Defluxing Process Roadmap

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So, You Need to Clean? A Defluxing Process Roadmap

We have witnessed the perfect storm to compel OEMs and contract assemblers to reinstate flux residue removal from circuit assemblies. I have written at length about the forces that combined to mandate a defluxing process. These modern trends include adoption of lead-free alloys, board and component miniaturization, increased reliability expectations, increased reliance on quality standards, and the increase in product liability. Be it by requirement (military/IPC cleanliness specifications) or by necessity, defluxing is once again part of the mainstream assembly processes.

You must implement a cleaning/defluxing strategy. Unlike in times past, there are a number of factors one must consider when choosing a defluxing process, hence the need for a practical roadmap. Our roadmap consists of several key factors. This article focuses on type of flux, type of assembly, product flow, volume, staff competency, facility restrictions, environmental restrictions, and budget.

For the purpose of relevancy, I disregard manual cleaning, as it represents a small segment of the total defluxing processes and is more common in touch-up and repair.

Type of Flux

Ironically, the most common flux cleaned today is no-clean. Rather than switching flux types, most assemblers have chosen to maintain their flux/paste selections and add a defluxing process. One must choose a defluxing process compatible with no-clean flux. No-clean flux will not be removed with water alone; a chemical additive is required. Aqueous-based (water and chemicals) processes remove all flux types, including water-soluble (OA) fluxes.

Why, if the flux is water-soluble, should a chemical be added to the wash solution? In any post-reflow cleaning process, while the primary goal is to remove flux residues, there are many other process-oriented residues on the assembly. Residues from board fabrication, component fabrication, and assembly all contribute contamination. These "stowaway" contaminants are often insoluble in water and consist of polar and non-polar contaminants, requiring a chemical additive. If you use a lead-free alloy, the reflow temperatures are normally 30°C hotter than lead-based alloys. This frequently leads to flux polymerization during reflow, preventing the flux from encapsulating the metal salts. A chemical additive is required to break down the polymerized flux and remove the surrounding contamination.

Cleaning equipment should be compatible with chemical use. Equipment capable of reusing the chemical containing wash solution will lower the overall cost of operation and reduce or eliminate chemical down drains, making the entire process more environmentally friendly.

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Type of Assembly

This is an easy selection. Are you cleaning through-hole or surface mount assemblies? For through hole, less pump power is required as the clearance between the bottom of the component and the board surface is relatively large. On SMT assemblies, the component's standoff height may be significantly lower, as little as 2 or 3 mils. SMT requires more mechanical energy to produce fine wash solution particles and direct them under (and out from under) a component.

While some glassware washers have been modified for defluxing, exercise caution. High-power pumps may not be required because the wash solution's chemical additives lower the surface tension, allowing wash solution to penetrate under fine-pitch components. However, that thin 25-dyne wash solution must be flushed out with thick 72-dyne rinse water. The only thing worse than leaving flux on an assembly is leaving behind wash solution. Good mechanical pump and nozzle designs are required for a successful defluxing process. Some equipment manufacturers also equip their machines with cleanliness testing capabilities that test for the presence of ionic residues during rinse.

Product Flow

There are two types of automated defluxing systems: batch format and conveyorized. Batch or conveyorized does not necessarily mean batch or in-line. Batch and conveyorized defluxing systems are capable of operating in a batch process. In fact, more than 80% of all conveyorized defluxing systems in North America operate in a batch format.

If an in-line defluxing process is desired, one must consider where to place the equipment. Many manufacturers install the in-line defluxer on the exit of the reflow oven. Others place it after selective soldering; others after rework. The fact is, no matter where you place the in-line defluxer, someone will carry assemblies to it "out of sequence," turning it into a batch process. It is more common in today's workplace to use a defluxing system in a batch process, regardless of the machine's intended configuration.

We have witnessed the perfect storm of events that have combined to compel OEMs and contract assemblers to reinstate a long-abandoned practice of removing flux residues from circuit assemblies.

I have written at length about the forces that have combined to mandate a defluxing process. These modern trends include the adoption of lead-free alloys, board and component miniaturization, increased reliability expectations, increased reliance on quality standards, and even the increased level of product liability. Be it by requirement (military/IPC cleanliness specifications) or by necessity, defluxing is once again part of the mainstream assembly processes.

Volume

In years past, volume determined with technology one would purchase, batch or inline. Batch machines were designed for low-volume, high mix while inline defluxing systems were designed for high volumes. Today, this has changed. Batch format defluxing system, while still suitable for low volume, high mix applications have been engineered to produce throughput rates as great or greater than inline systems. This technological advance has pushed out the volume threshold used to justify one technology over the other. There are three choice configurations to choose from; batch, high-yield batch, and conveyorized (inline) defluxing systems. As energy consumption, water consumption, chemical consumption, and environmental noise are added to the usual list of technical considerations, and because most defluxing process are utilized in a batch format, more companies are choosing batch-format defluxing equipment.

As a general rule, a conveyorized defluxing system's throughput capabilities are based on conveyor speed and board length. On most batch-format defluxing systems, throughput rates are based on programmed cleanliness settings and board size.

Staff Competency

This is an oft-overlooked criteria. Modern defluxing equipment, like other assembly equipment, has become highly automated. Some equipment allow operators to only choose from a library of recipes (designed by manufacturing or process engineer), reducing the chance of operator error. Modern defluxing systems are equipped with password protection, preventing an operator from modifying critical settings such as final cleanliness and desired chemical percentages. SPC functions record every cycle, including set and actual cleanliness, a valuable asset in today's TQM/ISO/Six Sigma world.

Different brands and configurations offer varying degrees of process control and user control. Regardless of the level of control and automation, one must ask, Who controls the process?

Facility Restrictions

Every automated defluxing system requires the following items: electrical power, water (DI), drain or recycling equipment, and exhaust. The amount of these resources vary widely based in the defluxing system's configuration (batch or conveyorized).

Electrical Power

Electrical utility requirements vary from 15 KW (high-performance batch) to 170 KW (high-performance conveyorized).

Water Requirement

Water requirements vary from 30 gallons per hour (high-performance batch) to 300 gallons per hour (high performance in-line).

Drain or Recycle Equipment

Keep in mind, all water that goes in must go out. This means that the water input requirement must be matched with a like drain requirement or an equivalent recycle (closed-loop) capacity. Zero-discharge evaporators are a popular choice on batch configurations due to their low discharge rates.

Environmental Restrictions

Environmental liability is a modern concern. Many municipalities monitor the volume of industrial effluent being directed to drains. Every gallon sent to drain counts, even if it is relatively "clean."

In years past, many defluxing systems, particularly conveyorized models, operated on just water, no chemicals. Water-only defluxing systems were easily and efficiently closed-looped with traditional carbon and ion-exchange resin technology. Today, with chemical additives representing the conventional wisdom, close-looping the process is costly due to the fact that the defluxing chemicals must be completely segregated from the carbon and resin media, lest it destroy the expensive resins. This normally means that a separate isolation section must be added to conveyorized cleaners to provide better separation between the wash chemical and the rinse sections. This results in a longer machine and frequently a non-closed-loop section.

If a zero-discharge configuration is desired, a batch configuration is preferred as there is normally internal segregation of the wash and rinse sections which prevent excess cross contamination without the need for isolation drains. Because the total effluent volume is low, waste water evaporators can be connected in lieu of a drain.

Budget

As equipment prices vary from the tens of thousands to the hundreds of thousands, the important calculation is the cost per clean board. If specified correctly, any defluxing process (batch or conveyorized) should yield a per board cost of mere pennies. Needless to say, the cost of contamination always exceeds the cost of cleaning.

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