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Alternative Processes to Methylene Chloride

Ten plus years later: a review of progress to date...

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In May 1985, the US Air Force at Hill AFB near Ogden, Utah, and Republic Airlines in Atlanta, Georgia, began production dry-paint stripping of F-4 Phantom and DC-9 airframes. Thus began a revolution in aircraft maintenance. In one decade, non-chemical stripping has taken over a majority of US military airframe and component stripping, civilian helicopter airframe and component stripping and airline component stripping.

Why eliminate chemicals? Indeed, the question is why not? Eliminating chemicals allows one to do the following:

- Eliminate water and its treatment as a consideration in the stripping process;
- Eliminate worker exposure to chemicals;
- Eliminate air pollution, emit zero Hazardous Air Pollutants (HAPS) and VOC's;
- Eliminate water pollution;
- Eliminate potential airframe damage from chemicals;
- Eliminate fire danger from stripping airframes with flammable liquid;
- Generate zero hazardous waste by recycling dry media;
- Strip thick paint films almost as easily as thin films;
- Strip paint from composite surfaces with the same process used for metals;
- Obtain an excellent paint job with improved paint adhesion; and
- Reduce cost and flow time.

The benefits of dry stripping are numerous. In addition to the items above, three more benefits include: 1) An increasing number of components will be manufactured from composites, which cannot be chemically stripped; 2) Water quality regulations will intensify scrutiny of chemical stripping; and 3) Dry starch media strips high-solids coatings without a problem.

With increasing pressure from regulatory agencies, chemical suppliers are offering compliant, green and environmentally acceptable paint strippers. However, the fact that a chemical is not yet listed by regulatory authorities often means that chemical is not well known to regulators.

Methylene Chloride is already dead. Six years ago, methylene chloride (MC), the main ingredient in conventional paint strippers, was "environmentally acceptable". Until 1990 MC was accepted by California's SCAQMD (South Coast Air Quality Management District) because MC is not a VOC. However, in 1990 it was listed as a toxic air contaminant that caused cancer and damage to heart, liver, lungs and the central nervous system. MC is also listed as a HAP by EPA in Title III of the Clean Air Act Amendments of 1990.

Use of MC has diminished sharply worldwide, and one major supplier of chemical paint stripper declared at the June 1994 Paris meeting of ISO/TC20/WG8 Paint Stripping Task Force that there will be no significant market remaining for MC. Acceptable one day, regulated the next.

Formic Acid. For a brief period, formic acid was hailed as a leading environmentally acceptable substitute for MC. But in early 1994, formic acid was placed on the California Hazardous Substance List and the Federal OSHA Table Z-1 Air Contaminants List. Acceptable one day, regulated the next. Note that acid stripping damages high-strength steel and magnesium. Its use requires extraordinary care. It is considered dangerous by many aircraft maintenance professionals.

Benzyl Alcohol. On February 12, 1991, at the *International Conference on Reducing Risk in Paint Stripping*, Washington, DC, benzyl alcohol was criticized as flammable, volatile and not effective by three US agencies: Occupational Safety and Health Administration (OSHA), Environmental Protection Agency (EPA) and Consumer Product Safety Commission (CPSP). Additionally, it was stated there is insufficient long-term data to confirm the chemical is safe.

In 1992 and 1993, the USAF at Tinker AFB, Oklahoma, investigated the feasibility of benzyl alcohol for paint stripping. USAF data were summarized, presented to the SCAQMD for

Continued on page three

Continued from page one

evaluation, and then presented at the US Department of Defense/ Industry Advanced Coating Removal Conference, May 25-27, 1993, in Phoenix, Arizona. An operator considering a benzyl alcohol stripping operation faced the alternative of spending approximately $3,000,000 for a vapor recovery system or purchasing VOC emission offsets at a minimum cost of $18,750,000.[1]

It is claimed that benzyl alcohol's toxicity is very low, as evidenced by the fact that it is used in cosmetics. No mention is made that until only a few years ago methylene chloride was widely used as propellant in such products as hair spray. Acceptable one day, banned the next.

Depending on the benzyl alcohol stripper formulation, there is potential for harmful corrosion of metals if not properly inhibited. A major aircraft manufacturer stated that more airframe damage is caused by improper use and handling of chemical strippers than any other single source of corrosion.

A British Airways Concorde experienced chemical-stripper (type not stated) induced structural failure of a rudder during a London to New York flight March 21, 1992.[2]

One major airline informed the IATA Paint Stripping Task Force, now ISO Technical Committee 29, Working Group 8, that an environmentally acceptable benzyl alcohol stripper was ineffective on aircraft with more than one coat of paint. Single coat aircraft with stripes may have seven to ten mils of paint in striped areas, and some strippers have difficulty removing the paint or they take a long time to work.

Operators electing to live with environmentally acceptable strippers will find an enormous reduction in paint stripping performance from the toxic methylene chloride. This further widens the advantage for non-chemical processes.

Following is data from a McGean-Rohco presentation on May 19, 1994, at the US Department of Defense Advance Coating Removal Conference, New Orleans, Louisiana. It compares performance of traditional MC strippers to non-MC benzyl alcohol products.

Productivity will suffer when converting from MC to acceptable strippers. With dry media stripping, productivity far exceeds the non-MC stripper, regardless of paint thickness, and can generate zero hazardous waste, VOCs and HAPs. See Table I below.

America West Airlines. America West Airlines does third-party work, and up to 1994 was willing to strip customer aircraft with dry media or with acid chemicals prior to repainting. Customers were charged less for dry media work vs. chemical, per Mr. Jerald Gelner, manager of Aircraft Maintenance Support.

The following 1993 comparative data was supplied by America West Airlines:

- Acid strip and paint:
  Man-hours: 650 Material and disposal cost: $9,600
- Dry media strip and paint:
  Man-hours: 700 Material and disposal cost: $4,950

(Media recycling not available in 1993.)

Some claim that the dry stripping process requires a separate, single-purpose facility, because dust from dry stripping may contaminate fresh paint. This is inaccurate. Smooth walls, ceiling and floor make clean up easy prior to painting.

Other Non-Chemical Processes. Other processes vying for attention in the non-chemical market are laser stripping, crystalline ice blasting, carbon dioxide pellet blasting, sodium bicarbonate and medium-pressure water blasting, flashlamp, flashblast and high-pressure water stripping.

Laser. Laser stripping has not developed into a viable process for paint removal from aircraft. It is still in a development stage, and the process has not been proven on actual aircraft (military or commercial). Laser stripping has been approved by OO-ALC for F-4 and F-16 radomes.

Crystalline Ice Blast. Crystalline ice (water) blasting is unable to remove aerospace coatings.

Carbon Dioxide Pellet Blast. Carbon dioxide pellet (dry ice) blasting by itself has proven ineffective for removing paint systems from aircraft. Development trends now center on its use in conjunction with either chemical paint softeners or flashlamps.

Sodium-Bicarbonate and Medium-Pressure Water Blast. Concerns have been raised about sodium bicarbonate slurry stripping and corrosion of aluminum aircraft structures, excessive clad removal, high stress saturation in aluminum substrates and damage to fiberglass (but not graphite epoxy).

Warner Robins ALC in Georgia uses this process on airframes. One million dollars was invested in a seven-nozzle system.

Flashlamp and Flashblast. Flashlamp alone failed to prove viable for effectively removing aerospace coatings, as did carbon dioxide. The two were combined into Flashblast.

Flashblast coating removal process rapidly heats a thin layer of paint with a pulsed flashlamp. In this process, the paint is either partially pyrolyzed or completely pyrolyzed and removed by ablation. The pyrolysis process involves the breaking of chemical

Table 1 - Stripping Time in Minutes

Test Panel	Alkaline MC	Alkaline non-MC	Acid MC	Acid non-MC
1	7 - 10	120 - 180	2	105
2	6	75 - 95	2	60 - 100
3	2	45	1	35

paint bonds, resulting in reduced adhesion to the substrate. The extent of the bond breaking process varies.

In the pyrolysis process, paint remains on the surface and must be removed by secondary CO_2 pellet blasting process. The pyrolysis/ablation process goes one step further to where the paint molecules evaporate from the surface (ablate). The pyrolysis/CO_2 process is preferable for delicate substrates and is the one most experimented with. Vaporization temperatures can vary from 200C for aliphatic paint compounds up to 500C for the thermally stable aromatic paint compounds. Thermal release coatings, designed to be released from the substrate when triggered by a pulsed light device (flashlamp or laser), may increase stripping efficiency from the current 35 to 50 pct.

For all the reasons discussed, dry media stripping is the present and the future. The remaining major market for paint stripping chemicals is airline and general aviation airframes, but given recent lifetime approval for dry media stripping with starch media by Boeing, airlines may soon accept this new technology for airframes.

REFERENCES

1. USAF sources state a C-141 aircraft (a medium size transport) will require approximately 1,600 gallons (12,500 lbs) of benzyl alcohol to effectively strip its coating. If this chemical were to be applied over two 24-hour periods, it would produce 6,250 pounds of VOC per day, which by law must be controlled or offset. The cost of purchasing offsets in 1993 is $3,000 - $5,000 per pound, per day of VOCs. This means a cost of $18,750,000 to $31,000,000 for permits. The other alternative is to install a vapor recovery system. Estimated cost for such a system is in excess of $3,000,000. (Note: In 1995 the cost of offsets is $1,000, therefore the permit cost would be $6,250,000.)
2. The following quotations from the press appeared March-May 1992, attributing Concorde rudder failure to chemical stripping. A British Airways Concorde rudder failed during a London to New York flight March 21, 1992. The aircraft made an emergency landing at Kennedy International Airport where it was learned that a five-by-10ft section ripped free of the upper rudder. (*Aviation Week & Space Technology*, March 30, 1992). The *Times of London* reported similar incidents occurred in January, 1991, while en route to New York and in 1989, while flying between New Zealand and Australia. The *Times* said British Airways inspections found paint stripper was eroding adhesives that bond the rudder's laminated metal layers. (*San Francisco Chronicle*, March 22, 1992)

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What did you say?

The streets are safe in Philadelphia, it's only the people that make them unsafe.

—Former Philadelphia Mayor and Police Chief Frank Rizzo

It's like an alcatraz around my neck.

—Boston Mayor Menino on the shortage of city parking spaces

They're multipurpose. Not only do they put the clips on, but they take them off.

—Pratt & Whitney spokesperson explaining why the company charged the Air Force nearly $1000 for an ordinary pair of pliers

The President has kept all of the promises he intended to keep.

—Clinton aide George Stephanopolous speaking on *Larry King Live*

We're going to turn this team around 360 degrees.

—Jason Kidd upon his drafting to the Dallas Mavericks

I'm not going to have some reporters pawing through our papers. We are the president.

—Hillary Clinton commenting on the release of subpoenaed documents

When more and more people are thrown out of work, unemployment results.

—Former U.S. President Calvin Coolidge