CLEANING LABORATORY EVALUATION SUMMARY

SCL #:	2012
DateRun:	05/12/2012
Experimenters:	Heidi Wilcox
ClientType:	Capacitor Manufacturer
ProjectNumber:	Project #2
Substrates:	Aluminum, Steel
PartType:	Coupon
Contaminants:	Oil
Cleaning Methods:	Ultrasonics
Analytical Methods:	
Purpose:	To find alternative chemistry and process for cleaning capacitors

Experimental Procedure:

The main push to work on a new cleaning system was that the company's custom, vacuum, vapor degreasing system was getting old and costly to maintain. So before replacement became a desperate situation or a major breakdown happened and affected production, they wanted to start looking at options. They wanted to do toxic use reduction and move away from a system that used toxic solvents to clean their capacitors.

This company had been a large manufacturer in the state of Massachusetts for years and had been working on site cleanup with the EPA for years which further motivated the company to move toward a cleaning system that would protect their workers, the environment, and the community in which they did business.

They wanted to retain as much of their current baskets and conveyor belt system as they could to deliver the parts during cleaning. They were open to go semi-aqueous or full aqueous if possible in order to leave nPB. As part of the process they were investigating ways to utilize evaporation and water recycling systems. The company also wanted a system that would give them flexibility and options in the future if they added any new products to their production.

So the water cleaning process that was not an option over a decade before was now viewed as an acceptable method for them and their clients. Therefore, the stage was set for them to find an aqueous or semi-aqueous system that would be compatible with their current production process, cleaning multiple soils and metals used on the production floor. The soils to be cleaned included the same four metal working fluids identified during the first project: 1-Soltex Polybutene 32 (9003-29-6); 2-Cargill, Inc Canola Oil (120962-03-0); 3-Nisseki SAS 40 oil (27776-01-8, 612-00-0, 103-29-7, 101-81-5); and 4-C.P. Hall Co. Plasthall ESO oil.

Results:

Phase I – Cleaning System and Equipment Selection
For the first step in the second round of the project, product selection was very important. Since the way the cleaner was going to be applied to the parts, how the parts would be rinsed, and the way drying was going to be done were to be changed, the selection of a cleaner was more difficult in the second project because it would need to be intimately tied to the new machinery. Both things had to be researched and tested concurrently. Everything was going to be started anew, not just the chemical.

In this phase, water was added to the system resulting in surface tension of the cleaning system being higher, creating the potential for the cleaning solution or solutions to stick or stay in corners and any blind holes in the parts. This added a complication of the parts rusting or oxidizing if they were not rinsed and dried correctly prior to prolonged storage. To make sure this did not happen, a lot of testing would need to be done with the company's parts with any potential cleaning systems in order to rule out any of these issues. The main testing would focus on the least robust surface, like regular steel, which can flash rust and oxidize, and any softer metals like aluminum to make sure the new solutions did not damage the metals.

As mentioned, the cleaning step would no longer be the only phase of the system that could be a potential problem. Now, the process would need a rinse phase of the system, which could cause an issue. Wetting agents would be looked at to avoid any issues. In the new drying phase, the addition of compressed air would be evaluated and if that did not work then nitrogen or another gas may be used. The good news was that these parts were not needed to be microscopically spot free and so regular compressed air should work for their needs.

Dialogue with the company about the new system began by discussing the concepts of using immersion cleaning, ultrasonic cleaning, and spray cleaning. In each scenario, the use of a conveyor belt or an automated lift system was posed as possible options. Variables abounded for to the new cleaning system, as well as equipment. The system would be of significant expense to buy, custom make, install, and retrofit the facility to handle it. Fortunately, the company had good space and infrastructure for the room sized machinery.

Phase II – Contacting vendors and technical resources
After deciding that the same vapor degreasing equipment would not be used this time, the next step was to talk to vendors and other technical experts in the metal cleaning field about the potential processes

and chemicals to be used on the company's capacitors. To further complicate the selection of any new cleaning system, the company revealed that some of the capacitors were cleaned only on the outside and others that were made in-house needed to be cleaned inside before being impregnated with the oils that conduct the electricity for their use. In the latter case, the cleaners and any other residue remaining on the inside of the capacitor had to be tested for any possible interference in conduction.

Expertise was sought from local vendors of chemicals and equipment. In addition, other metal finishers using similar cleaning systems were queried. Further input was solicited about the major metals being used, including stainless steel, steel, and aluminum from the local surface finishing trade group. The consensus was that a phosphating cleaning system should be used, as this would not only clean the oils and the waxes but would protect the regular steel from rusting or oxidizing. The remaining question was whether the phosphating system would interfere with the oil used in the capacitors.

With the type of chemistry to use identified, the focus shifted to identifying the equipment. The equipment options were narrowed down based on the company's needs. The investigation was to look at spray cleaning with a conveyor belt and a cabinet type or immersion tank on an automated line. The group's feeling was that a spray line would work best to clean all areas of the capacitors while utilizing both the current conveyor belts and the existing delivery baskets from the old system.

Phase III –Chemistry in the lab and in the field
The next step was to try phosphate cleaners on the soils to see if effective removal using basic immersion cleaning at room temperature was possible. Other variables, including, heat, mechanical energy, and concentration would eventually be worked on during piloting.

In the laboratory, testing was done using room temperature immersion cleaning with a 5% solution on the substrates of steel, stainless steel, and aluminum. The cleaning solutions showed effectiveness under these basic parameters. However, the true test would to be to take the worst case dirty capacitors and clean them. These would be the capacitors that needed to be cleaned on the outside and those units that needed the insides cleaned. Testing was set up to run both types through a cleaning line using the lab tested solution.

A company using the same cleaner was located through a vendor that was willing to offer up their facility for piloting. Their equipment was a bit different than the one being researched for the client. The testing line at the test location had a large spray line where the parts flowed through it on hooks. Also, the system cleaned large parts versus the smaller capacitors that would be in baskets in the client's system. This was only seen as a minor difference and testing proceeded. Three baskets of differing types of capacitors from the client were run through the line and sent back to the client for analysis.

The analysis was done by the client's in-house engineers to see if the proposed cleaner left a residue that would interfere with how the capacitor worked. Validation, which would take up to six months, also included checking the other capacitors that were cleaned while closed to make sure they were cleaned sufficiently.

Phase IV – Equipment research while waiting for client testing
While the client tested the cleaned capacitors, the team of technical experts researched the equipment that would be the best for this location and client. The vendor was known to work well with customers, was a nation-wide company, but had great local representatives to help install the equipment as well as train the client on how to operate the system. Since equipment and chemistry have to work together, the equipment company was asked to locate one of their customers that was going to be using a spray conveyor belt machine with a phosphating cleaner. This connection would allow for the client to discuss any reservations or get implementation questions answered.

In the meantime, the team checked in with the client to see how quality control testing was going. The report from the client's engineers showed three positive outcomes. First was that the residue from the cleaner was stopping any flash rusting or oxidation on the steel capacitors. Secondly, the process did not damage the aluminum. Finally, the cleaning did not have any effect on the oils in the capacitors that were washed before filling and closing them. This was a huge hurdle overcome.

From there, the next step reverted back to finding a line that was as similar to the proposed system as possible. If the exact chemistry could not be found with the right equipment, then two options existed. The first would be for the equipment company to pilot the exact chemistry in as close of a system as possible. Option two would be to see if another company with the exact line would allow the specific chemistry to be run in their machine for a pilot. All of the options were possible, but the logistics would need to be worked out.

Summary:

Conclusion:

Phase V Murphy's Law - What can go wrong will go wrong
With the finish line in site and many of the challenges conquered, Mr. Murphy walked in. The company put the brakes on, pulled the parachute, and took a detour, walked away or however you want to say it. As everyone knows, business is unpredictable and sometimes during a project things come up that the company has to concentrate on more than others. The team was notified by the operations officer that the company had other more pressing projects going on that they had to divert their attention to at this time. They were appreciative of the work done by all parties involved and promised they would be back. Based on their track record, they were to be believed.

All members of the team were contacted and told the project was on hold, and while disappointed, it was not anything anyone on the team had not dealt with before. It cannot be taken personally. The positive outcome was not tied to the adoption of a system, but to the good work and trust that was built up over the course of the project.