TURI
TOXICS USE REDUCTION INSTITUTE
UMASS LOWELL

CASE STUDY | JULY 2021

The TURI Cleaning Laboratory Verifies Cleanliness for Umicore

umicore

SUMMARY

Umicore worked with its vendors and the Toxics Use Reduction Institute (TURI) to find a safer parts cleaning process that eliminates its use of perchloroethylene (PCE). Using a new vacuum degreaser system with a safer cleaning chemistry, the company projects a savings of over $21,500 annually, while protecting worker health and safety and reducing its regulatory obligations.

Umicore Electrical Materials USA Inc. manufactures contact materials, including clad metals, tapes, buttons, absorber rods, and brazing materials for the electronics industry. This ISO 14001 certified facility employs 40 people in Attleboro, Massachusetts.

The facility had been using a vacuum degreaser manufactured by PERO Corporation. The machine held 2,000 pounds of perchloroethylene (PCE) which was changed out annually. Working with the manufacturer, Umicore was able to extend the changeout to 18 months, resulting in a 2,000-pound reduction in PCE over three years. Environmental Health and Safety (EH&S) staff at the facility wanted to eliminate the use of PCE entirely, for the benefit of worker health and safety and to reduce cost. Working with PERO and chemical manufacturer Kyzen, Umicore identified and purchased a new vacuum degreaser to be used with an alternative solvent blend of propylene glycol ethers, Metalnox M6386.

The old vacuum degreaser held 2,000 pounds of perchloroethylene.

Testing for Environmental, Health and Safety Differences

Metalnox M6386 is composed of a glycol ether blend, 90% propylene glycol butyl ether and 10% di(propylene glycol) dimethyl ether. An environmental health and safety assessment was conducted on the original solvent versus the identified alternative using TURI's publicly available hazard assessment tool, Pollution Prevention Options Analysis System (P2OASys). Comparisons of chemicals and products using P2OASys can be made by inputting both quantitative and qualitative data on the chemical toxicity, ecological effects, physical properties, process factors, and life cycle factors of each chemical or chemical mixture. Based on the P2OASys overall assessment of PCE and the alternative cleaner, Metalnox M6386 is considered a safer alternative.

Based on the information from safety data sheets, Metalnox 6386 is a safer alternative to PCE, if appropriate personal protective equipment is worn and safe handling practices are followed. The hazards of each solvent are listed below:

Environmental, Health and Safety Comparison

Category	Original Solvent: Perchloroethylene	Identified Alternative: Metalnox M6386 (propylene glycol ether blend)
Acute Human Health Effects	VH	VH
Chronic Human Health Effects	VH	L
Ecological Hazards	VH	M
Environmental Fate & Transport	H	M
Atmospheric Hazard	H	L
Physical Properties	VH	VH
Process Factors	VH	M

Low **Medium** **High** **Very High**

Perchloroethylene:
- Harmful if inhaled
- Skin irritation (GHS Category 1A)
- Dermal toxicity (GHS Category 2)
- Carcinogen (GHS Category 2A)
- Neurotoxicity (GHS Category: Single Exposure Category 3)
- Endocrine disruptor (European Union Category 2)
- Acute and chronic aquatic toxicity

Metalnox 6386:
- Skin irritation (GHS Category 2)
- Eye irritation (GHS Category 2A)
- Combustible liquid (NFPA 2; GHS Category 4)
- VOC - 877 g/L

Testing for Performance

Among its products, Umicore manufacturers multi-layered button contacts that are used in welding applications when a material cannot be directly welded to the main substrate or for varying thickness between the two materials being welded. Button contacts are used in applications like light switches, vehicle controls, and motor protectors.

Kyzen satisfactorily tested the cleanliness of the Umicore button contacts using Metalnox M6386, but Umicore asked the TURI Cleaning Lab to verify the cleanliness through a blind test. The buttons needed to be cleaned of grease and dirt residue.

Umicore sent the TURI lab multi-layered button contacts (90% silver and 10% cadmium) of three different sizes. The parts were divided into batches of ten to be cleaned by Product A, Product B, and Product C. The brand names were presented anonymously to avoid any bias. The facility requested that the lab test using three different analytical methods—contact angle, wipe test, and dyne test. The contact angle and dyne test measure wettability of the surface, and the wipe test is a visual observation of soils present on the surface.

The three different cleaning products were used with three different equipment configurations, because the goals of the test were to:
- determine the cleaning effectiveness of the cleaner and equipment selected by Umicore;
- see if adding ultrasonics to the cleaner and the degreaser enhanced cleaning effectiveness; and
- make sure that the new cleaning solvent and equipment cleaned at least as well as PCE with the old equipment.

For the contact angle test, one drop of deionized (DI) water was placed on the smooth surface of the button part supplied by Umicore and the contact angle was measured. The contact angle of a cleaned surface is normally compared to the initial contact angle and contaminated contact angle to determine cleanliness. In this case, the three contact angles were compared by the company to determine how well the new cleaner and applications did to the current cleaner and process as a measure of effectiveness.

TURI developed the Pollution Prevention Options Analysis System (P2OASys) tool to help companies determine whether the toxics use reduction (TUR) options they are considering improve upon their existing process when looking at environmental, health and safety endpoints. P2OASys can help identify potentially negative environmental, worker or public health impacts and avoid making regrettable substitutions.

Potential hazards are compared using data endpoints for eight main categories that encompass chemical, physical, workplace and environmental hazards. Scores range from 2 to 10 with the lower score being more desirable. Those scores have been translated to a ranking as noted in the table key.

Cleaning Results

Product	Cleaner and Equipment	Contact Angle	Wipe Test Results	Dyne Test Results
A	Metalnox and new degreaser	77.98°	Clean/no residue	70% effectively cleaned
B	Metalnox, new degreaser, Ultrasonics	75.94°	Clean/no residue	60% effectively cleaned
C	PCE and old degreaser	75.64°	Clean/no residue	40% effectively cleaned

For the wipe test, a clean, white cotton swab was swiped over the surface of the button and then observed for evidence of any dirt.

For the dyne test, three lines of the dyne test solution were applied to the button using a clean swab, and a lighted magnifying glass was used to observe the lines. Lines that held their shape for three seconds were considered effective. A percent effectiveness was calculated based on how many buttons passed the dyne test out of 10 samples per product.

Product C was the least effective, but products A and B performed well.

Financial Comparison

The new vacuum degreaser cost $250,000, but Umicore will enjoy significant savings over time, as shown in the table below.

The annual savings from the Metalnox system are expected to be $21,574. With a capital investment of $257,280, this results in a payback period of about 12 years. As the unit is expected to last well over 20 years, this is a worthwhile investment for Umicore. While this calculation does not factor in eventual repair costs, it does factor in the use of 80 gallons of Metalnox per year, and Umicore will almost certainly use less than that per year. Also, Umicore estimates that the new Metalnox system uses 50% less electricity than the PCE system, which is an additional source of savings.

Conclusions

The TURI lab verified the effectiveness of the safer alternative to PCE, as well as using P2OASys to analyze the improved health and safety profile of the new solvent. Umicore is satisfied with the cleaning effectiveness of the new degreaser and Metalnox M6386. The new degreaser is more energy-efficient than the previous one and will, therefore, deliver additional cost savings. Umicore's EHS staff are pleased with the improvement for worker health and safety.

Cost Comparison: Old vs. New Systems

	Annual Costs		Capital Costs
Cost item	Old Machine (PCE)	New Machine (Metalnox)	New Machine (Metalnox)
Equipment investment	n/a	n/a	$250,000
Training investment	n/a	n/a	$7,280
Repairs	$15,000	None in the first year and none expected for several years after	
Solvent/cleaner	$4,851	$2,736 for 80 gallons (expected to last a minimum of one year)	
Stabilizer to maintain acidity	$2,410		
Booster[1]		If used, $41 per year for a third of a gallon	
Waste disposal costs	$2,200	$110 per year for a 55-gallon drum	
Total costs	$24,461	$2,887	$257,280

1 Booster is an additive that is required only if the Metalnox begins to deteriorate. Alternatively, the solution can be discarded and replaced when it begins to deteriorate.