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The Environmental Cost of Green

By Michael Konrad, Aqueous Technologies Corporation

Being involved in the electronics assembly industry for more than 23 years, specifically in the field of defluxing and cleanliness testing, I have seen my share of environmental regulations. Long before the debate over lead-free alloys, there was the Montreal Protocol.

Back in the late 1980s and early 1990s, the elimination of CFC-based defluxing solvents dominated the covers of industry trade magazines. Emissions from Freon and Trichlorethene-based defluxing solvents threatened the Earth's ozone layer and would soon become banned from use.

The electronic assembly industry responded with two alternative strategies; no-clean fluxes/pastes and aqueous-based defluxing. No-clean fluxes and solder pastes proliferated in the market and many solvent-based defluxing systems were replaced by no-clean processes. History has taught us that no-clean technology is not compatible with all applications. High-reliability (medical, military, space, flight, etc) manufacturers have historically embraced a cleaning/defluxing process to improve product reliability and decrease potential liability. Additionally, when electronic assemblies are operated in harsh environments — heat, cold, humidity — a defluxing process normally is required.

While much of the assembly industry adopted no-clean processes, industries not suited for no-clean embraced aqueous defluxing techniques, considered environmentally superior to solvent-based technologies. In the late 1980s and throughout the turn of the millennium, any defluxing process that did not send emissions into the atmosphere was viewed as "green." Science proved the negative effects of CFC emissions and aqueous-based defluxing methods were CFC free.

For the high-reliability industry, where defluxing is required, there are basically two choices, low volume and high volume. This translates to batch processing or in-line (conveyor) processing. Early batch processing defluxing equipment, although environmentally superior to CFC-based defluxing systems, lacked the throughput required for much of the high-reliability manufacturing sector. As a result, aqueous-based in-line defluxing systems gained popularity.

Today, CFC emissions as they relate to defluxing are a distant memory, but governments and local municipalities have focused their attention on another byproduct of defluxing: effluent discharge. High-profile Environmental Protection Agency (EPA) enforcement operations have caused manufacturers to become more concerned about what is going down their drains. Ever-increasing punitive penalties associated with improper discharge have caught the attention of health and safety officers and corporate management. Modern assemblers seek defluxing alternatives that reduce or even eliminate effluent discharge.

In addition to reducing discharge-related liability, there are other factors that have impacted manufacturers and users of aqueous-based defluxing equipment. Consumers are becoming more aware of the environmental impact of various assembly processes, in particular, defluxing. Aqueous-based defluxing systems use water as the primary medium. The water, when spent, must either be recycled or disposed of. Energy costs, environmental noise, and chemical usage are among the other environmental considerations when choosing a defluxing process.

The electronic assembly industry frequently uses an in-line process for assembly. The defluxing process was no exception. In one of our industries' strange ironies, in-line defluxing systems were rarely in line with other equipment. This was due in part to logical requirements of DI water, and drain lines as well as vapor exhaust and ambient noise issues. Most assemblers placed the in-line cleaner in an area more suitable for a defluxing environment rather than in the assembly line.

While in-line defluxing technologies were environmentally attractive compared to CFC-based solvent cleaning systems, the standards by which we define "green" have changed. Today, water is a precious commodity in many parts of the world, particularly in my part of the U.S. (Southern California). Many in-line machines require as much as 19 liters of water per minute, a politically incorrect requirement in the western U.S. The rising cost of energy forces assemblers to consider electrical current requirements and the volume of discharge to drain determines if a user requires a special discharge permit (19 liters per minute in equals 19 liters per minute out).

Over the past two years, assemblers who require clean (flux-free) assemblies in medium to high quantities have begun to embrace new high-yield batch defluxing technology. Unlike traditional low-volume batch defluxing processes, high-yield batch processes are capable of high-volume defluxing. High-yield batch processes gained popularity in Europe where environmental regulations carry considerable weight in process and equipment selection. Users of high-yield batch defluxing processes are able to process equal quantities of electronic assemblies while consuming only a fraction of the water required by in-line processes. Less water in translates to less water out, thus reducing the volume of effluent discharge and associated liability. Because less water is required, zero-discharge configurations utilizing evaporative technology are implemented easily. Also, because most defluxing applications require a chemical additive as a percentage of wash water, less chemical input is required, reducing consumable expenses.

North America is beginning to embrace high-yield batch defluxing technology for a combination of reasons. Like Europeans, North Americans are increasingly cognizant of the environmental impact of modern manufacturing techniques. It doesn't end there. Americans are uniquely aware of the liability associated with environmental negligence. The U.S. is a litigious society and, as such, keenly aware of the repercussions associated with litigation. Any process that reduces product liability and environmental liability, while reducing a company's carbon footprint and reliance on natural resources, is valuable indeed.

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