stencil Cleaning: A Decision That Could Impact Production" by Richard S. Clouthier. Mr. Clouthier, of Xerox when the article was published, reviews several different chemistries and cleaning technologies. We keep a copy of this and other pertinent articles on our web site: www.smartsonic.com - click on the 'Recommended Reading' link.

Can the process potentially damage the stencil?

Stencils are heat-sensitive. The epoxy glue that bonds the screen to the frame and metal-etched foil is cured at approximately 60 degrees C (140 F). If a stencil is washed in hot water or dried with hot air, the bond will weaken and eventually fail.

In addition, stainless steel has a very poor memory. Once it expands, it does not like to contract back to the exact same position. Therefore, fine-pitch apertures can become distorted and miss registered if the stencil is consistently exposed to heat.

The Clouthier article illustrates how delicate land mass areas, between fine-pitch apertures, can bend from the impact of high-pressure air or high pressure water jets, so air knives and high pressure water jets should be avoided.

Is the process also used for cleaning misprinted PCBs?
The Clouthier article uses the term "Solder Ball Nightmare" when attempting to clean misprinted PCBs with spray jet technology. The sprays will broadcast the solder balls throughout the process chamber and contaminate the populated side 'A' of a reflowed board.

Ultrasonic technology will not broadcast the solder balls. The solder balls fall away from the board by gravity. So, if the board is oriented properly (populated side up), the solder balls will not contaminate to populated side.

Studies by GEC Maroni and the EMPF Laboratory are summarized in an article by William Kenyon, "Why Not Ultrasonic Cleaning?" (http://www.smartsonic.com/article.html) Mr. Kenyon stresses the importance of High Ultrasonic Frequency and Low Power Density when cleaning PCBs. Using the analogy of scrubbing with a brush, the Ultrasonic Frequency = the type of brush and the Power Density = the amount of pressure used on the brush. Common ultrasonic frequencies range from 20 kHz up to 68 kHz. Most all ultrasonic stencil cleaners use 40 kHz, which has been shown to be safe and effective for cleaning PCBs and stencils. The frequency is normally modulated +/- a few kHz to eliminate 'hot spots' in the cleaning bath (referred to as 'sweep' or 'variable' frequency).

Low ultrasonic frequency (20 kHz) = a wire scrub brush
High ultrasonic frequency (68 kHz) = a soft tooth brush
Low power density = holding the brush lightly with one hand
High power density = holding the brush strongly with two hands

The Power Densities of stencil cleaners can vary tremendously. Mr. Kenyon's article indicates approximately 10 watts / liter (amount of ultrasonic energy directed into the bath / amount of wash solution in the bath) as being safe. Many ultrasonic stencil cleaners use power densities of 15 w/l or greater. This is more than 50% higher than the recommended safety limits. The higher power densities are normally dictated by the chemistry used. Less effective chemistries require more scrubbing energy and therefore higher power densities.

What is the Environmental Impact?
Biodegradable and VOCs (Volatile Organic Compounds) are the two key variables. Many of the popular aqueous chemistries are biodegradable. However, many still have a high VOC content. The latest VOC standard set forth by the South Coast Air Quality Management District's Clean Air Solvent (CAS) Program is less than 25 grams per liter. Chemistries containing VOCs greater than 25 grams per liter are disallowed by California's Rule 1171. Other states and countries have or will

soon have similar restrictions.

User Safety?
Flammable solvents such as alcohol have been the cause of several fires and explosions when used in a stencil cleaner. Static charges, the mechanical spark of a spray nozzle hitting a metal stencil and nearby electrical equipment have been the sources of ignition.

Noxious odors of some cleaning solutions can cause illness and employee discomfort.

Versatility?
Can the process clean a broad spectrum of solder pastes or just the current flux type in use? If a new flux is introduced, will the process support the change? Newly introduced chemistries will not have the necessary track record. If a company has needed to introduce new formulations over the years to keep up with current flux technologies, the newest and greatest formulation from that company should be suspect. If the chemistry needs to change, the waste management and possibly the machine will also need to change starting the selection process for new equipment all over again.

If cleaning lead and lead-free solder pastes, are two separate machines required? Traces of lead will be present in the form of fugitive solder balls or lead ions in any stencil cleaner used for cleaning lead solder paste, so the potential of lead contamination onto a lead-free stencil is always present. Solder paste is broadcast throughout and adheres to the side walls and plumbing of the chamber of a spray technology stencil cleaner and ions often flow through micron filters. Lead ions will also be found in the wash solution of an ultrasonic machine. The key element to determine if two separate machines are required is the rinsing ability of the chemistry. Surfactants (detergents) tend to rinse easily and thoroughly. Saponifiers and solvent-based chemistries usually require longer rinse cycles.

In summary, first select a broad spectrum, non-flammable and low VOC chemistry that rinses easily. If using a spray jet technology and are also cleaning misprinted PCBs, be aware of potential solder ball contamination and use low spray pressure for cleaning delicate stencils. If using ultrasonic technology, orient misprinted PCBs properly to prevent solder ball contamination of reflowed components and use the highest ultrasonic frequency and lowest power density to effectively clean. Make sure that the chemistry manufacturer and the machine manufacturer guarantee the complete process else, if it fails to perform properly, support will be difficult.

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Mr. Schreiber developed the original ultrasonic stencil cleaning process in 1989. Obtained the only EPA Verification for specific parameters of Environmental Safety, User Safety and Cleaning Efficiency for a stencil cleaning process. Introduced 440-R SMT Detergent in 1990 for cleaning all types of solder paste, flux residues and SMD adhesives.

Fist, the answer is the same regardless of the specific paste type, (leaded or non-leaded).

High pressure sprays should never be applied to a stencil. Stencils are relatively delicate and should not be exposed to either high pressures or high temperatures. The application of ultrasonic energy (sound waves) is considered by experts to provide thorough cleaning while avoiding any damage potential.

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A great question with a simple answer. In my experience, ultrasonics do a much better job of cleaning the stencils than high-pressure jets. Ultrasonics impart far more energy into the contamination through the solvent than any high-pressure spray could generate. Some tests have found collapsing cavitation can generate up to 10,000 times the force of gravity, which will certainly knock any solder paste off a stencil. No pump system can produce that kind of energy.

Now, there is always the question of damaging the stencil with ultrasonics. The people who most often ask this question are the guys selling the high-pressure spray systems (**sigh**). It's old news. In the old days, most ultrasonic-equipped vapor degreasers operated at a single-frequency, usually in the 40 KHz range for solvents. It was found that certain components, such as the tiny metal traces holding a BGA pattern into the stencil, could suffer damage to their leads from the harmonic vibrations of the ultrasonic frequencies.

(Remember the collapse of the Tacoma Narrow's bridge, "Galloping Gertie"? It is the same effect only with wind instead of ultrasonics providing the energy.... See this link.

However, in today's world almost all ultrasonic systems using frequency "sweeping" to enhance the cleaning process. Thus, the transducer will start at 25 khz and race up to, say, 90 khz, and then drop back down in random patterns. Since there is no repetitive frequency used, harmonics do not accumulate in the solvent. So the risk is completely eliminated.

Most companies using modern, digitially controlled, sweeping ultrasonics find they can do so without damage to their boards or stencils. Of course, get some expert assistance when specifying a cleaning machine, because too much power can break anything apart, with or without the harmonic build-ups.

More importantly, do not use flammable solvents with ultrasonics. The risk of a sonic transducer going bad, while tiny, is still a risk. In such an event, the transducer would fire a bolt of electricity right into the sonic bath. If the bath were say, alcohol, it would be like hitting the IPA with a bold of lightning, and a pretty spectacular fire would result. So get an ultrasonic tank and use a nonflammable solvent, like Micro Care's BGA Stencil Cleaner, to do the cleaning.

The attached article, by a fellow named Kenyon, pretty well explains the process.
http://www.smartsonic.com/article.html

Best regards,

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Micro Care

Mr. Jones is an electronics cleaning and stencil printing specialist. Averaging over one hundred days a year on the road, Mike visits SMT production sites and circuit board repair facilities in every corner of the globe, helping engineers and technicians work through the complex trade-offs today's demanding electronics require.