

Environmentally Sound Cleaning

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In the past, partially halogenated hydrochlorofluorocarbons (HCFCs), predominately 141b, were often used to clean electronic assemblies. With the ban on HCFCs for cleaning applications at the end of 2008, Matra Électronique, a manufacturer of high-end electronic military equipment needed to evaluate and approve a new cleaning process. The goal of the new cleaning process was compliance with regulation No. 2037/2000 issued by the European Parliament on 29 June 2000 addressing substances that deplete the ozone layer and with the regulation issued on 28 February 2002 on the use of VOCs. We take a look at the requirements for the new cleaning process as well as how the evaluation and the qualification were implemented by Matra Électronique.

Matra Électronique is part of the European company group MBDA and produces high-quality and high-end electronic military equipment. Onboard electronics for defence systems are one of the company's key areas of expertise. The company is also well established in related fields where high quality requirements in terms of long material life cycles are requested, such as civil and military aviation, crude oil research and medical engineering.

Reasons for cleaning electronic assemblies

During the production of an electronic assembly, various flux formulations are applied in different types of manufacturing equipment. To prevent oxidation and to trigger surface activation during the solder-

ing phase, acids are formulated into the flux system. After the soldering process (vapour phase, wave, selective wave or manual soldering), the flux residues must be removed to ensure the long-term reliability of the electronic assembly.

In the consumer industry, the removal of these flux residues is not always required. However, for the manufacturing of class 3 assemblies as produced by Matra Électronique, cleaning becomes a mandatory step to guarantee highest reliability.

Another reason why printed circuit boards need to be cleaned regards the quality of the coating. To ensure optimum levels of functional reliability even in harsh environments, the coating has to adhere perfectly. This requires completely clean and dry surfaces to ensure optimal adhesion of the coating.

Requirements for the new cleaning process

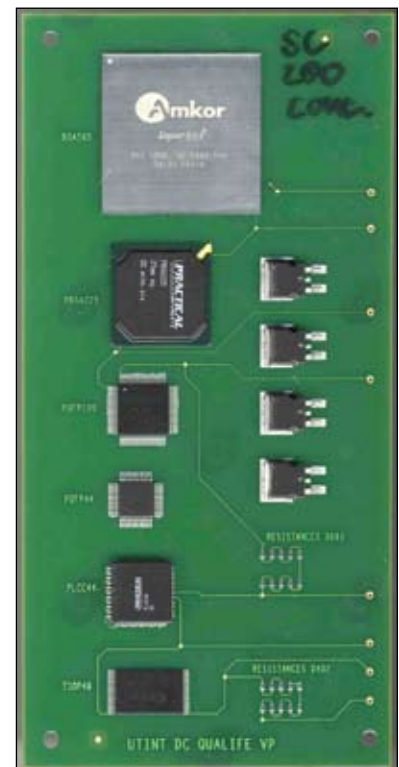
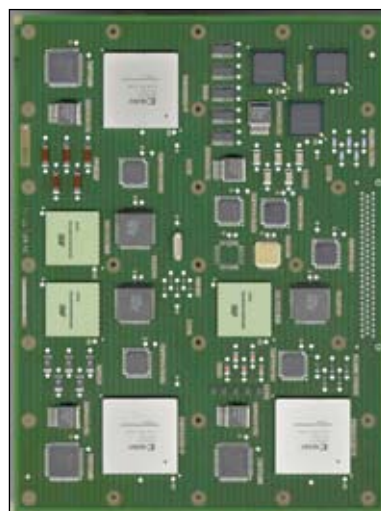
In the past, the cleaning of the electronic assemblies at Matra

Électronique was done with 141b in an immersion cleaning machine. Due to the high environmental incompatibility of HCFCs, including 141b, and the harmful effect on the ozone layer, these substances have been prohibited in France. For this reason, Matra Électronique needed to find a new cleaning process which would not only be in accordance with the latest legislation but also serve as a long-term solution.

An extensive market study was conducted in collaboration with the technical laboratory of the MBDA Group. Following this study and to further evaluate the selected processes, a test scheme was developed.

The idea of a chlorine-based process solution was soon dismissed because, as mentioned above, these substances have been prohibited by legislation since the end

Figure 1 – Test substrates



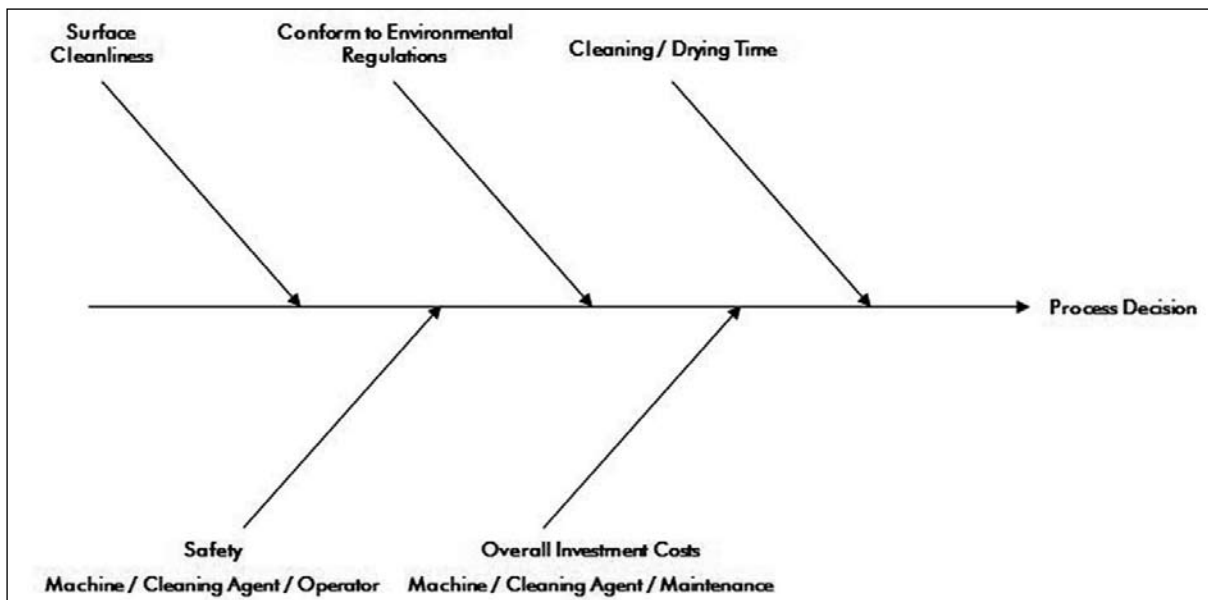


Figure 2 – Factors determining the process decision at Matra Électronique

of 2008. Other cleaning solutions were soon discarded, too. For instance, fluorine solvents (HFE) were banned by the MBDA. Likewise, supercritical CO₂ cannot be used with printed circuit boards as the excessive pressure would damage the cavities of the components. Thus, either water-based cleaning processes or processes applying A3 Solvents were under close consideration.

In order to evaluate the new cleaning process, the first step was to compile a performance envelope specifications. The specifications included items such as the surface cleanliness level of the PCBAs after cleaning, process parameters of the cleaning agent and the machine as well as any requirements with regard to health, safety and the environmental compliance.

The cleaning process had to meet the following criteria (Figure 2):

- Visual inspection according to IPC A 610D
- Ionic contamination according to IPC CH 65
- Health, safety and environmental requirements, including no air pollution by the cleaning agent and no discharge of hazardous compounds into the sewage system
- Complete drying to eliminate the need for additional storing in drying chambers.

Evaluation of the new cleaning process

At this point, an analysis of the cleaning requirements had been successfully completed and a

performance envelope had been compiled for Matra. Additionally, cleaning trials had been conducted considering the various characteristics of the PCBs that need to be cleaned (dimensions, types of fluxes and solder paste used, and material compatibility of components and cleaning agent). Hence, the next step was to select a cleaning machine for the internal evaluation.

Based on Matra's requirements, the best match was a combination of a water-based, surfactant-free MPC (Micro Phase Cleaning) Technology-based cleaning agent developed by Zestron and an NC25 machine by m.b.Tech.

MPC Technology-based cleaning agents combine the advantages and benefits of conventional solvents and surfactants without any of their drawbacks. The active cleaning components, called micro phases, completely remove flux and resin residues as well as any other contaminants without leaving any residues on the substrate's surface.

The working principle is the following (Figure 3):

- The micro phases are activated by temperature and agitation (spray-under-immersion, in this case).

Figure 3 – Working principle of the MPC Technology

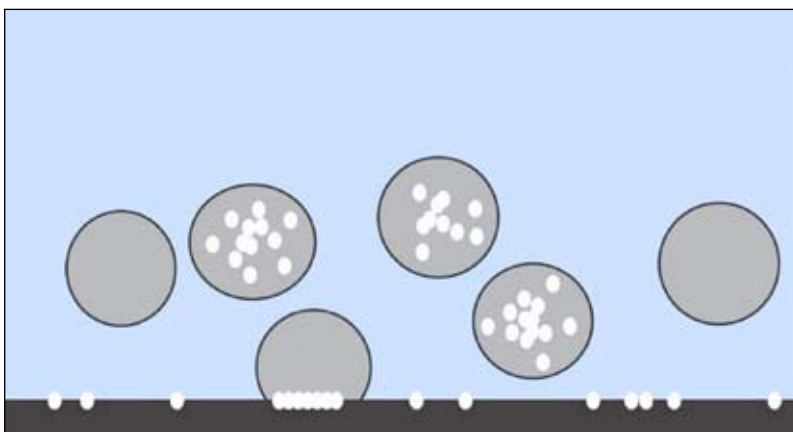




Figure 4 – NC25 cleaning machine from m.b.Tech

- The impurities are removed from the substrate's surface by the micro phases and transferred to the surrounding solution.
- The residues are filtered out of the cleaning bath while the micro phases remain active in the bath.

Due to its surfactant free formulation, the cleaning agent used at Matra Électronique does not leave any residues on either the populated boards or inside the cleaning equipment. Furthermore, this water-based cleaning agent has no flash point and is not categorized as hazardous material for transportation or storage. Thus, it meets all health, safety and environmental requirements.

The NC25 from m.b.Tech is a 4 chamber spray-under-immersion cleaning machine and has been specifically developed for MPC cleaning processes (Figure 4). Once inside the machine, the assemblies are first dipped into the cleaning bath. The most effective cleaning results are achieved by a combination of vertical movement and spray-under-immersion agitation. Afterwards, the PCBs are carried into two DI-water rinsing tanks before finally being vacuum-dried. During the transfer from one tank to another, the drag out is kept to a minimum.

With the cleaning agent applied in

a closed loop system, this cleaning machine not only meets environmental compliance requirements, but also Matra's requirements in terms of costs.

Success of the new cleaning concept

As the cleaning machine was provided by m.b. Tech for a three week testing phase, various performance envelope specifications could be verified. The primary focal points were the cleaning quality, health, safety and environmental aspects, the cycle times (cleaning + drying), the operating costs and the amount of maintenance required.

The cleaning machine accomplishes the cleaning of the electronic assemblies and at the same time, meets all requirements stipulated in Matra's performance envelope specifications. Thus, air pollution or waste water generation can be completely prevented. The cleaning agent used is changed and disposed, the mixed bed ion exchange cartridges for the DI-water treatment are regenerated and the active carbon filters are recycled. Thus, Matra Electronique's commitment to full compliance with its environmental policy according to the ISO 14001 standard could be achieved.

In addition to the NC 25, Matra Électronique has also obtained an NP15 machine from the same manufacturer (Figure 5) that will be used for removing flux residues manually. This equipment is used with Vigon SC 200, a water-based, pH-neutral cleaning agent.

Conclusions

With the collaboration of Zestron, m.b.Tech and Matra Électronique, the complete replacement of 141B for Matra's entire production site was achieved. This was made possible by the investment in three NC 25 machines applying Vigon US and the additive Vigon plus CI 20. In addition, one NP15 machine was purchased for selective flux removal with Vigon SC 200.

The number of cleaning machines to be acquired was estimated based on the substrate surface that would need to be cleaned in the course of one year adding a safety margin of 30%.

The set objective has been fully achieved: a water-based alternative to HCFCs that takes into account environmental compliance and worker safety and at the same time has no drawbacks with regard to quality or cost effectiveness.

Figure 5 – NP15 cleaning machine (prototype developed by m.b.tech according to Matra Électronique's specifications)

