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Project Summary

Bicarbonate of Soda Blasting Technology for Aircraft Wheel Depainting

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This evaluation addressed product quality, waste reduction/pollution prevention, and economics in replacing chemical solvent strippers with a bicarbonate of soda blasting technology for removal of paint from aircraft wheels. The evaluation was conducted in the Paint Stripping Shop at Ellington Field, National Aeronautics and Space Administration/Lyndon B. Johnson Space Center (NASA/JSC), in Houston, TX. The evaluation used limited new test data, information from previous tests by NASA/JSC as part of their program to adopt this process as a nondestructive inspection of aircraft wheels, cost estimates for the chemical stripping and bicarbonate blasting based on facility records. Because the paint being removed contained hazardous metal constituents, the liquid and solid wastes as well as the cloud of spray generated were evaluated for metal concentrations present and their leachability. Analyses for Cd, Cr, Cu, Pb, Mn, Ni, and Zn were made as well as total metals concentrations, pH, total suspended solids, and oil and grease. The blasting technology is effective for removing paint from aircraft wheels without significant damage to the anodized surface under the paint. Engineering improvements that avoid the need of respirators, reduce noise levels, and minimize water use could enhance the application. Applications that do not contain hazardous materials in the coating being removed could be significantly more lucrative. In comparison to solvent depainting, this technology reduced the amount of hazardous waste generated as well as cost savings due to reduced operating and disposal costs, resulting in a 15% return on investment in about 4 years.

This Project Summary was developed by the EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The objective of the U.S. EPA's Waste Reduction Innovative Technology Evaluation (WRITE) Program was to evaluate, in a typical work place environment, examples of prototype technologies with the potential for reducing wastes at the source or for preventing pollution. The goal of this study was to evaluate a bicarbonate of soda depainting technology that uses sodium bicarbonate-based blasting media to replace chemical solvents, such as trichloroethylene (TCE), for stripping paints from aircraft wheels. Specifically, this study evaluated (1) the effectiveness of this technology, (2) the waste reduction and pollution prevention potential, and (3) the economics.

Bicarbonate of soda blasting is a relatively new process that is commercially available. Compressed air delivers sodium bicarbonate media from a pressure pot to a nozzle where the media mix with a stream of water. The media/water mixture impacts the coated surface and removes old coatings from the substrate. The wa-

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Table 1. *Oil and Grease, TSS, pH, and Metal Contaminants in Wastewater Collected from the Vat*

Parameter	Mean Concentration	Local[a] Discharge Limit
Oil and grease (mg/L)	49.1	200
TSS (mg/L)	253	365
pH	8.367	6-10
Cd[b] (mg/L)	0.033	0.2
Cr[b] (mg/L)	8.0890	5.0
Cu[b] (mg/L)	1.240	2.0
Pb[b] (mg/L)	1.430	1.5
Mn[b] (mg/L)	0.022	3.0
Ni[b] (mg/L)	0.006	3.0
Zn[b] (mg/L)	5.990	6.0

[a] *Maximum allowable limits for grab samples. Industrial Waste Permit No. 1030, City of Houston, Texas, March 10, 1989.*
[b] *Total metal.*

Table 2. *Total and Leachable Metals in Solid Waste that Settled to the Vat Bottom*

	Total Metal (mg/kg)		Leachable Metal (mg/L)	
Metal	Field Blank	Mean Concentration	Field Blank	Mean Concentration
Cd	0.50	2.73	0.0050	0.0303
Cr	0.69	146.07	0.0127	2.2006
Cu	1.30	32.97	0.0036	0.3927
Pb	1.70	70.87	0.0190	0.5397
Mn	0.19	2.77	0.0056	0.0023
Ni	0.50	0.72	0.0050	0.0017
Zn	1.90	281.33	0.0560	4.2840

Data have been corrected with field blank.

operator was measured in terms of airborne metal concentrations. Noise levels were measured on a sound-level meter and a dosimeter.

Air emissions were measured in the breathing zone of the operator and analyzed for Cd, Cr, Cu, Pb, and Zn. The cloud of mist created around the blasting activity was maintained within the work area and removed by a ventilation system consisting of an exhaust hood and a rotoclone dust separator.

The results of the airborne metal exposure study indicated that 8 hr time-weighted average (TWA) exposure to the airborne metals were below specified OSHA and American Conference of Governmental Industrial Hygienists (ACGIH) limits. Sound levels measured periodically in the operator's hearing zone during the two blasting sessions ranged from 76.8 decibels (dB) on the "A"-weighted scale (dBA) to 120.0 dBA. Dosimetry samples integrated cumulative noise exposures of 106.6 and 101.7 dBA for the first and the second blasting session, respectively. These samples were based on 8-hr TWA calculated from dosimetry results recorded during the period sampled. If the actual work period were increased to a full 8 hr, the projected 8-hr TWAs would be 121.3 for the first test and 115.9 dBA for the second test. A peak level of 146 dBA, the maximum level the dosimeter is capable of measuring, was recorded during both periods sampled.

Economic Evaluation

Cost comparisons were made for bicarbonate blasting vs. chemical stripping. Blasting times to strip each wheel were measured during the test. NASA/JSC historical data were used to determine chemical stripping times. The capital investment, operating costs, and payback period were calculated according to the worksheets provided in the U.S. EPA Waste Minimization Opportunity Assessment Manual. The results of the economic analysis indicated that a return on investment (ROI) greater than 15% (which is the cost of capital) could be obtained in 4 years, or that the payback period for NASA/JSC would be 4 years.

Conclusions/Recommendations

Based primarily on two depainting cycles and a previous NASA/JSC study, the bicarbonate of soda blasting evaluation concludes that the blasting technology can effectively strip paint from aircraft wheels. The anodized surface damage, as a result of blasting, is considered minimal.

The blasting technology substantially reduced the number of man-hours required for paint stripping in comparison to chemical stripping. The time saved was more than 95%. The liquid waste accumulated in the vat contained higher-than-discharge-limit Cr and could not be disposed of to the POTW. The quantity to be shipped away as hazardous waste was about 7.5 gal/T-38 aircraft wheel. The solid waste in the vat contained paint chips and debris, most of which was insoluble under the TCLP conditions. The wastewater in the rotoclone separator could be sewered without treatment. Although convenient for this application and within the existing local limits, the source reduction of this waste as well as reuse/recycling should be investigated in greater depth.

Although the exhaust ventilation system kept the heavy metal concentrations in the workspace below OSHA and NASA limits, the opportunities for source reduction to minimize rotoclone wastewater should be explored.

The operator of the blasting equipment was required to wear a full-face air-purifying respirator and protective clothing. Although the present test results did not make this an OSHA requirement, previous testing of this system produced chrome particulate concentrations that did. The added precautions are recommended until a better understanding of the system is developed. Improved lighting for better visibility at the work surface also is recommended.

The noise measurements indicated that, under the conditions encountered during this study, hazardous noise exposures can result. Therefore, engineering control of noise exposure should be investigated. Hearing protection devices for all personnel who operate or work in the vicinity of the operation should be provided with the present configuration. Evaluation of the hearing protectors used during the actual times worked during this study indicated that the protectors reduced exposures to below the OSHA and NASA permissible exposure limits. For compliance with the

NASA NHS/H-1845.4, work durations using the blasting equipment and the hearing protectors assigned should not exceed 5 hr in an 8-hr work shift. NHS/IH-1845.4 requires use of both plugs and muffs when exposures equal or exceed 110 dBA. NASA Environmental Health Services (EHS) also requires all personnel who routinely operate the blasting equipment to be placed in a hearing testing and evaluation program at the NASA/JSC clinic.

The blasting technology has good potential for reducing waste and consequent waste disposal costs. For the application studied, this is due primarily to changing the waste from a RCRA hazardous category to a nonhazardous category. Paint stripping shops may find this technology beneficial, especially as more stringent federal and local regulations are implemented for the disposal of the toxic solvent-contaminated wastes. When no hazardous contaminants are present in the paint, elimination of all hazardous waste may be possible.

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***Ivars Licis** is the EPA Project Officer (see below).*
The complete report, entitled "Bicarbonate of Soda Blasting Technology for Aircraft Wheel Depainting," (Order No. PB94-193323; Cost: $19.50, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
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ter used dissipates the heat generated by the abrasive process, aids the paint removal by hydraulic action, and reduces the amount of dust in the air. As another convenience, the workers do not need to prewash or mask the surface. The dust, unlike that of plastic media, is not an explosive hazard, nor is sodium bicarbonate toxic in this form. The airborne particulates generated from the stripping operation, however, can contain toxic elements from the paint being removed.

The effectiveness of bicarbonate of soda blasting depends on optimizing a number of operating parameters including nozzle pressure, standoff distance, angle of impingement, media flow rate, water pressure, and traverse speed.

The present study evaluated the bicarbonate of soda blasting technology, ARMEX®/ACCUSTRIP™ (see Figure 1)*, marketed by the CDS Group (Houston, Texas). The evaluation was conducted at NASA/JSC's Ellington Field, which maintains and repairs a fleet of 37 aircraft and has adopted this method for inspecting aircraft wheels.

* Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Product Quality Evaluation

Although the quality of the work for this bicarbonate blasting system was based on paint removal without damage to the wheel surface that either modified metal performance or masked any cracks during inspection, an additional issue was the anodized layer below the paint.

The previous method included scrubbing and scraping that produced significant damage to the anodized layer. As an added feature of the bicarbonate blasting technology, the effect on the anodized layer was determined by inspection of the condition of the anodized layer for two cycles of depainting.

A special test method was developed to qualitatively assess the anodized surface damage resulting from bicarbonate blasting. The method required visual inspection of the same wheel pieces after they were first stripped and after they were repainted and restripped under the same stripping conditions.

The results of the inspection suggested minimal, if any, damage as a result of bicarbonate blasting. Most damage observed occurred in the areas around the slots, ridges, and bead rim and was attributed to mechanical wear caused by tool contact and wear and tear.

This study did not evaluate the effects of blasting on metal substrate damage and crack closure because the literature has already established the negligible damage and crack closure caused by the blasting.

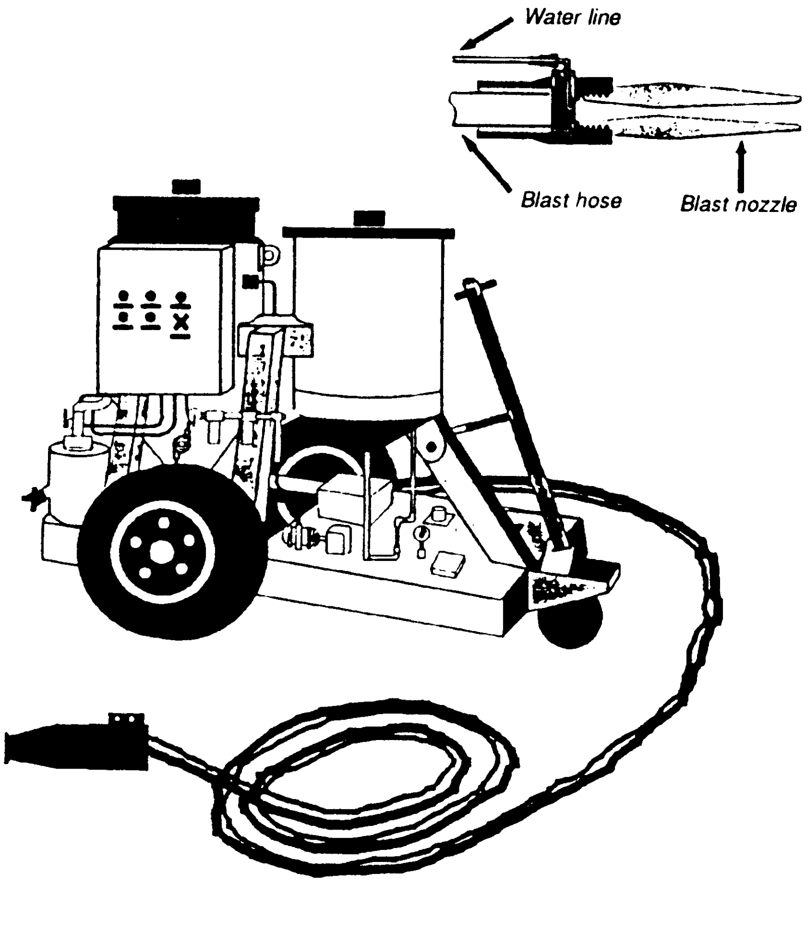

Figure 1. ACCUSTRIP SYSTEM™ with wet blast head.

Waste Reduction and Pollution Prevention Potential Evaluation

The waste reduction was measured in terms of volume reduction and pollutant reduction. Volume reduction addressed the gross wastestream such as liquid and solid wastes in the vat and wastewater in the rotoclone separator. Pollutant reduction involved individual pollutants, such as oil and grease, total suspended solids (TSS), and heavy metals, in the gross wastestream. Pollutant reduction addressed the specific hazards of individual pollutants.

About 30 gal of wastewater was generated and collected in a vat during each of the two blasting sessions. The mean values for the measured pollutants are presented in Table 1. The Cr concentration did not meet the local discharge limits, so the wastewater could not be disposed of to the Publicly Owned Treatment Works (POTW).

About 8 gal of solid waste settled to the bottom of the vat. Metal concentrations measured are presented in Table 2. Only a very small fraction of these metals was leachable under the Toxicity Characteristic Leaching Procedure (TCLP) conditions (see Table 2). TCLP requires the waste to meet limits of 1.0 mg/L Cd, 5.0 mg/L Cr, and 5.0 mg/L Pb. No regulations have been set for Cu, Mn, Ni, and Zn. The wastewater in the rotoclone separator contained less than detection limit of TSS and a very small amount of heavy metals, ranging from 0.005 mg/L of Cd to 0.39 mg/L of Zn. For the particular case tested, the wastewater could be sewered without treatment.

Other considerations were hazards that the stripping technology might pose to workers. These included toxic airborne particulates and unsafe noise exposures. Air quality in the vicinity of the blasting