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Clean Matters

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In almost every context, clean is good and not clean is bad. In almost every industry, internal components are cleaned before installation. At times, the electronics assembly industry is an exception to the rule.

As I have mentioned in more than one past article, I have been involved in electronics assembly cleaning — more specifically defluxing — for more than 20 years. Perhaps that is why I look at the world in terms clean or not clean.

In almost every context, clean is good and not clean is bad. When an Olympic athlete's drug test comes back clean, that's good. One is relieved to receive a clean bill of health. A clean sweep by your favorite sports team is cause for celebration and who doesn't want to clean up in Las Vegas?

The most common dictionary definitions of clean include free from dirt, extraneous matter, irregularity, defects, etc. In almost every industry, internal components are cleaned before installation. When substances are left on a part — grease on a gear for example — the substance specifically adds value to the component. At times, the electronics assembly industry is an exception to this rule. In many segments of our industry, cleaning and maintaining a clean environment are considered vital to the successful production of a product. Anyone who has to don cleanroom garments knows the costs of contamination. There is a segment of our industry that seems to ignore the value of a clean product.

When electronic components are soldered to a PCB, flux is applied to prevent oxidation of the heated molten solder, improving a solder joint's integrity. Flux has a distinct and specific purpose. Once that purpose has been achieved, the remaining flux residue serves no other purpose. In fact, the remaining residue is a contaminant, still conductive and corrosive.

Virtually without exception, all manufacturers of electronics assemblies used in high-reliability applications remove flux after reflow. The military requires defluxing to specific cleanliness levels, and many other industries also require defluxing. Manufacturers of medical devices remove flux residues from their assemblies to improve product reliability. Commercial aircraft manufacturers clean all flight boards to eliminate residue-caused defects. Space, broadcasting, emergency response, and hundreds of other high-reliability industries all implement flux residue removal procedures within their assembly processes.

The turn of the 21st century introduced an interesting phenomenon into our industry. Defluxing, formally a practice of high-reliability manufacturers, began to trickle down to manufacturers of less-critical devices. For example, manufacturers of audio amplifiers determined that removing flux from circuit assemblies resulted in truer sounds, with less distortion. One major manufacturer informed me that their version of cleanliness testing was plugging in a guitar and listening to the amplified sound. They can hear the presence of flux residue on the board.

Unfortunately, flux residue does not often expose itself audibly. In most applications, remaining flux residues attack the assembly over time. The time required to generate a failure can be accelerated when heat and humidity are factors because both accelerate corrosion and dendritic growth.

As electronic components shrink (01005s), so does the electronics assembly. High-density, low-standoff technology combined with ever increasing demands for increased reliability, even in consumer products, has forced assemblers to reconsider the perceived benefits of leaving flux residue on an assembly. Even low residue (so called no-clean) solder pastes leave behind residues that provide no benefit but rather add a bullet in the chamber in a Russian roulette version of quality control.

Search through popular technical forums and you'll see the common demand for cleaning prevails. IPC's Tech-Net yields 5,590 search results for "cleaning," while SMT-Net's Electronics Forum archive produces 4,242. Clearly, someone's asking a lot of questions about cleaning. Foresite, a Kokomo, Ind.-based consulting service and analytical test laboratory, profits by "specializing in residue characterization and its impact on performance and reliability of electronic applications." While it is no doubt an oversimplification, perhaps even a fallacy, to suggest that all contamination is caused by flux, or that all reliability issues are caused by flux, it is safe to say that the majority of in-field mortality issues regarding circuit assemblies are caused by flux-related residues. To phrase it in a former 1992 U.S. presidential candidate's vernacular, "It's the flux, stupid."

Conclusion

Removing flux from post-reflowed circuit assemblies remains a rapidly adoptive process. Recent advances in defluxing processes — equipment and chemical — have lowered the cost of defluxing to literally pennies per board. Advances in equipment efficiencies and chemical "environmentalness" make defluxing an environmentally responsible process. Reduction in equipment size, and cost, has allowed assemblers to implement this value-added process with little impact on space and budgets.

Finally, because modern defluxing systems commonly are outfitted with on-board cleanliness testers, the question, "how clean is clean?" can be answered. SMT

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