Converting to an Aqueous Cleaning System

A profile of several major companies that have converted solvent degreasing equipment to aqueous cleaning systems . . .

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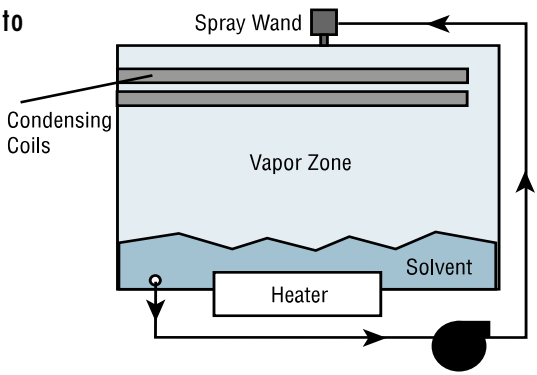
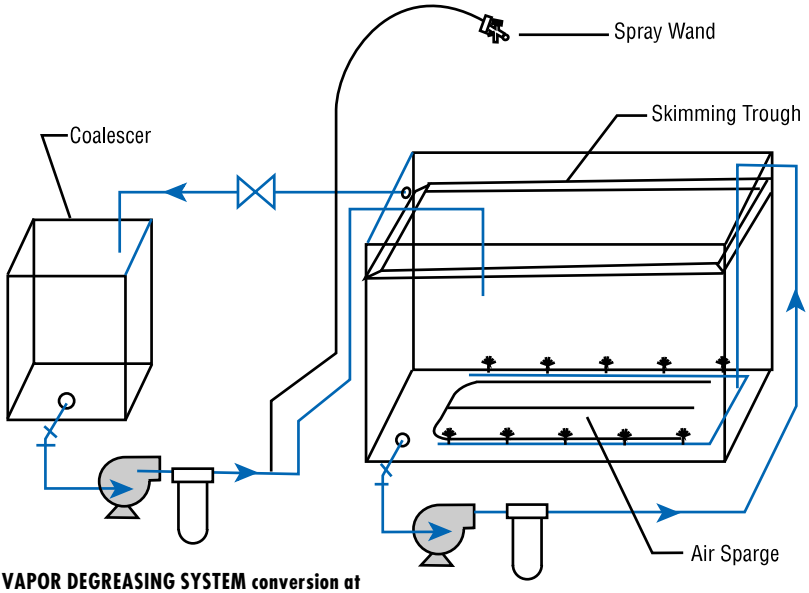
Vapor degreasing equipment is designed for use with volatile organic compounds (VOCs) such as methyl chloroform (1,1,1-trichloroethane), trichlorethylene, methylene chloride or Freon®. As shown in Figure 1, the chemical is heated to boiling to form vapors; the cold part is then exposed to these hot vapors. The hot vapors condense on the cold part, dissolve oily soils and flush them from the part. Cleaning action continues until the part warms up and condensation stops. This condensation action takes approximately 10 min, after which the part is removed clean and dry.

These hydrocarbon solvents are especially effective on organic soils such as petroleum-based cutting oils, grease and wax. They are less effective on inorganic soils such as finger prints and water-soluble salts. Particulate soils such as metal chips and fines are frequently removed manually using an attached spray wand.

However, the phase-out of CFCs and other VOCs is stimulating the



1. TRADITIONAL Vapor Degreaser



2. VAPOR DEGREASING SYSTEM conversion at Beech Aircraft Co.

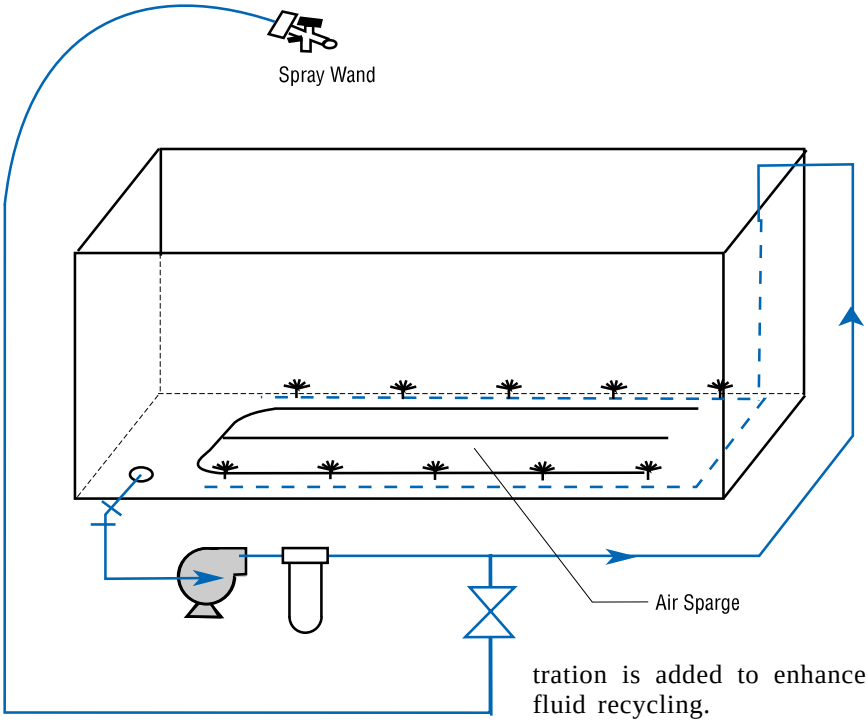
development of aqueous replacement cleaners. These new cleaners are aqueous solutions containing water conditioners, varying amounts of alkalinity builders and a careful selection of organic surfactants that produce the desired foaming, wetting and detergent action. Since these aqueous cleaners are not volatile, cleaning cannot take place in a vapor phase; chemical exposure takes place via immersion, spray or hand-wipe methods.

Aqueous cleaners remove both organic and inorganic soils in several ways: solubilizing the soil; chemically reacting with the soil to effect saponification or chelation; lifting the soil through surface action or detergency; and/or using mechanical action to displace the soil.

Often a combination of methods is used in aqueous cleaning. The equipment used and the mechanics involved can vary significantly as aqueous technology evolves.

Equipment Needs. Keeping health, safety and environmental issues in mind, the end-user must select a product that will remove most soils at a concentration, temperature and time frame compatible with production needs. He must also select equipment that will maximize cleaning while staying within budget.

To minimize capital expenditures, many end-users have designed ways to modify existing equipment to meet the requirements of aqueous technology. The chemical tank is converted to an immersion bath. Metal banding can be used if necessary to reinforce



3. VAPOR DEGREASER at General Electric

a light-gauge tank, where the pressures of increased fluid volume are a concern. This usually pertains only to very large or deep tanks.

Agitation is necessary in an aqueous cleaning system. Fluid recirculation, air sparging, mixer agitation and/or ultrasonics can be used for agitation. Frequently, an existing spray wand is retained for hand detailing if needed.

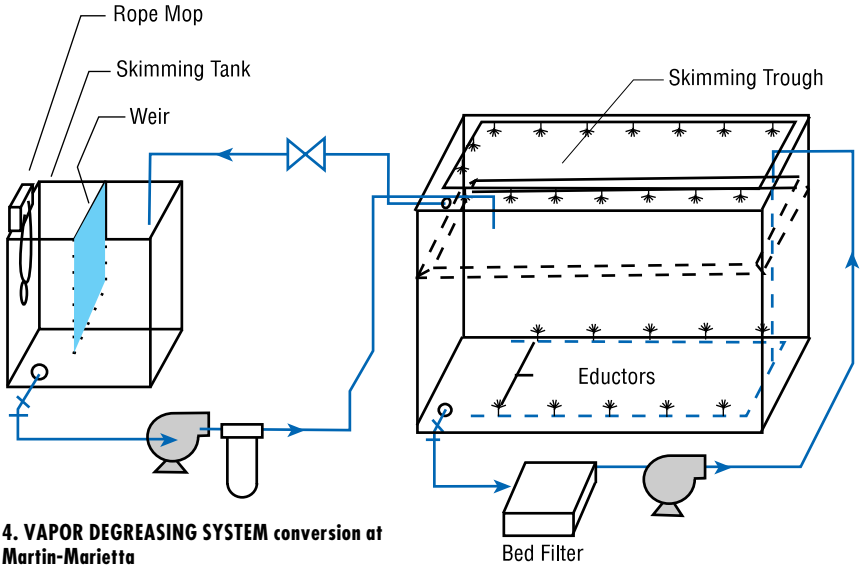
Filters, skimmers, separate skimming tanks, fluid overflow, coalescers and/or vacuuming systems are often added to remove contaminants from the cleaner. Occasionally microfiltration is added to enhance fluid recycling.

If needed, rinsing stations are added to the line. Sometimes a spray wand is used to rinse parts as they exit the wash tank; other times a fine spray rinse is added directly over the tank or a separate rinse stage.

A forced-air knife can be used to drive off excess water and facilitate drying.

Companies that Converted Equipment

Beech Aircraft Co., Wichita, Kansas, manufactures commercial aircraft components. The company converted to aqueous technology in 1993, replacing 1,1,1-trichloroethane. Multi-metals are involved, including aluminum alloys and chromium-con-



4. VAPOR DEGREASING SYSTEM conversion at Martin-Marietta

version-coated cadmium plate. A broad spectrum of oily-type soils and shop dirts are removed.

Several small vapor degreasers were converted to immersion tanks. When attempting to convert the large unit, they found that it had too many leaks and was not salvageable. Instead, they removed the unit and installed a large 304 stainless steel tank to fit into the same space.

As shown in Fig. 2, this tank measures 768 cu ft and holds 6,000 gal of aqueous cleaner. Steam heat is applied through external heat exchangers to maintain the cleaning bath at 150-160F.

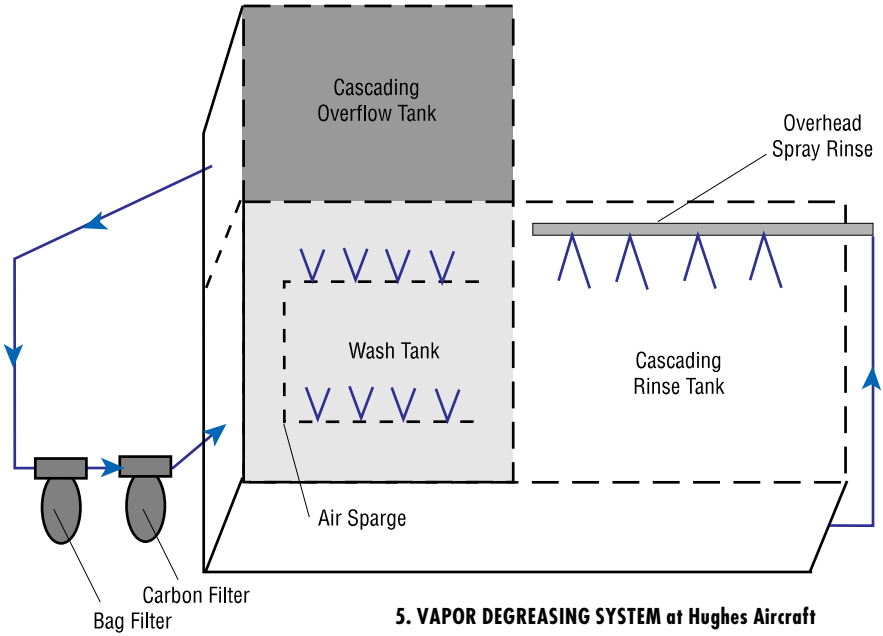
Air sparging is used for agitation. A spray wand is available for hand detailing. Two 100-gpm pumps recirculate solution. A third pump has been added to the spray wand for increased pressure.

The air sparger uses two to three psi compressed air. The piping is usually PVC or steel with $^1/_8$- to $^1/_4$-inch holes drilled every four to six inches. No nozzles or eductors are used.

To remove contaminants and increase bath life, the tank has been equipped with a 50-micron bag filter, an overflow trough and an oil coalescer. Rinsing is done in a separate tank.

General Electric, Evendale, Ohio, manufactures high-nickel-alloy turbine vanes and blades for aircraft engines. The primary soil is EDM oil and graphite from the electrodes.

Since 1992, this facility has converted five vapor degreasers to aque-



5. VAPOR DEGREASING SYSTEM at Hughes Aircraft

ous cleaning systems. These 304 stainless steel tanks range in size from 75 cu ft to 480 cu ft and hold 400 to 2,600 gal. The original electric heaters are used to maintain a 1,400F bath temperature.

As shown in Figure 3, agitation is accomplished by recirculating cleaner through a series of nozzles. An air sparger is also used. A spray wand is available on some units for hand detailing.

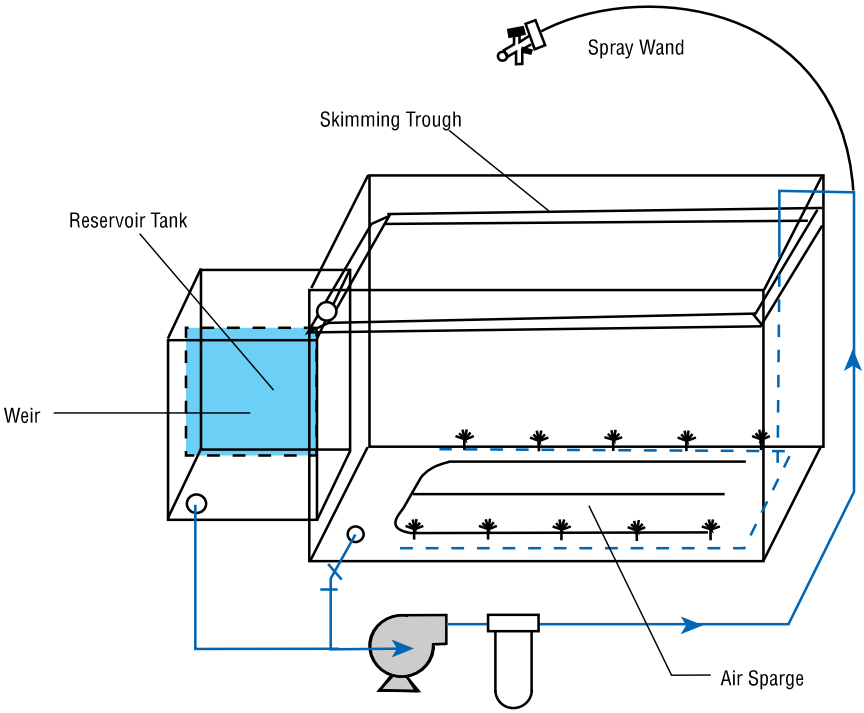
To remove contaminants, each unit is equipped with a five- to 10-micron polypropylene bag filter on the fluid recirculation line. Coalescers are available but have not been hooked up yet.

One unit is equipped with a spray wand rinse. The remaining cleaning lines use a separate rinse tank .

Average tank life of the aqueous cleaner baths in these converted vapor degreasers exceeds six months.

Martin-Marietta, Denver, Colorado, fabricates high-technology aerospace components. The company extensively studied aqueous alkaline cleaners as replacements for 1-1-1, trichloroethane. Vapor degreasers had been used to remove gross soils from metal parts prior to chemical processing, including deoxidizing, acid etching for bonding prep and chemical milling. This study also addressed equipment issues.

The study determined that conversion of two existing vapor degreasers



6. CORPUS CHRISTI ARMY DEPOT vapor degreaser system conversion

to aqueous immersion baths was both practical and economical. The one-quarter-inch 304 stainless steel, 18,000-gal tank was retrofitted as shown in Figure 4. Steam heat with the plate-and-frame heat exchanger outside the tank maintains bath temperature at 130F.

Agitation is accomplished by recirculating the cleaning fluid through the system. Two pumps, each with a flow rate of 200 gpm, are used alternately. Fluid is circulated through a series of 15 eductors on each side for increased turbulence. In-line pressure is maintained at 25 to 40 psi with a maximum of 60 psi.

A bed filter with 50-100 micron paper is used to remove particulate contaminants. An overflow trough was added for constant skimming of floating contaminants. A separate saddle tank is used as a skimming tank, and a rope mop is used to pull the oils out of the bath. The pumps are shut down four hours daily to further enhance separation and removal of contaminants.

To facilitate rinsing and replace water volume lost due to evaporation, a water spray was added over the tank.

A second, smaller vapor degreaser tank has also been retrofitted and is plumbed to the larger unit.

The company is still using the initial charge of aqueous cleaner; bath life to date is more than three years.

Hughes Aircraft, La Grange, Georgia, manufactures missile components. It has converted a vapor degreaser to an aqueous system. As shown in Figure 5, this 304 stainless steel, 85-gal-capacity unit is equipped with three separate tanks: a wash tank with a fluid capacity of approximately 30 gal where 150F cleaner is maintained at 10 pct; an over-tank spray rinse along with a cascading rinse with cleaner concentration at two pct for rust control; and an oil separation tank behind the wash tank where floating tramp oils are overflowed from the wash stage and then removed via use of bag and carbon filters.

Electric heat is used and agitation is accomplished with air spargers. The ultrasonic transducers have been disconnected.

Corpus Christi Army Depot, Corpus Christi, Texas, is a military facility that has acquired numerous agitating, high-pressure turntable and ultrasonic washers (with costs ranging from $14,000 to $75,000) for use with aqueous technology. These will be used to clean a variety of missile components.

An existing vapor degreaser has also been converted to an 864-gal aqueous immersion cleaning system. Materials cost for the conversion was $3,054 and labor cost was $2,000, for a total expenditure of just over $5,000.

As shown in Figure 6, agitation is accomplished with recirculation using three-quarter-inch eductors spaced approximately two-ft apart and angled upward 45 degrees. A pump capacity of 29 gpm turns the bath over every 15 min.

Fifty- to 100-micron bag filters are used to remove particulates and a separate reservoir tank is used to collect tramp oils. A skimmer is used to remove the tramp oils from the reservoir tank.

An overhead spray system rinses parts. Wide-patterned spray nozzles are spaced six inches apart and manually controlled.

Martin-Marietta, Beech Aircraft Co., General Electric, and Hughes report comparable or better cleaning using an aqueous cleaner in conjunction with modified equipment. In all cases, the aqueous cleaner bath has proven to be more economical than the previous process. Bath life has been extended and waste generation has been reduced. Toxic chemical releases have been reduced as much as 90 pct.

As reported by Martin-Marietta, the cost of converting its existing vapor degreasing equipment was approximately one-third that of a new state-of-the-art vapor degreaser. The modifications were also custom designed to meet the cleaning requirements of the user. Corpus Christi Army Depot was able to retrofit its unit for just over $5,000, approximately one-third the cost of new

cleaning lines in other areas of the facility.

Each of these customers has successfully incorporated aqueous cleaning technology to reduce or eliminate CFC consumption. Using existing equipment reduced the need for major capital expenditures. As seen in these examples, compliance need not be cost prohibitive. **PF**

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