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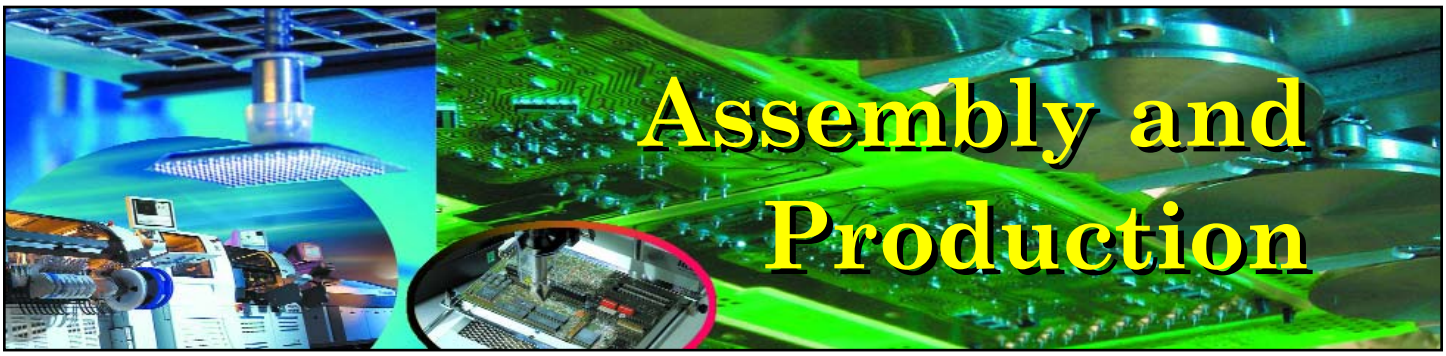

A Winning Scenario for Cleaned Circuit Assemblies

By Mike Konrad, Aqueous Technologies Corporation

Much can be learned from 28 years involvement in the electronics assembly cleaning industry. This almost three-decade period can be separated into three distinct periods.

Prior to 1989, virtually all assemblies were cleaned after soldering. During the period from 1989 through 2005, electronics assembly cleaning was the almost exclusive realm of military, aerospace, and medical (high-reliability) electronic assemblers. In the current period, from about 2005 to the present, according to industry polls, about two-thirds of all electronic assemblers are cleaning their assemblies and 52 percent of all no-clean solder paste applications result in cleaning.

Cleanliness has historical significance. Anthropologists believe that the great plagues of the Middle Ages can be attributed, in part, to the decline in cleanliness standards including personal hygiene in that era. Throughout human history, lack of cleanliness often results in undesirable outcomes. Cleanliness is highly valued in modern society. In major cities, such as Los Angeles, CA, for example, restaurants are given letter grades, such as A, B, and C, to denote quality. Most diners in that town would think twice before choosing a "B" or "C" rated restaurant. In the same city, most car owners wash their vehicles at least as often as they wash their hands. Similarly, pet owners religiously schedule their animals for appointments with groomers and demand the same cleanliness from their daily lives. But ironically, there is one area in which much less attention is paid to cleanliness, in an area that affects almost every aspect of their daily lives. It is an area that can impact how people communicate, how they travel, how they protect themselves, how they work, play, eat, even how they access medical care. The area is electronics. Electronics is an important part of many different aspects of daily life, but too often too little attention is paid to the cleanliness of the electronic assemblies that become part of many daily lives.

Trident XLD zero-discharge automatic defluxing and cleanliness testing system.

Banning Solvents

Some of that lack of attention can be traced back in history to 1989 and when popular electronic cleaning solvents were banned due to environmental concerns. Rather than switching to environmentally responsible alternative solvents, many electronic circuit assemblers chose a "no-clean" approach. Low-residue flux formulations were being introduced at that time, which left only small amounts of flux residue on circuit assemblies — amounts considered acceptable.

The industry weighed the cost of switching to newer alternative solvents and compatible cleaning equipment versus accepting small amounts of residue on the circuit assemblies, and cost savings won. Circuit assembly cleaning was largely abandoned for commercial applications, although military, medical, aerospace, and other high-reliability electronic assemblers maintained cleaning programs. Many of these high-reliability electronic assemblers switched to alternative

cleaning technologies, most often aqueous-based cleaning methods.

For many years, this "parallel universe" went on side by side, with high-reliability electronic assemblers completing 100 percent cleaning while commercial electronic assemblers for the most part performed no cleaning of their electronic circuits. But over time, commercial assemblers have adopted some form of cleaning process — as noted earlier, two-thirds of all electronic assemblers claim that they clean between 25 and 100 percent of their assemblies. Of the multitude of commercial electronic assemblers using no-clean solder pastes, 52 percent of them are cleaning after solder reflow. After so long, why would so many electronic assemblers be interested in adopting or re-adopting a cleaning process?

Ironically, the same factor that drove the electronics industry away from cleaning 24 years ago — economics — is driving the industry back to cleaning today.

Trident XLD cleaning system.

Ironically, the same factor that drove the electronics industry away from cleaning 24 years ago — economics — is driving the industry back to cleaning. When assemblers stopped removing flux from their electronic assemblies with the adoption of low-residue fluxes, all cleaning stopped. Contamination from bare board fabrication, component fabrication, and assembly processes were allowed to remain on electronic assemblies along with flux residues. But today's miniature, lead-free electronic assemblies cannot tolerate as much contamination as electronic assemblies of 24 years ago. Such factors as smaller circuits, higher circuit and component densities, lower component standoff heights, faster circuit speeds, and higher reflow temperatures can combine for electrical migration and electrical leakage failures on assemblies throughout the world. In-field failures of electronic assemblies can be costly, and a measurable percentage of the electronics industry has determined that it is more cost effective to remove contamination than to suffer the costs of contamination-related failures.

Cleaning Costs Can Be Low

In adopting a cleaning process, many electronic circuit assemblers have learned to evaluate the impact of the added process in terms of the cost of cleaning or cost to clean per assembly, and even the cost of the cleaning process to the environment. At the same time, many electronic assemblers have discovered that the cost of cleaning is surprisingly low. They have found many cleaning methods, machines, and processes from which to choose.

The correct specific method is determined by several variables including desired throughput, types of contamination being removed, and environmental restrictions in a work area. No single solution is ideal for all electronic assemblers, but a handful of cleaning solutions can fill the needs of almost all electronic assemblers.

A cleaning process may take some time to match the needs of a particular electronic assembly or group of assemblies but, once the cleaning process has been optimized, with the correct machine to match the required throughput, equipment readiness, cleanliness requirement, and discharge configuration, cleaning costs will usually be minimized. The total cleaning costs per assembly for a "properly optimized" cleaning process can be expected to be less than $0.06 USD per assembly for low-discharge (environmentally beneficial) cleaning applications to $0.16 USD per assembly for zero-discharge (environmentally responsible) cleaning applications.

Many assemblers have resisted cleaning processes for strictly environmental reasons. Many have been concerned that by solving one issue — such as assembly failures — they would exchange that issue for another issue — such as environmental regulatory concerns). But recent advances in cleaning technology have allowed electronic assemblers to clean assemblies, no matter the flux type, while operating in a completely zero-discharge configuration. By operating a cleaning process in which the cleaning chemical is reused, for minimal operating costs, without a connection to a drain so that environmental regulations are bypassed, it is possible to manage an optimized cleaning process that eliminates contamination-caused assembly failures at an acceptable cost per cleaned assembly. This is truly a winning scenario for cleaning electronic assemblies.

EcoCycler rinse water recycler.

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