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Project Summary

Pollution Prevention Demonstration and Evaluation of Paint Application Equipment and Alternatives to Methylene Chloride and Methyl Ethyl Ketone

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The report gives results of demonstrations of technologies to prevent or control emissions of hazardous air pollutants (HAPs) and volatile organic compounds (VOCs) at the Marine Corps Logistics Base in Albany, GA. The processes with high solvent usage selected for demonstration were: (1) paint stripping using methylene chloride, (2) cleaning paint equipment with methyl ethyl ketone (MEK), and (3) applying paint by spraying solventborne coatings. For Demonstration (1) N-methyl pyrrolidone (NMP) was chosen to replace methylene chloride because it effectively removed Chemical Agent Resistant Coatings (CARCs) in laboratory tests, is nonflammable, and is not classified as a HAP by EPA. The annualized costs for NMP stripping are lower than for methylene chloride stripping, but implementation requires high capital investment. This substitution will lower HAPS 11% from 1992 levels. For Demonstration (2), a blend of 40% propylene carbonate and 60% benzyl alcohol (PC/BA), by weight, was chosen to replace MEK. This choice was based on the results of laboratory screening, materials compatibility, and paint removal efficiency tests. No capital investment was required. Based on the demonstration, PC/BA cleans green CARCs from the pumps as well as MEK, and cleans epoxy primers better than MEK. Advantages of using PC/BA are lower vapor pressure, reduced solvent use and labor time for cleaning, and classification of the hazardous waste as non-regulated by the Resource Conservation Recovery Act . The disadvantage is a higher cost for the PC/BA blend than for MEK. This substitution will lower emissions from HAPs 21% from 1992 levels. The objective of Demonstration (3) was to determine if the amount of paint applied to a vehicle could be decreased by providing the painters with a real-time readout of the amount of paint they were using. A system was installed that monitored paint use gravimetrically by continuously measuring the weight of the pot from which the paint was pumped to the spray guns. The system worked reliably, and paint use measurements were obtained on 19 vehicles. Results showed that, for identical vehicles, differences up to 30% in the amount of paint used occurred, indicating that potential exists for significant reductions. No actual reductions were shown during the demonstration.

This Project Summary was developed by EPA's National Risk Management Research Laboratory's Air Pollution Prevention and Control Division, Research Triangle Park, NC, 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).

Overview

The Clean Air Act Amendments of 1990 (CAAA) and Executive Order 12856 mandate that military depot activities reduce air emissions. Specifically, the CAAA requires a reduction in hazardous air pollutant (HAP) emissions for "major" sources and Executive Order 12856 requires that

military installations reduce HAP emissions by 50% of their 1992 levels. Accordingly, the U.S. EPA and the U.S. Marine Corps Logistics Base (MCLB), Albany, GA, with sponsorship from the Strategic Environmental Research and Development Program (SERDP), conducted an initial evaluation and subsequent demonstration of pollution prevention (P2) technologies for reduction of HAPs. Processes and related high solvent usage sources were identified and P2 recommendations were made. EPA and the host facility MCLB performed the research. Research Triangle Institute personnel provided contractor support.

MCLB carries out maintenance activities on a wide variety of equipment from small arms to tanks, trucks, and other vehicles. Much of the maintenance on the vehicles requires removing existing paint prior to repairing procedures and applying new paint once the maintenance has been performed. The processes for paint stripping, repainting, and cleaning of paint equipment release significant amounts of HAPs.

The purpose of this research was to demonstrate viability of P2 technologies on a full production scale at the MCLB. Three processes with high solvent usage were selected for demonstration:

- stripping paint by immersion in methylene chloride,
- cleaning paint equipment with methyl ethyl ketone (MEK), and
- applying paint by spraying solventborne coatings.

First Demonstration

For the first demonstration, n-methyl pyrrolidone (NMP) was selected as the alternative to methylene chloride for stripping cured coatings from metal parts. NMP was chosen during a scoping study for the facility demonstration because it effectively removed Chemical Agent Resistant Coatings (CARC) in laboratory tests, is nonflammable, and is considered by the EPA not to be a HAP. Two drawbacks are that the NMP must be heated to be effective, and NMP is subject to reporting under the Superfund Amendments and Reauthorization Act (SARA).

The first step in preparing for the demonstration was to retrofit an existing tank on the Base. The stripping tank required plumbing to heat the bath with steam, and a recirculating pump to provide enough agitation to ensure uniform temperature throughout the bath. An adjacent rinse tank required a pump to draw recycled NMP for rinsing stripped parts. Finally, a vacuum distillation unit was installed to reclaim used solvent from the stripping bath and provide recycled NMP for rinsing. After the tank retrofit was completed, the heating and recirculating systems were tested using water. The stripping tank was then emptied and filled with an initial charge of 38 55-gal (208 L) barrels of technical grade NMP. An additional ten barrels was added to the stripping tank later.

The NMP, when heated to 150 ±10˚F (66 ±6˚C), was able to remove multiple layers of CARC and strip parts to the base metal within 3-4 hours. The heated NMP was able to successfully remove Plastisol®, a plastic coating, from battery tie-down brackets. These parts were previously stripped in a hot alkaline bath, followed by scraping and blasting to remove the coating. Also, NMP was able to soften epoxy-based topcoats, but removal usually required overnight soaking.

Second Demonstration

For the second demonstration, a blend of propylene carbonate and benzyl alcohol was chosen to replace methyl ethyl ketone (MEK) for cleaning the paint application equipment (pumps, hoses, and guns). This demonstration consisted of a preliminary screening to identify several possible solvent alternatives, testing to select the most effective cleaners, and full-scale demonstration at the MCLB.

Sixty-five alternative cleaners were tested in preliminary screening for their effect on fully cured single- and plural-component CARCs and an epoxy primer. From these 65 alternatives, 5 were selected for further testing. The cleaners were tested for their compatibility with materials that would contact the paints and the cleaner. No measurable weight gain or loss, pitting, or other signs of corrosion were found among any of the five cleaners or MEK and the four metals tested: aluminum, stainless steel, nickel, and brass. Material compatibility was also tested with four plastics (Teflon®, acetal, Nylon®, and Delrin®). Results showed slight weight changes in all coupons tested with the five cleaners and with MEK. Of the five cleaners, the two showing the least overall weight gain or loss for the four plastics were evaluated for paint removal efficiency in a laboratory setting. Overall, both of the cleaners were comparable to MEK for CARCs, and both cleaners were better than MEK at removing white primer.

Based on the test results, the blend of 40% propylene carbonate and 60% benzyl alcohol (PC/BA) by weight was selected by the research team for demonstration. Subsequently, four barrels of this cleaner were shipped to the base, and the cleaner was used as a direct replacement for MEK. No capital investment was required.

Use of the PC/BA cleaner was monitored by weighing the amount of cleaner flushed through the system. Amounts of cleaner used for the initial prewash, the final wash, and the filter wash were recorded. Date and time at start and finish of each step were also recorded.

Results showed that PC/BA cleans green CARC from the pumps as well as MEK, and cleans epoxy primers from the pumps better than MEK. Advantages of using PC/BA are lowered inhalation hazard to workers, and reduced cleaner usage and labor time for cleaning. Other advantages are that PC/BA is non-regulated by the source Conservation Recovery Act, and the use of PC/BA significantly decreases downtime of the primer pumps. The disadvantage is a higher cost for PC/BA than for MEK, but the higher cost may be offset by cleaner recovery and reclamation, and further waste reduction.

Third Demonstration

For the third demonstration, the objective was to determine if the amount of paint required to coat a vehicle could be reduced by providing the painters with a real-time readout of how much paint they were using. The study began with the design, specification, purchase, and installation of a paint monitoring system in a paint booth. The system monitored paint use gravimetrically by continuously measuring the weight of the 5-gal (18.9 L) pot that held the paint to be pumped to the spray guns. The system included programmable digital scales, a small printer, and large remote displays visible from within the paint booth. Displays continuously showed the cumulative amount of paint used.

The initial portion of the test period was devoted to baseline or control measurements taken “without feedback” of paint consumption. During this period, the displays were not visible to the painters. After sufficient baseline information had been gathered, the displays were installed in the paint booth and the painters were instructed in how the displays could be used to control their usage rate. “Target” levels for High Mobility Multipurpose Wheeled Vehicles (HMMWVs) and 5-ton (4.5-tonne) trucks were set based on the lowest usage during the baseline period.

The system proved to work reliably, and paint usage measurements were obtained

on nineteen vehicles: 10 HMMWVs, five 5-ton cargo trucks, and four other vehicles. Measurements show that, for one set of identical vehicles (the 10 HMMWVs), paint consumption differed by up to 30% between the highest and lowest vehicles. This indicates that a potential for significant reductions may exist. However, during the brief study period, no statistically significant decrease in paint usage was seen between the baseline (without feedback) and the experimental (with feedback) portions of the demonstration. This may be due to the brevity of the demonstration and to the presence of monitoring personnel at the paint booth during the baseline period. However, the system could still provide reductions in paint usage and other benefits when used in combination with other strategies such as mixing only the amount needed for each vehicle rather than the current practice of mixing paint in multiples of 5 gal. The system could also be used in training new employees, and in assessing the impact of equipment inspection and maintenance practices on paint consumption.

It is recommended that MCLB continue to collect paint usage data for several months to determine if measurable reductions in paint usage are realized after the staff becomes accustomed to the equipment.

The MCLB has already replaced 1,1,1-trichloroethane vapor degreasers with aqueous parts washers. This change alone will reduce emissions from HAPs by 16%. By eliminating the methylene chloride for immersion stripping, the MCLB can reduce emissions another 11%. By replacing MEK with a PC/BA blend for cleaning paint application equipment, the MCLB can reduce emissions from HAPs an additional 21%. These three changes combined result in a reduction of emissions of 48%. The MCLB plans to replace solventborne CARCs with waterborne CARCs in 1996 to achieve over 50% reduction in emissions from HAPs.

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The complete report, entitled "Pollution Prevention Demonstration and Evaluation of Paint Application Equipment and Alternatives to Methylene Chloride and Methyl Ethyl Ketone," (Order No. PB97-104632; Cost: $49.00, subject to change) will be available only from:
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