

**ALTERNATIVES TO PERCHLOROETHYLENE VAPOR DEGREASING FOR
PLATING OPERATIONS: CASE STUDY CONVERSIONS**

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PREFACE

This document was produced with funding from Cal/EPA's Department of Toxic Substances Control, Los Angeles County Sanitation Districts and the City of Los Angeles Bureau of Sanitation. It presents detailed case studies of five plating shops in Southern California that have converted from perchloroethylene vapor degreasing to water-based cleaning systems and acetone. These case studies demonstrate that the safer alternatives can be used as replacements for perchloroethylene in these operations. The case studies also show that the alternatives are technically feasible and cost effective for plating shops. The information presented here should be of use to plating companies using perchloroethylene in vapor degreasers, to vendors of water cleaning systems and water-based cleaners and to regulatory agencies that wish to disseminate outreach material.

ACKNOWLEDGEMENTS

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I. INTRODUCTION AND BACKGROUND

In the early 1990s, there were as many as 3,000 vapor degreasers in the South Coast Basin. Most of these vapor degreasers used 1,1,1-trichloroethane (TCA), a chlorinated solvent. In 1996, TCA production was banned because the solvent contributes to stratospheric ozone depletion. Many of the companies using the solvent converted their operations to water-based cleaning and more traditional VOC solvents. Some of the companies continued to use vapor degreasers with other halogenated solvents. By 2002, there were only about 250 companies using vapor degreasers and most of these companies were using perchloroethylene (PERC).

PERC is exempt from VOC regulations but the chemical is a suspect carcinogen. The chemical appears on EPA's Hazardous Air Pollutant (HAP) list, the California Toxic Air Contaminant list and California's Proposition 65 list. PERC is a listed RCRA hazardous waste. The South Coast Air Quality Management District amended one of their cleaning rules, Rule 1122 "Solvent Degreasers" in December of 2002 to prohibit the use of PERC and other chlorinated solvents in vapor degreasers after January 1, 2003.

The Institute for Research and Technical Assistance (IRTA) is a nonprofit organization established in 1989 to assist companies in adopting alternatives to solvents in cleaning, coating, adhesives and paint stripping. IRTA runs and operates the Pollution Prevention Center (PPC). The mission of the PPC is to help companies in implementing low- and non-solvent technologies. IRTA and the PPC provide pollution prevention technical assistance to individual firms and also work with whole industries on tests and demonstrations of new and emerging technologies.

Several members of IRTA's PPC were concerned that companies may need assistance to convert from PERC vapor degreasing to alternatives. Many of the companies using PERC for vapor degreasers were small plating shops. Three PPC members provided funding for IRTA to assist small plating shops in making their conversion away from PERC.

During the project, IRTA worked with five plating companies that had relied on PERC for their cleaning needs for many years. These companies adopted alternatives and IRTA prepared case studies that could be used by other similar companies or companies with similar operations as examples of successful conversions.

The results of the project indicate that water-based cleaners are a viable alternative to PERC vapor degreasing. The water-based cleaners offer an overall advantage from the human health and environmental standpoint and, in most cases, they are less costly or about the same cost as PERC vapor degreasing. Four of the companies that participated in the project converted to water-based cleaners. Acetone is also a viable alternative to PERC vapor degreasing for certain types of operations. Acetone is not classified as a VOC and it is relatively low in toxicity. One of the companies that participated in the project converted to acetone handwipe cleaning.

Section II of this document identifies the companies that participated in the project and provides information on the assumptions used in the cost analysis to compare PERC vapor degreasing to the alternatives adopted by the companies. A short stand-alone case study for each of the companies is included in Section III of the document. Finally, a summary and the conclusions of the analysis are presented in Section IV.

II. TECHNICAL FEASIBILITY AND COST ANALYSIS

Five plating companies participated in the project. Each of them worked with IRTA to test alternatives and each of them adopted an alternative system that was most suitable for them. The companies include:

- AH Plating, Inc.
2117 West Empire Avenue
Burbank, CA 91504
- Anodyne
2230 South Susan Street
Santa Ana, CA 92704
- Drilube Company
711 W. Broadway
Glendale, CA 91204
- Multichrome/Microplate
1013 W. Hillcrest Blvd.
Inglewood, CA 90301
- Normandy Metal Refinishers
355 So. Rosemead Blvd.
Pasadena, CA 91107

A description of the process used by the company in the past and the new process the company has adopted are discussed below. The assumptions used in the cost comparison of the new and previously used process are provided and the cost comparison is presented. In two cases, AH Plating and Drilube Company, the cost information on the degreaser and new process were not available.

AH Plating, Inc.

AH Plating is currently located in Burbank. The company processes pistons and hydraulic systems that are used in military and commercial aircraft. The company's customers include Boeing, H.R. Textron, Lockheed and Fairchild. AH plates the inner diameter of cylinders and landing gear. The parts processed by the company are made of various substrates including steel and titanium.

The parts are shipped to AH with a preservative oil to prevent rusting. Before they can process the parts, AH must remove the oil. The parts are large and they range from six to eight feet in length; some of the parts have a four foot diameter. The width of the inner diameter of most of the parts ranges from two to six inches.

The parts must be clean prior to plating and after the plating operation, the company either puts the parts through an abrasive blasting process or they go to inspection. Two types of inspection processes are used on the parts to determine if they are free from cracks. These include dye penetrant inspection and magnetic particle inspection. The parts must be cleaned prior to inspection. They are then coated with the dye penetrant or magnetic particle fluids and examined under the light. The fluids will fluoresce if there is a crack. After the inspection is completed, the fluid must be removed from the part.

For several years, AH used a vapor degreaser containing PERC for all of their cleaning needs, including the cleaning before and after inspection. IRTA began working with the company in April of 2002 to assist them in adopting an alternative water-based cleaning system. Because of the SCAQMD regulation, AH needed to find an alternative process by January 1 of 2003.

IRTA and AH conducted testing of alternative cleaning agents and equipment at a test center, Applied Cleaning Technologies, in Anaheim. After a substantial amount of field testing and visits to companies using different types of equipment, AH decided to purchase two water-based cleaning systems. The first system, called a Pressure Island, can be used to clean the large assemblies processed by AH. The parts are placed on a platform and an operator sprays them at high pressure with the cleaning agent. The cleaning agent is recycled to the self-contained tank for reuse in cleaning the next part. A picture of AH's Pressure Island is shown in Figure 2-1.



Figure 2-1. Pressure Island Cleaning System at AH Plating.

The second system AH purchased is an agilift unit that is being used to clean the smaller parts. This system contains a water-based cleaning tank and a rinse tank. The parts are placed on a platform and the platform is moved up and down to provide agitation for removing the oil and inspection fluids. Two views of the agilift system at AH are shown in Figure 2-2 and Figure 2-3.



Figure 2-2. Side View of Agilift Cleaning System at AH Plating



Figure 2-3. Top view of Agilift Cleaning System at AH Plating.

AH has closed down their vapor degreaser and is using the new water cleaning systems. The company is still testing different cleaning agents so a cost analysis cannot be performed at this time.

Anodyne

Anodyne is a plating shop located in Santa Ana, California. The company has a number of different plating processes. They process raw and machined parts made of brass, stainless steel, aluminum, steel, precious metals and copper. The company also has anodizing operations, performs inspections and paints some parts. Most of the parts processed by the company are aerospace and aircraft parts.

For many years, Anodyne relied on a PERC vapor degreaser for cleaning the parts prior to plating. Some of the parts are covered in buffing compound and oil. Many of the other parts were covered with oil that had to be cleaned from the parts prior to plating. A picture of Anodyne's vapor degreaser is shown in Figure 2-4.



Figure 2-4. Old Vapor Degreaser at Anodyne.

IRTA and Anodyne tested a number of water-based cleaners before finding one that could clean both the buffing compound and oil effectively from the parts. The cleaner is made by Kyzen and it is designed for immersion cleaning operations. There are two methods for removing buffing compound, high pressure spray and ultrasonics. Anodyne did not need a conveyORIZED high pressure spray system so the company made a decision to purchase an ultrasonic cleaning system. The system holds about 130 gallons of cleaner. Two different views of the water-based cleaning system are shown in Figure 2-5 and Figure 2-6.



Figure 2-5. Side view of Ultrasonic Unit at Anodyne.



Figure 2-6. Top view of Ultrasonic Unit at Anodyne.

The cost of the ultrasonic cleaning system purchased by Anodyne was \$16,970. Assuming a useful life of 10 years for the machine, the annualized capital cost is \$1,697. The Anodyne workers did not require any training costs to use the new system.

The vapor degreaser used by Anodyne had a 60 gallon capacity. The degreaser was completely cleaned out once every two months. In addition, the company had to add about 11 gallons of make-up solvent to the degreaser every week to replace the solvent that had evaporated. The total amount of PERC purchased by the firm annually is 932 gallons. The cost of the PERC purchased by Anodyne was 61 cents per pound or \$8.30 per gallon. The cost to the company for purchasing PERC amounted to \$7,736 per year. Anodyne uses their new water-based cleaner at about 15% concentration in the 130 gallon cleaning bath. Anodyne adds about one-half gallon of the water-based cleaning concentrate to the system each week and the company estimates that the bath will require changeout four times a year. The company purchases 104 gallons of water cleaning concentrate each year. At a cost of \$10.90 per gallons for the water-based cleaner, the annual cleaner cost amounts to \$1,134.

Anodyne spent about 2.5 hours per day cleaning with the vapor degreaser. The company estimates that the workers spend an extra half-hour or three hours per day cleaning with the new ultrasonic system. The Anodyne labor rate is \$50 per hour. On that basis, the vapor degreaser labor cost was \$32,500 annually and the water cleaning system labor cost is \$39,000.

The cost of maintenance has not changed. The workers spend five minutes twice a day performing maintenance. Assuming the labor cost of \$50 per hour, the annual maintenance cost for the degreaser and the water-based cleaning system each amount to \$2,167.

The vapor degreaser was operated for about 2.5 hours per day. It used nine kW of electricity. Assuming a cost of 12 cents per kWh, the total annual electricity cost for the vapor degreaser was \$702. The ultrasonic cleaning tank has an eight kW heater and 3.6 kW ultrasonic generator. The

water cleaning unit is used for about three hours per day. Again, assuming a cost of 12 cents per kWh, the annual electricity cost for the water cleaning system is \$1,086.

The PERC waste from the degreaser was shipped off-site as hazardous waste. The cost of disposal was \$2 per gallon. The 60 gallon degreaser was changed out six times per year. The annual cost for disposing of the PERC was \$720. The water-based cleaner, when it is spent, contains some oil and possibly some metals. The company disposes of the water cleaner in their treatment system. The cost of the treatment of an additional 130 gallons periodically is small compared with the treatment cost for the plating wastewater so it is not included in the costs.

PERC is classified by the SCAQMD as a Toxic Air Contaminant. Fees for emissions of PERC are 25 cents per pound. The makeup solvent added to the bath is the PERC that is emitted. The balance is disposed of as hazardous waste. Emissions total 11 gallons per week or 572 gallons per year. Assuming a PERC density of 13.6 pounds per gallon, the toxics fees amounted to \$1,945 annually. The company also had an annual permit renewal cost that amounted to \$196. There are no emission or permit fees for the water-based cleaning system.

Anodyne’s costs for the PERC degreaser and the water cleaning system are shown in Table 2-1. The values indicate that the total cost of using the water cleaning system is slightly lower than the cost of using the PERC vapor degreaser. This is true even if the capital investment of the water cleaning unit is taken into account. The electricity and labor cost for using the water cleaning unit are higher but these are more than offset by the higher cost to purchase PERC and the PERC disposal cost and regulatory fees.

	PERC Degreaser	Ultrasonic System
Equipment Cost	-	\$1,697
Cleaner Cost	\$7,736	\$1,134
Electricity Cost	\$702	\$1,086
Labor Cost	\$32,500	\$39,000
Maintenance Cost	\$2,167	\$2,167
Disposal Cost	\$720	-
Regulatory Fees	\$2,141	-
Total Cost	\$45,966	\$45,084

Drilube Company

Drilube is a plating company currently located in Glendale. Much of the Drilube facility was destroyed in a fire and the company is planning to move to a new facility in Santa Fe Springs within the next three months.

Drilube processes parts for the aircraft and aerospace industries. They apply coatings and dry film lubricants, primarily to fasteners. The company also performs non-destructive testing. Many of the parts processed by the company are made of low grade steel but parts made of titanium, beryllium, copper and aluminum are also treated. The parts generally contain light machining oils or preservative oil when they come to the facility.

Historically, all of the parts were cleaned in one of two vapor degreasers that relied on PERC. One of the degreasers was used all day and the other was used when additional capacity was required.

IRTA and Drilube conducted testing of water-based cleaners and water-based cleaning systems. The company decided to purchase an agilift system and began using a cleaning agent made by Magnaflux. Shortly after the new system was installed, the fire broke out and destroyed most of the facility. Drilube is using a small water cleaning system until the company completes the move. At that time, Drilube plans to purchase a larger water cleaning system. Cost data are not available currently to perform the cost comparison of the PERC vapor degreasers and the water cleaning system.

Multichrome/Microplate

Multichrome is a small company located in Inglewood, California that performs plating and tests like dye penetrant and magnetic particle inspections. The company processes parts made of various substrates, including steel, stainless steel, aluminum, titanium and sometimes magnesium.

The parts contain oil that must be removed. After cleaning, the parts are masked and then plated. Some of the parts are inspected and they are cleaned both before and after the dye penetrant and magnetic particle inspections.

The parts were historically cleaned with a vapor degreaser that used PERC. A picture of this degreaser is shown in Figure 2-7. Multichrome already owned a water-based agilift cleaning unit that had not been used for many years. The company and IRTA tested a water-based cleaner that was designed for cleaning parts before and after inspection. The water-based cleaner worked well and Multichrome decided to use the agilift cleaning system. No capital investment was required since the company already owned the equipment. A picture of the equipment is shown in Figure 2-8.



Figure 2-7. Old Vapor Degreaser at Multichrome.



Figure 2-8. Agilift Cleaning System at Multichrome.

When Multichrome used the vapor degreaser, they purchased a drum (55 gallons) of solvent once every month and a half. At \$375 per drum, the annual cost of the PERC purchases was \$3,000. The water cleaning unit has a capacity of 84 gallons and the company uses the cleaner at a 10% concentration. The bath is replaced every two months and the cost of the cleaner is \$15 per gallon. On this basis, the cost of the water-based cleaner is \$756 annually. Multichrome also uses acetone for handwiping parts that undergo the inspection process. The company purchases one gallon of acetone a month at a cost of \$5 per gallon. The total annual cost for acetone is \$60.

The vapor degreaser used nine KW of electricity and it was operated for eight hours per day. Assuming an electricity cost of 12 cents per kWh, the annual electricity cost for the degreaser was \$2,246. The water-based cleaning system has a nine kW heater and it is also operated for eight hours per day. The electricity cost for the water cleaning system is the same as the electricity cost for the vapor degreaser.

With the vapor degreaser, the cleaning time was approximately three to five minutes for each job and the company processed about 20 jobs on average per day. With the water-based cleaner, the cleaning time has increased to five to seven minutes. Assuming a labor rate of \$10 per hour and a cleaning time of four minutes, the vapor degreaser labor cost was \$3,467; the water cleaning system labor cost is now \$5,200 assuming a cleaning time of six minutes.

Multichrome spent about one-half hour training three workers to use the new cleaning system. Assuming a labor rate of \$10 per hour, the training cost amounted to \$30. Amortizing the cost over a 10 year period, the useful life of the equipment, leads to an annual cost of \$3.

Multichrome hired a maintenance company to clean and maintain the vapor degreaser. The cost of this service was \$600 per year. The company now spends one-half hour every two months to clean and maintain the water-based cleaning system. At a labor rate of \$10 per hour, the annual maintenance cost amounts to \$30.

The spent PERC was disposed of as hazardous waste at a cost of \$2 per gallon. The 40 gallon vapor degreaser was changed out twice a year. The annual waste disposal cost for the vapor degreaser was \$160. The spent water-based cleaner contains some oil and possibly some trace metals. Multichrome can easily treat the spent cleaner in the waste treatment system. These costs have not been included since they are negligible compared with the treatment of the plating wastewater.

The SCAQMD emission fee for PERC, because it is classified as a Toxic Air Contaminant, is 25 cents per pound. Multichrome purchased eight drums or 440 gallons of PERC annually. Eighty gallons of the spent material is disposed of as hazardous waste. Assuming a PERC concentration in the waste of about 20%, the waste PERC amounts to 16 gallons. Thus 424 gallons or 5,766 pounds of PERC are emitted. At a fee of 25 cents per pound, the cost for emitting PERC was \$1,442 annually. The company also paid a fee of \$196 annually for renewing the permit on the vapor degreaser. The total regulatory fees amounted to \$1,638.

Table 22 shows the cost comparison for Multichrome for using PERC and the water-based cleaning system. The costs of the water cleaning system are lower than the cost of using the PERC vapor degreaser. Multichrome reduced their costs by 25% through the conversion.

	PERC Degreaser	Agilift System
Equipment Cost	-	-
Cleaner Cost	\$3,000	\$816
Electricity Cost	\$2,246	\$2,246
Labor Cost	\$3,467	\$5,200
Training Cost	-	\$3
Maintenance Cost	\$600	\$30
Disposal Cost	\$160	-
Regulatory Fees	\$1,638	-
Total Cost	\$11,111	\$8,295

Normandy Metal Refinishers

Normandy is a small family run company located in Pasadena, California. Another facility run by the same family is located in Orange County.

Normandy provides the fine restoration of brass, silver, copper and gold items. The company has polishing, plating and clear coating operations for antique and precious metals. Some of the pieces processed by Normandy are shown in Figure 2-9.

Historically, the company used a PERC vapor degreaser to remove the buffing compound and oil from the parts prior to plating or coating. IRTA and Normandy conducted testing with a water-

based cleaner in an ultrasonic cleaning system. Even with the PERC system, the workers handwiped the parts after they were cleaned in the vapor degreaser. Normandy decided to implement a handwiping system rather than a water-based cleaning system as an alternative to the PERC vapor degreaser. Since the company was already spending time handwiping, it was judged that the increased labor cost would be reasonable.



Figure 2-9. Pieces Processed at Normandy.

Normandy installed a small booth with the features and ventilation required by the fire department for handwiping the parts. A picture of this booth is shown in Figure 2-10. The cost of the enclosure and ventilation system amounted to \$500. Spreading the cost over 10 years, the annual cost is \$50.



Figure 2-10. Picture of Acetone Handwipe Booth at Normandy.

Normandy purchased 83 gallons per year of PERC at a cost of \$8.18 per gallon. The annual PERC cost amounted to \$679. The company personnel estimate they will use approximately 87 gallons of acetone annually. At an acetone cost of \$7 per gallon, the total annual cost is \$609.

The vapor degreaser used 1.2 kW of electricity and it was operated for two hours per day. At an electricity cost of 12 cents per kWh, the annual electricity cost was \$75. The ventilation enclosure for the acetone handwiping has a one-fourth horse power blower (0.2 kW). It runs for about three hours per day. The electricity cost for the acetone operation amounts to \$19 per year.

Normandy had one worker who spent one-half hour each day cleaning with the vapor degreaser and handwiping the parts. At a labor rate of \$10 per hour, the labor costs amounted to \$1,300 per year. The owner estimates that the labor hours have increased by about 20% with the conversion to acetone. The current labor cost is therefore \$1,560 annually.

No training was required since the workers already performed handwipe operations.

The owner estimates that there will be no change in maintenance with the new system.

On average, Normandy disposed of a drum of PERC waste once every two years. At a cost of \$250 per drum, the annual disposal cost amounted to \$125. The owner estimates that disposal costs for the acetone handwipe operation will be the same.

The SCAQMD fee for the emission of PERC is 25 cents per pound. Normandy purchased 83 gallons of PERC annually. Some of this PERC ended up as hazardous waste. Assuming that about three-fourths of the PERC, or about 62 gallons, were emitted, the emission fees for the PERC operation amounted to \$211 per year. Normandy also paid a permit renewal fee of \$196 annually to SCAQMD for operating the vapor degreaser. The total regulatory costs for using PERC were \$407.

The cost comparison for the PERC and the acetone operations is displayed in Table 2-3. Normandy reduced their costs slightly by making the conversion from PERC to acetone.

	PERC Degreaser	Acetone Handwipe
Equipment Cost	-	\$50
Chemical Cost	\$679	\$609
Electricity Cost	\$75	\$19
Labor Cost	\$1,300	\$1,560
Disposal Cost	\$125	\$125
Regulatory Fees	\$407	-
Total Cost	\$2,586	\$2,363

III. CASE STUDIES

A stand-alone case study was developed for each of the companies that participated in the project. These case studies are presented in this chapter.

AH PLATING CONVERTS FROM SOLVENT TO WATER

AH Plating, a small company located in Burbank, processes pistons and hydraulic systems used in military and commercial aircraft. Boeing, H.R. Textron, Lockheed and Fairchild number among the company's customers.

AH plates the inner diameter of cylinders and landing gear. The types of parts processed by the company include steel and titanium. The parts are large, ranging in size from six to eight feet in length and four feet in diameter. When the parts arrive at AH, they contain a preservative oil to prevent rusting. Before the parts are plated, they are cleaned to remove the oil. The parts are also cleaned after plating before they undergo dye penetrant or magnetic particle inspection. The dye penetrant and magnetic particle fluids must then be removed in another cleaning operation.

Historically, like many other plating shops, AH relied on a perchloroethylene (PERC) vapor degreaser to clean the parts at all of the stages in the operation. The South Coast Air Quality Management District (SCAQMD) amended one of their cleaning regulations, Rule 1122, to prohibit the use of PERC in open top vapor degreasers after January 1, 2003. IRTA began working with AH Plating to find an alternative that would be suitable for their cleaning needs.

AH and IRTA tested water-based cleaners and water-based cleaning equipment at a test center, Applied Cleaning Technologies, in Anaheim. AH also visited other companies that had made a conversion to see their cleaning equipment. Henry Moran, the company's Quality Control Manager, was involved in the testing to ensure that cleaning with the water systems would be adequate. "The water-based cleaners worked well," says Mr. Moran. "They worked as well as the degreaser in removing the oil."

The company decided to purchase two water cleaning systems to replace the vapor degreaser. The first system, the Pressure Island, is used to clean oil from the large assemblies. The parts are placed on a platform and the operator sprays them with a wand that delivers a high-pressure spray. The water cleaner is captured by the self-contained tank under the platform for reuse. The second system, an agilift unit, has both a wash and a rinse bath. The smaller parts processed by AH are placed in a basket on a platform and the unit agitates the platform up and down in the cleaning agent to clean the parts.

Says Cliff Meeks, General Manager of AH Plating, "at first I didn't believe the water-based cleaners would perform well on our parts, especially with the inspection process cleaning. The two new systems work well." The company is still testing various water-based cleaning formulations to find the one that will suit them best.

"We didn't want to continue using the vapor degreaser," says Mr. Meeks. "The conversion was a good decision. We don't have to deal with the air regulations. We helped improve the air and the water cleaners are better for our workers. We may even have lower costs."

SANTA ANA FIRM ADOPTS WATER CLEANING SYSTEM

Anodyne, a small company located in Santa Ana, California, processes parts for the aerospace and aircraft industries. The company has a number of different plating operations and processes a variety of substrates including aluminum, brass, stainless steel, steel, precious metals and copper. Anodyne also has anodizing operations, performs inspections and paints some parts.

Like many other plating companies, Anodyne used a perchloroethylene (PERC) vapor degreaser for cleaning their parts. Most of the parts contain oil but some steel parts routinely processed by Anodyne also contain buffing compound. PERC is a very effective cleaning agent for buffing compound because its boiling point is much higher than the melting point of the compound.

Anodyne had to find an alternative to the PERC vapor degreaser because of the South Coast Air Quality Management District (SCAQMD) regulation that banned open top vapor degreasers by January 1, 2003.

IRTA and Anodyne tested a number of different cleaning systems and settled on an ultrasonic unit. Buffing compound is difficult to remove and only conveyORIZED high-pressure spray systems and ultrasonic systems are capable of removing it. Since Anodyne required a batch process, the ultrasonic system seemed the most feasible for their operation.

IRTA and Anodyne tested a variety of different cleaners and only one was able to remove both the oil and buffing compound from the steel parts containing buffing compound. Anodyne adopted the cleaning agent which is made by Kyzen and it works well for all of their parts. Says Sean McShefferty, Manager of the Western Region for Kyzen, “we worked hard to find a cleaning agent that would work for Anodyne and our work paid off.”

Anodyne purchased an ultrasonic cleaning system for about \$17,000. Even with the capital investment, the cost of using the water system is roughly the same as the cost of using the PERC vapor degreaser. “We’re happy with the new system,” says Bob Sargent, Vice President and Quality Control Manager at Anodyne. “For a long time, I didn’t believe we could find an effective alternative to the PERC vapor degreaser. But we did get rid of a toxic chemical, we did our part for the environment and we reduced our costs in the process. It’s a win-win.”

Annual Cost Comparison for Anodyne		
	PERC Degreaser	Ultrasonic System
Equipment Cost	-	\$1,697
Cleaner Cost	\$7,736	\$1,134
Electricity Cost	\$702	\$1,086
Labor Cost	\$32,500	\$39,000
Maintenance Cost	\$2,167	\$2,167
Disposal Cost	\$720	-
Regulatory Fees	\$2,141	-
Total Cost	\$45,966	\$45,084

GLENDALE PLATER CONVERTS FROM SOLVENT TO WATER CLEANING

Drilube is a plating company that has been located in Glendale, California for 57 years. Much of the Drilube facility was destroyed in a fire and the company is currently planning a new operation that will be located in Santa Fe Springs.

Drilube processes parts for the aircraft and aerospace industries. The company applies coatings and dry film lubricants, primarily to fasteners. The company also performs non-destructive testing. Many of the parts processed by Drilube are made of low grade steel but parts made of other substrates like titanium, beryllium, copper and aluminum are also treated. The parts generally contain light machining oil or preservative oil when they arrive at Drilube.

Historically, all of the parts were cleaned in one of two vapor degreasers that relied on perchloroethylene (PERC). One of the degreasers was used all day and the other was used when additional capacity was required. The degreaser was especially effective at removing the non-destructive testing fluids that are applied to the parts to determine if they have flaws.

The South Coast Air Quality Management District (SCAQMD) amended Rule 1122, one of their cleaning rules, to prohibit the use of open-top vapor degreasers containing PERC after January 1, 2003. Drilube began investigating alternatives with IRTA.

Drilube and IRTA conducted testing of water-based cleaners and water-based cleaning equipment. Drilube decided to purchase a large multi-stage agilift system. The parts are placed on a platform that is agitated up and down so the cleaner can remove the oil and non-destructive testing fluids. Drilube decided to use a cleaner called Daraclean 212 which is made by Magnaflux. The company installed the new system and began using it. When the fire broke out, the cleaning system was destroyed. Drilube is currently using the cleaner in a temporary unit and plans to buy a larger cleaning system after the company moves.

Kevin Fairfax, President of Drilube, is satisfied with the new cleaning system. "We investigated the cleaning systems that were available and settled on the agilift," he says. "The cleaner we ended up using performed better than the other cleaners we tested on the non-destructive fluids. Water-based cleaning is better for workers and the environment and we did our part by converting."

INGLEWOOD COMPANY CONVERTS TO WATER CLEANING

Multichrome/Microplate is a small company located in Inglewood, California, that performs plating and inspection tests. The company processes parts made of many different substrates including steel, stainless steel, aluminum, titanium and sometimes magnesium.

When the parts arrive at Multichrome, they contain oil that must be removed prior to plating. Before the inspection process, the parts must be cleaned. During the inspection process, the parts are covered with dye penetrant or magnetic particle fluids which are used to detect faults. The parts must be cleaned again after inspection.

Multichrome relied on a vapor degreaser that used perchloroethylene (PERC) for removing the oil and inspection fluids from their parts. The South Coast Air Quality Management District (SCAQMD) amended one of the cleaning rules, Rule 1122, to ban the use of PERC in open top vapor degreasers by January 1, 2003. IRTA began working with Multichrome to find a suitable alternative.

Multichrome and IRTA tested alternative water-based cleaning formulations and identified one, made by Magnaflux, that was designed specifically for cleaning inspection fluids. Multichrome had an agilift unit that had not been used for years. The unit still operated well and Multichrome decided to use it rather than purchase a new, expensive system.

Multichrome has been using the water cleaning system for several months. The company found they also had to handwipe the parts in some cases with acetone during the inspection process. The labor cost with the water-based cleaner is higher than the labor cost with the vapor degreaser. With the vapor degreaser, the workers spent about four minutes on each of the jobs; with the water cleaning system, the workers must spend more time, about six minutes on average, on each job. The increase in the labor cost is more than offset by the lower cleaner cost, maintenance cost and disposal cost.

Says Ricardo Flores, Quality Assurance Manager at Multichrome, "we were skeptical that the water-based cleaning system would work. We are happy with the conversion." Currently the company has the cleaning system in one room and the rinse in another room. They plan to consolidate the operation in the future. According to Aurelio Guerrero, General Manager of Multichrome, "we'll probably save more time on the cleaning when we consolidate the cleaning operation. The new process is a lot better. We eliminated a toxic and you can't put a price on a hazard."

Annual Cost Comparison for Multichrome		
	PERC Degreaser	Agilift System
Equipment Cost	-	-
Cleaner Cost	\$3,000	\$816
Electricity Cost	\$2,246	\$2,246
Labor Cost	\$3,467	\$5,200
Training Cost	-	\$3
Maintenance Cost	\$600	\$30
Disposal Cost	\$160	-
Regulatory Fees	\$1,638	-
Total Cost	\$11,111	\$8,295

SMALL PASADENA COMPANY MAKES THE SWITCH AWAY FROM PERC

Normandy Metal Refinishers is a small company run by a father/son team in Pasadena. The family also owns another similar facility in Orange County. Both facilities have polishing, plating and clear coating operations for antiques and precious metals. The company restores fine pieces made of brass, silver, copper and gold.

Like many other plating companies, Normandy used a vapor degreaser containing perchloroethylene (PERC) for removing the oil and polishing compound from the parts prior to plating or coating. PERC is especially good at removing the polishing compound. After putting the parts through the vapor degreaser, the workers at Normandy handwiped the parts with lacquer thinner to ensure that all the residue from the polishing compound was removed.

IRTA began working with Normandy to help the company find an alternative to PERC. The South Coast Air Quality Management District (SCAQMD) amended one of their cleaning regulations, Rule 1122, to prohibit the use of open-top PERC degreasers after January 1, 2003.

Normandy and IRTA tested various ultrasonic cleaning systems with water-based cleaners to see if they would be suitable for the company's requirements. It was determined that in most cases, handwiping of the parts after processing them through the water-based cleaning system would be required as it was with the PERC degreaser.

"We decided to go with handwiping the parts with acetone instead of buying an expensive water cleaning system," says Greg Sarkisian, owner of Normandy. "We were already handwiping and the small increase in labor seemed reasonable."

Normandy installed a small booth for the handwiping process. The booth included a ventilation system required by the Fire Department. Says Mr. Sarkisian, "the new arrangement works out well. We no longer have to deal with the regulatory problems with the PERC. We made the switch which is better for the workers and the environment and it actually reduced our costs."

Annual Cost Comparison for Normandy		
	PERC Degreaser	Acetone Handwipe
Equipment Cost	-	\$50
Chemical Cost	\$679	\$609
Electricity Cost	\$75	\$19
Labor Cost	\$1,300	\$1,560
Disposal Cost	\$125	\$125
Regulatory Fees	\$407	-
Total Cost	\$2,586	\$2,363

IV. SUMMARY AND CONCLUSIONS

Many plating companies relied on PERC vapor degreasers to clean their parts prior to plating. PERC is considered a suspect carcinogen and it is regulated heavily. The SCAQMD modified one of their cleaning regulations, Rule 1122, to forbid the use of PERC open-top vapor degreasers after January 1, 2003.

IRTA received funding from three Pollution Prevention Center partners--Cal/EPA's Department of Toxic Substances Control, Los Angeles County Sanitation Districts and the City of Los Angeles Bureau of Sanitation--to assist small platers in making the conversion away from PERC.

During the project, IRTA worked with five platers. Three of the platers were using PERC degreasers to remove non-destructive testing fluids and two were using the degreasers to clean oil and buffing compound from the parts. These applications were perceived to be more difficult than other applications where simple oil requires removal.

IRTA and the companies participating in the project tested alternative cleaning systems. Four of the companies decided to implement water-based cleaners. Three of these companies now use aglift systems to remove fluids and oil and one uses an ultrasonic system to remove oil and buffing compound. One company opted to substitute acetone handwiping for PERC vapor degreasing. That company uses the acetone to remove oil and buffing compound.

IRTA analyzed the costs of the conversion for three of the facilities. The cost comparison for these facilities demonstrates that, in all cases, it is less costly to use the alternative system. In two cases, the costs were not available for analysis.

The companies that made the conversion away from PERC vapor degreasing serve as examples for other companies in California and the U.S. The project demonstrates that small plating shops that process parts made of various substrates that are contaminated with oil, buffing compound and non-destructive fluids can make a successful and cost effective conversion to safer alternatives.