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Project Summary

Parts Washing Alternatives Study United States Coast Guard

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This study was conducted to provide guidance for the United States Coast Guard (USCG) industrial managers in choosing cost-effective parts cleaning chemicals that have minimum environmental and safety impacts. The three facilities chosen for the study were Aviation Training Center (ATC), Mobile, AL; Air Station Cape Cod (ASCC), Falmouth, MA; and Support Center NY (SCNY), Governors Island, NY. ATC and ASCC parts washing applications focused on cleaning contaminated parts from aviation operations; SCNY parts washing applications were directed at cleaning contaminated parts from seafaring vessels. The evaluation of alternative parts cleaners included the following categories: process description; environmental, safety and health (ESH) impacts; cost analysis; and material usage and emission reduction opportunities. The following parts cleaners were evaluated; Penatone 724, Bio Seven, Safety Kleen 105, and Brulin 815 GD*. All four cleaners are effective cleaners for the specific applications described in this evaluation. Penatone 724 is a non-recycled petroleum distillate that has been qualified to military specification PD 680 type II for a parts cleaner but possesses potential personnel and environmental concerns. Bio Seven is an on-site recycled aqueous parts cleaner that has minimal ESH impacts and is currently being tested to qualify to military specifications. Safety Kleen 105 is a full service recycled petroleum solvent that has also been qualified to military specification PD 680 type II but has potential long-term hazardous waste liability concerns. Brulin 815 GD is a non-recycled aqueous alkaline parts cleaner that has apparent minimal ESH impacts but must be maintained at a temperature of 140°F to 160°F for effective cleaning.

This Project Summary was developed by the U.S. 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

Four parts cleaners were chosen for the alternatives study. The cleaners were selected from three different Coast Guard facilities consisting of two aviation centers, ATC Mobile, AL, and ASCC Falmouth, MA; and one marine and ground support facility, SCNY Governors Island, NY. The different functions of the sites selected allowed for a broad study of the alternative parts cleaners.

Aviation cleaning requirements are different from those of a marine and ground support facility. Because of the complexities of an aircraft, it is necessary to divide aviation cleaning into three distinct categories. Category one includes tires and wheels of the aircraft. Category two includes engine components, and category three is general aviation equipment. A

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

cleaner must be qualified by the USCG within a specific category for aviation cleaning.

The alternatives in the study include a full-service recycled cleaner (Safety Kleen 105), an on-site recycled cleaner (Bio Seven), and two non-recycled cleaners (Penatone 724 and Brulin 815 GD). These cleaners were selected because of their high usage level and different chemical constituents. Safety Kleen 105 and Penatone 724 have been qualified by the USCG to military specification PD 680 type II for parts cleaning in all three aviation categories. Bio Seven is used to clean category two and three aviation parts and is currently being tested for qualification to military parts cleaning specifications. These cleaners are classified by category and application in Table 1.

The detailed report presents each parts washing cleaner in a similar format to provide a consistent approach for evaluating impacts and developing comparison trends. The format is divided into two main sections: (1) a discussion and (2) worksheets. The discussion presents (1) the step-by-step procedure used in parts cleaning, (2) environmental impacts or possible health and safety risks associated with the cleaner, (3) identifiable costs associated with using the cleaner, (4) a material and emission reduction opportunity assessment, and (5) summarized conclusion of the parts cleaning process. The worksheets describe the parts cleaning activity in quantitative terms and are composed of a process description, process flow diagram, material balance, calculations used to derive numerical data, cost analysis, and material and emission reduction options for the process.

Labor cost associated with the cleaning process is not presented in this report. There were no significant deviations in the amount of effort expended on the task of cleaning the parts, therefore labor would not be a deciding factor for the selection of an alternative cleaner in this study.

A comparison of total costs among the cleaners should be avoided. The total cost for a specific cleaner will vary depending on the materials and surface area of the contaminated parts being cleaned, geographical location, and facility preferences.

Procedure

The following is a condensed version of the categories evaluated for the selected USCG parts washing alternatives:

Process Description
: Process location, summary of the operations performed, equipment, process controls, and a material balance to include products, input materials, and the waste streams affected.

ESH Impacts
: Associated regulatory requirements and impacts of using the cleaner at the facility.

Cost Analysis
: Divided into the following sections: (1) material and equipment acquisition, (2) inputs and outputs such as utilities and effluents, and (3) ESH cost-related impacts.

Material and Emission Reduction Opportunities
: Identify opportunities that offer real potential to minimize waste and reduce costs. A detailed evaluation of technical and economic feasibility is labor intensive, therefore the proposed opportunities should be screened to identify high priority opportunities.

Conclusion
: Decisions on improvement options should be based on the conclusions developed in the evaluation.

The detailed report contains an outline with worksheets for each category listed above. This procedure can be used for future evaluations on other parts washing alternatives.

Table 1. *Parts Washing Cleaners*

Chemical	***Category***	***Application***
Safety Kleen 105	*Full Service Recycle: Petroleum Distillates*	*Aviation: Categories one, two, and three*
Penatone 724	*Non-Recycle: Petroleum Distillates*	*Aviation: Categories one, two, and three*
Bio Seven	*On-Site Recycled: Aqueous - Mild*	*Aviation: Categories two and three*
Brulin 815 GD	*Non-Recycle: Aqueous - Alkaline*	*Marine and Ground Support: No restrictions*

Discussion of Results

Process Description

The contaminated parts were divided into two areas: (1) aviation operations and (2) seafaring vessels. The USCG facilities ATC and ASCC provided information regarding the cleaning of contaminated parts from aviation operations. The aviation parts cleaned were from Dauphin Helicopters (HH-65), Jayhawk Helicopters (HH-60), and Falcon Jets (HU-25). SCNY provided information regarding the cleaning of contaminated parts from seafaring vessels. The marine parts cleaned were from high endurance cutters, buoy tenders, bay class icebreakers, harbor tugs, search and rescue utility boats, and ferry boats. The parts cleaned were from periodic maintenance or routine repair operations. The contaminants that were typically removed from the parts consisted of grease, oil, dirt, and hydraulic fluid.

The ATC uses a petroleum distillate, Penatone 724, and an aqueous surfactant, Bio Seven, to clean aviation parts. Penatone 724 is currently being used in two separate parts cleaning processes: (1) an aerosol canister to spot-clean various contaminated parts and (2) the complete immersion and saturation of the contaminated part with the cleaning solvent in an open container. Approximately 80% of the Penatone 724 is used for the immersion and saturation procedure with the remaining 20% used for aerosol cleaning. The parts are typically wiped down after cleaning with a disposable hand towel or an absorbent cloth to remove traces of contaminants and solvent. The cleaned parts are allowed to air dry.

ATC has three separate parts cleaning stations using the cleaner Bio Seven. Each station contains a polyethylene parts washing tank that is designed to hold approximately 36 gal of cleaning solution, which is a 50/50 mixture of Bio Seven and potable water. The cleaning solution is heated in the holding tank to the temperature range of 96°F to 104°F and is continuously recirculated as parts are being washed. The contaminants are removed from the parts by manual brushing. The contaminants are washed away with the cleaning solution into the enclosed section of the tank. The parts cleaning process is followed by a water rinse to remove any residual cleaner and contaminants from the parts. The parts are then wiped dry.

The ASCC has three parts washing stations located in the aircraft maintenance hanger that use Safety Kleen 105. Each parts washing station has approximately 30 gal of the cleaning solvent in a holding tank located below the parts washing basin. The cleaning solvent is pumped from the holding tank, through a discharge tube, onto the part, and drains back into the holding tank. The technician removes the contaminants by holding the part under the discharge tube and scrubbing or rubbing the part with a brush or gloved hand. The contaminants drain into the holding tank along with the cleaning solution. The parts do not require any rinsing or further use of different chemicals to complete the cleaning process. The parts are typically wiped down with a disposable hand towel or an absorbent cloth to remove traces of contaminants and solvent and then allowed to air dry.

Brulin 815 GD is currently being used in the industrial motor repair shop at SCNY. The parts cleaning solution is a mixture of 20-50% Brulin 815 GD in potable water and is contained in an insulated 1,200 gal capacity tank. The percentage of Brulin 815 GD in the potable water is important in that the higher the concentration the better removal efficiency of heavy contaminants (grease, high viscosity oil). The cleaning solution is maintained at a temperature of 140°F to 160°F. The contaminated parts to be cleaned are placed in a metallic basket and then lowered into the tank by a mechanical hoist. The cleaning solution is not agitated in the tank and there is no manual brushing of the contaminated parts to stimulate the removal of the contaminants. The contaminated parts soak in the cleaning solution for periods of 4 to 12 hours. The parts cleaning processes is followed by a steam rinsing to remove any residual cleaner and contaminants from the parts. The cleaned parts are then hand wiped to quicken the drying time.

ESH Impacts

Penatone 724 is composed of aliphatic hydrocarbons (classified as 100% volatile organic compounds) and is a combustible material. Safety Kleen 105 is also a combustible material that contains petroleum distillates and trace quantities of perchloroethylene and 1,1,1-trichloroethane. The volatility of the two cleaning solvents requires personal protective equipment (gloves, glasses, etc.). Hand towels that contain residual Penatone 724 or Safety Kleen 105 are not considered hazardous waste in the state of Alabama or Massachusetts. The used towels should be put into a proper waste disposal container with the lid tightly covered. Penatone 724 and Safety Kleen 105 vapors are heavier than air. Local fire codes may also restrict use of these cleaners. There are a multitude of potential health hazards associated with the use of the two cleaning solvents. Eye contact with liquid or exposure to vapors may cause mild to moderate irritation. Skin contact may cause redness, dryness, cracking, burning, or dermatitis. Inhalation or ingestion may cause central nervous system effects and cause nausea, vomiting, and in severe cases, death.

Bio Seven is a clear, free-flowing surfactant that contains no listed hazardous ingredients. Brulin 815 GD is a blue-green blend of detergents, alkaline builders and inhibitors that contains no phosphates and has no listed hazardous ingredients. Both Bio Seven and Brulin 815 GD are soluble in water, biodegradable, nonflammable, and will not support combustion. Bio Seven and Brulin 815 GD are considered to have minimal health hazards associated with their usage.

Cost Analysis

The annual cost of each cleaner (Table 2) was based on information provided by the USCG facility and was geographically dependent. Costs were divided into three separate sections: (1) material acquisition, (2) inputs and outputs, and (3) ESH impacts. Material and equipment acquisition includes initial start-up costs and annual costs. The input and output costs included items that were identified through a material balance on each of the parts cleaning processes (e.g., energy, water, hand wipe towels, hazardous waste disposal). Certain input and output items did not have any identified cost for this evaluation.

Material and Emission Reduction Opportunities

Penatone 724 contains volatile organic compounds (VOCs) at a concentration level of 780 g/L of solution. Because of the volatility of the cleaning compound, much of the solution is lost through evaporation. VOCs are not an issue with the ATC since the state of Alabama does not currently restrict the amount of VOCs allowed to be dissipated into the environment from this type of parts cleaning process. Other locations may have regulations to reduce VOC emissions such as (1) best available control technology requirements or (2) a usage permit with fees based on the amount of releases into the atmosphere. An alternative to the current immersion cleaning procedure used at ATC would be to use an enclosed parts cleaning station for the cleaning solvent. The station would be designed for the containment of the solvent with a cover to reduce losses through evaporation. The parts cleaning station could extend the usage life of the cleaning solvent and significantly reduce environmental releases.

The annual loss of the Bio Seven cleaning solution is about 25%, primarily due to “drag-out” and evaporation. Drag-out is the liquid residual on the part after it has been removed from the cleaning station. The water and cleaning solution from the rinsing process could be captured and utilized as makeup for the losses incurred by drag out and evaporation.

Safety Kleen 105 and Penatone 724 have environmental and heath risks associated with their usage. Efforts should be taken to find a viable cleaner that would reduce these risks for the parts cleaning operations. Potential candidates to replace the petroleum distillates could be Bio Seven and Brulin 815 GD.

A material reduction opportunity for the Brulin 815 GD parts cleaning process would be to establish a continuous filtration system to separate the contaminants from the cleaning solution. Approximately 575 lb (64 gal) of Brulin 815 GD is used as makeup for the losses incurred through the removal of the sludge from the parts washing tank. This is about 47% of the total annual usage of the Brulin 815 GD parts cleaner. A cost savings of $600 would result from the elimination of Brulin 815 GD in the sludge. The total weight for the sludge could be reduced by 75% with the separation of the cleaner from the contaminants. This reduction would have a cost savings of $458 annually. The “mucking” out the tank and removal of the sludge would be reduced to every 3 yr. The total savings associated with the use of a continuous filtration unit, including any water losses, would be almost $1,100 annually.

Conclusions

Penatone 724 is qualified to military specification PD 680 type II as a parts cleaner. Penatone 724 can clean in all three aviation parts cleaning categories (engine components, general aviation equipment, and tires and wheels). Concerns about using the cleaning solvent focus on the potential ESH impacts.

The ATC is presently using Bio Seven as a test solution for cleaning engine components and general aviation parts. Bio Seven is designated as a test solution because at the time of this report it does not have a military specification. Plans

Table 2. *Regulatory and Cost Factors*

	Penatone 724	Bio Seven	Safety Kleen 105	Brulin 815 GD
Regulatory Requirements				
OSHA	*Combustible*	*None*	*Combustible*	*None*
RCRA	*Hazardous Waste*	*None*	*Hazardous Waste*	*None*
TSCA	*Listed Ingredients*	*None*	*Listed Ingredients*	*None*
SARA, Title III section 311,312	*Listed Ingredients*	*None*	*Listed Ingredients*	*None*
Cost				
Material & Equipment Acquisition				
Start-Up	*$1,945*	*$3,363*[1]	*$4,000*	*$3,410*
Annual Contract Fee	*None*	*$1,440*	*$4,000*[2]	*None*
Annual Operating	*$555*	*$225*	*None*	*$2,093*
Inputs and Outputs				
Energy	*None*	*$198*	*None*	*$6,887*
Water Usage	*None*	*$100*	*None*	*$216*
Atmospheric Emissions[3]	*None*	*None*	*None*	*None*
Liquid Effluent	*($3)*[4]	*None*	*None*	*None*
Solid Waste	*$1,200*	*$400*	*$400*	*$709*
Environmental, Safety & Health				
Personal Protective Equipment	*$268*	*$160*	*$340*	*$96*
Total Start-UP Cost	*$1,945*	*$3,363*	*$4,000*	*$3,410*
Total Annual Operating Cost	*$2,020*	*$2,523*	*$4,740*	*$10,001*
Annual Contaminated Parts Cleaned (pounds)[5]	*1,000*	*300*	*2,000*	*60,000*

[1] *Includes three cleaning stations.*
[2] *Contract cost for five cleaning stations.*
[3] *here was no identifiable cost for the atmospheric emissions.*
[4] *ATC Mobile, AL, sells the waste solvent at $0.03/gal to an Energy Recovery Company.*
[5] *Due to the differences in materials and surface area of the contaminated parts being cleaned by the USCG facilities, the annual weight should not be used as a comparison between facilities. It is presented in this chart to provide an approximation of cost/lb of contaminated parts within a specific facility.*

are in progress to classify the cleaner as a Navy soap. This classification would qualify the cleaner to the Mil-C-85570, type II specification when approval has been granted. One concern with the use of Bio Seven is the potential to cause hydrogen embrittlement. Hydrogen embrittlement is the degradation of high strength steels, such as aluminum and magnesium, that are used as bearings and bolts on aircraft wheels. Bio Seven is a viable cleaner for aviation parts cleaning categories two and three (engine components and general aviation equipment) but should not be used to clean category one (tires and wheels) aviation parts until its potential to cause hydrogen embrittlement has been determined.

Safety Kleen 105 is also qualified to clean all three aviation categories (engine components, general aviation equipment, and tires and wheels). Potential long-term liability risks for the Coast Guard are increased with continued use of this parts cleaner. If Safety Kleen Corporation uses poor practices in the recycling process, the USCG could be responsible for paying any cost incurred to remediate the resulting environmental contamination. Safety Kleen Corporation completes the hazardous waste manifests, but the USCG is on record for the purchase and generation of the solvent waste.

The industrial motor repair shop at SCNY has cleaned over 60,000 lb of contaminated parts with the Brulin 815 GD solution. The cleaner has proven to be effective at removing contaminants from the various ship parts located on the island. Important factors in using the Brulin 815 GD as a parts cleaner are the solution temperature, concentration, and soaking time. Operational experience indicates that for the Brulin 815 GD to be an effective parts cleaner at SCNY, the temperature must be at least 140°F with the concentration of Brulin greater than 20% and a soaking time of at least 4 hr if there is no agitation. Brulin 815 GD is considered to be a relatively benign solution and requires minimal environmental monitoring. The cleaning solution possesses no significant ESH concerns. Efforts should be taken to ensure that the discharge of the cleaner into the sewer system does not require any pretreatment by local water treatment facilities.

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***James Bridges** is the EPA Project Officer (see below).*
The complete report, entitled "Parts Washing Alternatives Study United States Coast Guard," (Order No. PB95-166146; Cost: $19.50, subject to change) will be available only from

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