PCB Cleaning Process Improved Through Collaboration

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Collaboration between a CEM and a cleaning equipment supplier resulted in increased productivity for the CEM and an improved cleaning machine for the supplier.

In the competitive electronics assembly industry, contract electronics manufacturers (CEMs) must provide high quality, contaminant-free products. To improve its PCB cleaning process, one CEM partnered with a supplier of aqueous cleaning equipment to develop an inline aqueous cleaner with vastly improved efficiency and repeatability.

The Cleaning Process

The use of flux on PCBs in the wave soldering process usually requires the boards to be cleaned. Even with the advent of no-clean fluxes, many CEMs have found it necessary to clean all boards to meet the requirements of their customers.

The following cleaning process has worked well for many CEMs. The cleaning process consists of prewash, wash, rinse and drying stages. The prewash stage rinses off the gross contaminants from the board before the wash stage. The wash stage, which can use a saponifier, consists of eight spray bars and 64 nozzles to remove all remaining contaminants. An anti-dragout section is in between the wash and the rinse stages. The use of an air knife in this section helps prevent any liquid dragout from the wash to the rinse tank. Some cleaners also have a wet isolation that provides further rinsing of the wash water from the PCB, plus extra air knives to remove even more of the solution.

The rinse stage consists of 10 spray bars with 80 nozzles that flush and remove the remaining wash water from under components. The final rinse section has two spray bars with 12 nozzles, providing the purest rinse of the process. Most often, this rinse is accomplished with the use of deionized water. The drying stage includes three air knife blowers designed to remove all liquid from the PCBs.

Controlling the Spray Angle

Two challenges in cleaning complex circuit boards are the spray angle and volume repeatability. These two factors ensure that PCB cleanliness stays within specifications. However, with prior design techniques, spray bars could not be precisely returned to their original nozzle angle, after being removed for scheduled preventive maintenance.

Specifically, the prior design of the spray bars required each individual nozzle (in some cases, over 100 nozzles) to be removed for preventive maintenance or when changing the pressure/flow requirements for cleaning different PCBs. The spray bars were attached to the plumbing wall of the cleaner using a standard pipe threading system. However, each time the bars were replaced and tightened, these threads would erode slightly. Over time, precise repetition of the desired angle of the spray bars became increasingly difficult.

To overcome this problem, new spray bars were designed with a quick connect-disconnect locking feature that automatically repeats the exact position and angle of the bar, and hence the realigned angle and pressure of the spray. With a quarter-turn of the bar and a pull, the entire bar and nozzle assembly can be easily removed from the cleaner (Figure 1). The operator can then conveniently access and inspect all of the nozzles at any time. When maintenance is required, the entire bar is removed to a nearby workbench. Afterwards, the operator simply returns the spray bar to its original alignment in the cleaner and turns the locking pin to the desired position.

The new quick-connect/disconnect feature has completely solved the prior difficulties of

FIGURE 1: Removable spray bar and nozzle assembly.

maintaining a consistent cleaning process, while also reducing maintenance and production-related shutdowns. By having duplicate spray bars on hand, the CEM always has clean nozzles ready to plug into the cleaner, when the spray bar needs to be removed for scheduled maintenance. A process that previously required hours of downtime now takes only minutes.

Spray bars are available with a wide array of different nozzles, allowing the CEM to customize the cleaning process for specific production runs. For example, if the CEM is running PCBs through the cleaning equipment at high pressure/low flow and the next production run has more delicate boards requiring low pressure/high flow, the spray bars can be quickly changed. By keeping reserve spray bars on hand for the specific cleaning processes of the various production runs, the CEM can substantially reduce downtime between each run.

Removing Excess Liquid

The most challenging part of cleaning a PCB is drying the board, especially complex boards with side connectors and shielded components. This CEM was faced with precisely this difficulty. Originally, the CEM's cleaner was equipped with state-of-the-art top and bottom convection heated air knife blowers. These convection air knives provided heated air at temperatures up to 200°F. The need for an infrared panel, which evaporated water and therefore left behind contaminants, was eliminated by the convection heat system. This system was already an improvement over other heating systems that required heat exchangers and recirculated air through the blowers and filters.

FIGURE 2: Multiple air fins along each side of the PCB conveyor.

However, these features did not address the side components and did not efficiently remove liquid from inside the edge connectors. Removing this excess liquid required additional time and effort. In addition, some production failures were experienced during subsequent testing processes due to moisture-related issues.

To improve the drying process, a new component called an edge air knife with air fins was developed by the CEM and the equipment supplier (Figure 2). The edge air knife is actually comprised of multiple air fins, which are shrouded vents positioned at a 30° angle (the

desired angle for this process) opposite to the motion of the PCB conveyor. Each air fin discharges high velocity air along each side of the conveyor. The edge air knives were added to both sides of the conveyor, at the beginning of the drying stage, to maximize their effectiveness. This innovation successfully removed all excess liquid from side connectors and shielded components.

Going Beltless

In many assembly applications, a topside mesh conveyor belt is used on a cleaner to stabilize the position of lighter weight PCBs through the cleaning process. However, the CEM had a specific application that would not allow the use of a topside belt. The CEM needed to run PCBs with components that would not accommodate the topside belt, but still needed some extra help to stabilize their position.

The solution was the addition of independent pressure controls on the upper and lower air knives. Using a butterfly valve system, pressure from the top and bottom air knives keeps the PCBs securely in place through the drying stages. To ensure repeatability, two independent pressure gauges were installed for each upper and lower air knife. Slide out, self-tensioning Paxton blowers were used to provide easy maintenance.

Conclusion

Consistent, continuous improvement in process and equipment requires collaboration and a close working partnership between a CEM and its cleaning equipment supplier. However, the benefits of such a collaboration can be substantial. In this case, the result was increased process effectiveness and reduced total cost for the entire clean/dry operation.

For the CEM, the partnership resulted in an improved cleaning process and increased productivity. For the cleaning equipment supplier, collaboration resulted in important new options to its line of cleaning equipment plus an improved relationship with the CEM. Some guidelines for collaborating with suppliers include:

- Communicate: have an ongoing dialog with everyone involved in the process
- Check egos at the door: the design and process can always be improved
- Choose wisely: work with a company that has an excellent reputation for quality, service and integrity
- Corporate value: working on a project that benefits both CEM and supplier will help ensure that it is completed in a timely manner.

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