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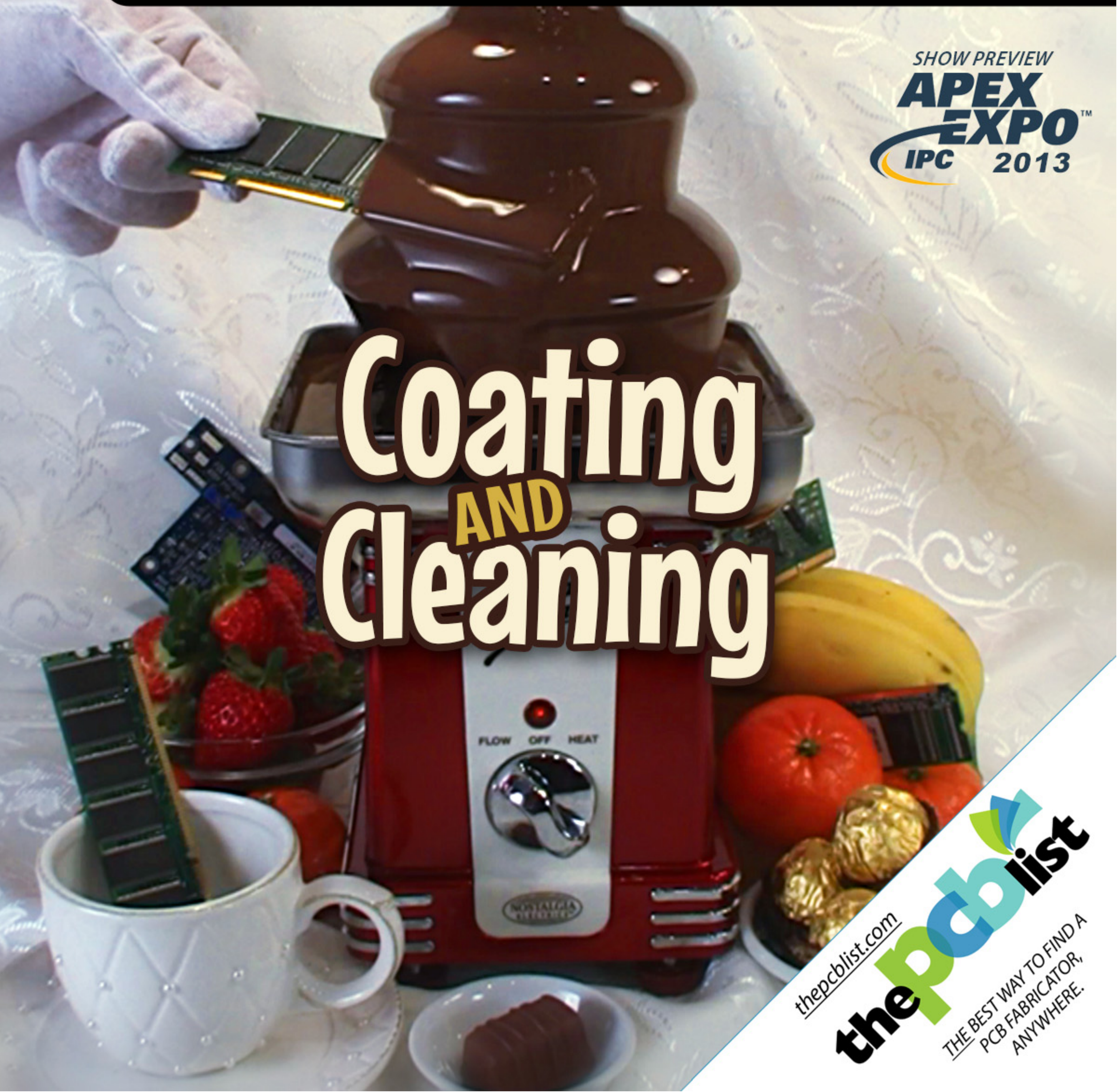
Comparative Cleaning Study to Showcase the Effective Removal of OA Flux Residues p.16

Plasma Polymerization: A Versatile & Attractive Process for Conformal Coating p.38

High Reliability and Low Variability Results with Benchtop PCB Cleaning p.46

IPC APEX EXPO 2013 Pre-Show Coverage p.72



# Environmentally-Responsible Defluxing

**by Michael Konrad**
AQUEOUS TECHNOLOGIES

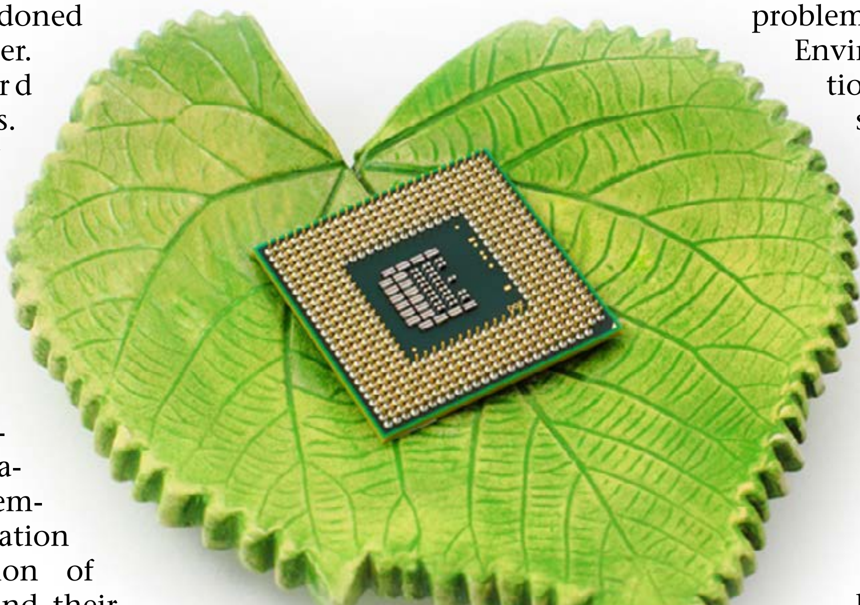
***SUMMARY: Cleaning is on the rise and today it is possible to improve assembly reliability via cleaning—all while maintaining an environmentally-friendly configuration. Michael Konrad explains how.***

No longer does one have to exchange one problem for another.

The New Year brings a sense of déjà vu. Flashback to the late 1980s. In that era, virtually all circuit assemblies were cleaned after soldering. Flux and other process-related contaminants were removed as a matter of standard process. Cleaning was not considered to be an option.

Concerns about the environment, specifically ozone depletion, lead to the elimination of the industry's most popular cleaning solvents. No-clean flux alternatives eventually replaced cleaning as a standard process, relegating cleaning mainly to high-reliability assemblers such as military and medical manufacturers. Most commercial assemblers, representing the majority of all electronic assembly, abandoned cleaning altogether.

Fast-forward to modern times. Today, cleaning has returned for many commercial assemblers. Many reasons exist for the return of cleaning as a mainstream process. Primary reasons include assembly miniaturization and the adoption of lead-free alloys and their associated higher reflow temperatures.



Unlike past defluxing processes, which utilized CFC-based solvents, most modern defluxing processes use aqueous-based chemical additives. By far, the majority of all defluxing processes are aqueous-based. Aqueous-based cleaning processes, while capable of removing all flux types (rosin, no-clean, water-soluble), are not associated with ozone depleting reactions. While aqueous-based cleaning chemicals contain VOCs, which are regulated in some urban regions, most are designed to operate well in VOC-controlled regions. In regions where VOCs are regulated, the majority of the regulations restrict VOC content to 50 grams per liter (in usable concentrations). In Southern California, the restriction is 25 grams per liter. Fortunately, effective defluxing chemicals are available for both non-restricted and VOC restricted regions.

Cleaning improves assembly reliability. Many assemblers have returned to cleaning to solve product reliability problems in the field. It does not make sense to swap one problem for another. For some assemblers, contamination-caused reliability problems were solved at the expense of environmental problems. Between the Environmental Protection Agency (EPA), state agencies, and municipal water districts, many regulatory authorities may be interested in your cleaning processes. With so many agencies claiming jurisdiction, and with potential environmental liability at an all-time high, the need for an environmentally-responsible cleaning process has never been greater.

In the past, environmental concerns were mitigated by reducing the volume of effluent being directed to the drain. Today, simply reducing the volume of effluent may not be enough. Two specific actions eliminate environmental liability:

1. Utilize VOC-compliant defluxing solutions.
2. Operate in a completely zero-discharge configuration.

**VOC Compliance**

As stated earlier, all regions of the United States allow the use of VOC-containing chemicals for use in defluxing applications. When regulated, most regions allow VOC levels up to 150 grams per liter. In specific urban areas, VOC content may be limited to 50 grams per liter. In specific regions known for air pollution, i.e., Southern California, VOC contents may be limited to 25 grams per liter. All major defluxing chemical providers offer effective VOC-compliant solutions. Consult with your defluxing chemical provider to ensure compatibility with both the contamination removal requirement and local air quality regulations.

**Effluent Elimination**

Over the years, the subject of effluent mitigation has changed from the minimization to the elimination of discharge. For the past two decades, the desire to "close-loop" the cleaning process was fueled by economic, not environmental interests. Close-looping part of a cleaning process could save money and therefore was embraced by many assemblers. The problem is assemblers were chasing the wrong "green." While it is true that closing-looping part of the cleaning process will reduce specific consumable expenses, it formally was only successful by directing the most contaminated effluent to the drain so that the cleaner effluent could be captured, filtered, and reused. In other words, sacrifice the dirty water so that the cleaner water can be reclaimed. This process does not make environmental sense.

Recent advances in defluxing machine technology have allowed all process solutions (wash and rinse solutions) to be reused. While both inline and most batch defluxing machines maintain the ability to capture, filter, and reuse the wash solution, the same has not been true for the rinse water. Inline defluxing systems often are equipped with rinse water recycling systems, allowing the used rinse water to be captured, filtered, re-deionized (via traditional carbon and ion-exchange resin media), and reused. For the rinse water within inline defluxing systems to be re-used as described, the machine must be equipped with a suitable chemical isolation section, allowing the dragged-out chemical-containing wash solution to be blown and/or rinsed off the assembly prior to entering the pre-rinse and final-rinse sections of the machine. The stripped-off wash solution along with the water used to remove it would be directed to the drain. This is required due to the fact that the volume of defluxing chemical dragged out from the wash section, if not stripped off of the assembly, would prematurely cause carbon and ion-exchange media failure, adding thousands of dollars annually to the operating cost. Because of this, it is unlikely that an inline defluxing system running with a defluxing chemical would be a candidate for a complete closed-loop (zero-discharge) configuration.

Historically, batch-format defluxing systems have not been able to operate with defluxing chemicals in a complete zero-discharge configuration. Like their inline format counterparts, wash solution drag-out from wash to rinse has prevented the reuse of 100% of the rinse water. Formally, the solution was to connect the rinse water drain to an evaporation system. The wash solution would be filtered and reused while the rinse water would be evaporated. While this configuration eliminated the need to connect the batch-format defluxing system to a drain line, there was a need to remove "sludge" (highly contaminated/concentrated solution) from the evaporator several times per year. Rather than connecting to a drain, the user had to remove sludge as hazardous waste. Alternatively, some batch-format defluxing systems allowed one to more of the rinse cycles to be directed to the drain, allowing the balance of the rinse water to be close-looped. This configuration still witnessed contaminated rinse water being sent to drain and only the cleaner water close-looped. This configuration, like the evaporative approach, did not eliminate a waste stream.

Recent advances in batch-format defluxing systems have allowed 100% of the rinse water to be captured, filtered, and re-deionized via traditional carbon and ion-exchange methods without fear of severally premature filter media failure. The ability to send all of the rinse water directly to the filter media is possible by substantially reducing the volume of chemical-containing wash solution dragged out into the rinse water.

Two sources exist for wash solution to mix with the rinse water:

1. Plumbing.
2. Wetted surface area.

**Plumbing**

Most batch defluxing machines utilize the same pump for several applications including wash, drain, and rinse functions. Virtually all defluxing machines utilize centrifugal pumps. Centrifugal pumps provide both high-volume and high-pressure fluid flow. Unfortunately, they also lack the ability to fully drain the fluid from inside their caverness interior. This results in a high volume of fluid retained in the pump at the end of a cycle. Normally, this results in wash solution mixing with the rinse water and then rinse water mixing with the wash solution. When wash solution is allowed to mix with the rinse water, added defluxing chemical is sent to the rinse water recycler, damaging the carbon and ion-exchange media.

In addition to the centrifugal pump issues, many plumbing designs require pump pressure to drain the lines. When the pump begins to cavitate at the near end of a drain cycle, the pump loses pressure and the ability to push fluids through a pipe. This allows fluids to stay in the plumbing lines, eventually mixing with the rinse water in subsequent cycles. One solution to this problem is to utilize segregated pumps. One pump may be used for generating spray pressure to wash and rinse the assemblies while another may be used for draining or fluid transfer. In a multiple pump configuration, the high-flow/pressure centrifugal spray pump may be mounted in a vertical format rather than in the traditional horizontal configuration. By mounting the spray pump in a horizontal and inverted (upside down) configuration, the fluid will immediately "fall" out of the suction section of the pump head when the pump turns off. This action eliminates the high volume of pump-caused drag-out associated with horizontally-mounted centrifugal pumps.

> ***"In addition to the centrifugal pump issues, many plumbing designs require pump pressure to drain the lines."***

The use of a self-priming positive displacement drain/transfer pump physically mounted at the lowest gravity point within the hydraulic system will allow all fluids that drain from the spray pump to be suctioned from the plumbing system and removed. These specific pump configurations substantially reduce the volume of plumbing-caused dragged-out effluent to a tolerable amount.

**Wetted Surface Area**

Wetted surface areas include the walls of the cleaning chamber and the surface area of the assemblies being cleaned. Even though assemblies are mounted and cleaned in a near vertical configuration (in batch-format defluxing systems), a tangible volume of fluid may remain on the wetted surfaces for a short time. Use of a programmable rest-time delay between the end of the wash cycle and the transfer of the wash solution is beneficial. By allowing assemblies to "rest," even for 30 seconds, will allow wash solution to be drained off of the assemblies and chamber walls, reducing the wetted-surface fluid drag-out volume by as much as 90%.

To review:

- It is no longer enough to reduce environmental liability; it is better to eliminate it.

- Determine the VOC restrictions (if any) in your region and select a defluxing chemical additive compatible with the target contamination and any VOC regulations.
- Select a defluxing machine with wash solution filtration and re-use capabilities.
- Utilize a rinse water recycling system (may be part of the defluxing machine or a separate appliance).
- Select a defluxing machine designed to direct all of the rinse water to a recycling system (no requirement for first-rinse bypass/segregation), and with specific drag-out reducing designs to maximize filter media life while operating in a complete zero discharge configuration.

It is possible today to increase assembly reliability through cleaning while maintaining an environmentally-responsible configuration. No longer does one have to exchange one problem for another. **SMT**

Mike Konrad has worked continuously within the electronics assembly equipment industry since 1985. In 1989, in response to the Montreal Protocol, he designed a new generation of aqueous-based defluxing equipment, allowing rosin-based fluxes to be removed in water-based cleaning equipment. In 1992, Konrad founded Aqueous Technologies Corporation, North America's largest manufacturer of fully automated defluxing and cleanliness testing equipment where he serves as president and CEO. Aqueous Technologies manufactures defluxing, stencil cleaning, cleanliness testing, and water recycling equipment designed specifically for the electronics industry.

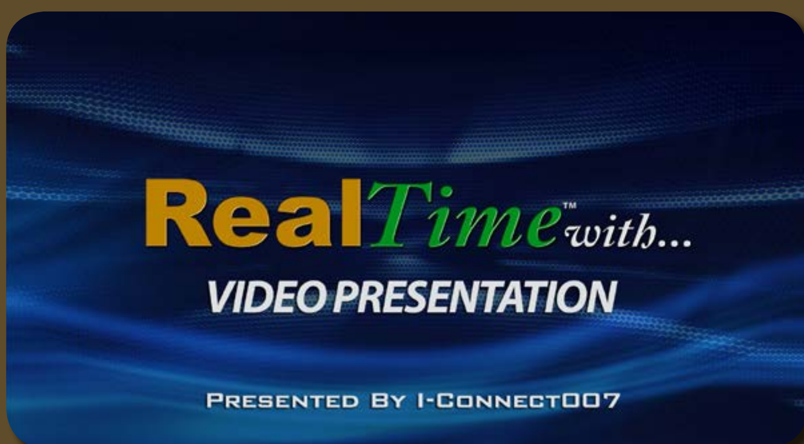
Konrad previously served on the U.S. Navy's EMPF Manufacturers Committee in the late 1980s, is a current member of the SMT Magazine Editorial Advisory Board, and has published dozens of articles on cleaning and cleanliness testing. He is a regular speaker at industry conferences has taught cleaning and cleanliness testing workshops around the world. Contact him at konrad@aqueoustech.com.

## Video Interview

# How Clean is Clean?

***by Real Time with...***
***NEPCON South China 2012***

CEO Michael Konrad of Aqueous Solutions says that cleaning is for everybody. He discusses why the need for higher-reliability products, even in commercial electronics, brought him to China. He also chats about clean versus no-clean flux.

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