Cleaner Technology Demonstration Site Case Study

Lockheed Martin Defense Systems, Pittsfield, MA

'Closed Loop' Aqueous Cleaning[1]

Summary

As part of Lockheed Martin Defense Systems' (LMDS) continued commitment to good corporate citizenship, they have reduced their use of ozone depleting compounds from 125 tons per year to less than two tons per year by installing nine aqueous-based cleaning systems.

Background

LMDS designs and manufactures a variety of complex, precision aerospace products for the armed forces of the United States and its allies. These products include missile fire control systems, missile and gun turret drives, and of particular interest to this case study, combat vehicle transmissions. To ensure product reliability, parts are cleaned thoroughly and frequently throughout the assembly and reassembly process. Parts were cleaned using chlorinated solvent vapor degreasers containing the ozone depleting compounds (ODCs) 1,1,1 trichloroethane (trichlor, 1,1,1 TCA, methyl chloroform) and chloroflourocarbon-113 (CFC-113, freon). Facility-wide, LMDS operated thirty nine vapor degreasers that used 125 tons per year of chlorinated solvents, 70 tons of which were emitted to the air. Due to environmental impacts and increasing economic and regulatory disincentives, LMDS made a commitment to eliminate their use of

ODCs.

Toxics Use Reduction Innovation

Teams at LMDS (including representatives from environmental, health and safety, accounting/financing, management and purchasing departments, and workers) explored alternatives to their vapor degreasing processes. The teams used the services of vendors, the Toxics Use Reduction Institute (TURI), and the Massachusetts Office of Technical Assistance (OTA) to assist them in generating a list of cleaning alternatives and evaluating the alternatives for economic and technical feasibility and potential environmental and worker health and safety impact. Facility-wide, LMDS replaced thirty six of their thirty nine vapor degreasers with seven aqueous systems and two semi-aqueous systems. This case study focuses on one 'closed loop' aqueous ultrasonic cleaning system used in the transmission assembly and repair process.

This process involves numerous substrates and contaminants. Substrates include steel and stainless steel, aluminum, cast iron, bronze and plastic. Prior to assembling new transmissions, oils, greases, and waxes need to removed. During repair processes many contaminants may be encountered including carbonized oils, greases, and metal, plastic, or rubber shavings.

In the ultrasonic wash (100 gallons) and rinse (94 gallons) tanks used at the transmission build and repair process, parts are cleaned in a slightly alkaline(2) aqueous solution at 150^{o}F and rinsed in 165^{o}F water. Because of the elevated rinse water temperature, rapid evaporation makes drying unnecessary. The 5% by volume cleaning solution used in the wash tank is Daraclean 212, produced by W. R. Grace, which contains builders, additives, and surfactants that provide a

combination of functions to perform the cleaning.

Six transducers, located on the bottom and front of the wash tank, generate ultrasonic waves which cause a phenomenon known as cavitation. Cavitation is the formation of tiny bubbles at the surface of the part. These bubbles implode causing estimated instantaneous pressures of 10,000 psi and temperatures of 10,000^{o}F, providing the increased mechanical energy and heat which is often required to remove soils. To minimize any potential worker exposure to noise and heat from the new system, LMDS required that the system be designed with additional insulation.

To extend the cleaner and rinse bath lives, LMDS continuously filters the wash and rinse tanks through coalescing and cartridge filters. The coalescing filters cause oils to float to the surface of the filtration tanks so that they may be removed; the cartridge filters (50 microns and 10 microns, in series) remove fine particulate materials that are suspended in the baths. The use of this filtration system has allowed the wash and rinse baths to be used for approximately eighteen months before changing. When the wash bath was changed, the rinse bath was used as make-up water for the new wash bath.

Toxics Use Reduction Assessment

- By installing aqueous and semi-aqueous systems, LMDS reduced their solvent use facility-wide from 125 tons per year to fewer than two tons per year. Facility-wide, air emissions of ODCs were reduced from seventy tons per year to fewer than one ton per year.

Economic Assessment

- Facility-wide, LMDS saves $497,000 in solvent procurement costs, $17,500 in waste disposal costs, and $65,000 in permitting and record keeping costs annually.

- In the transmission assembly and repair process LMDS saves $3,450 in water and sewer costs annually (two million gallons at $1.77 per thousand gallons). Significantly more water was required for cooling the vapor degreasers than is required for aqueous cleaning. The filtration system provides additional water savings.

Transferability

Aqueous cleaning is an effective replacement for chlorinated solvent vapor degreasing. The type of cleaning process and cleaning solution selected is dependent on the cleaning needs of a given process. Although LMDS selected ultrasonic cleaning, another facility may find that another aqueous process, such as spray washers or immersion baths, may provide the required level of cleanliness for their parts. Likewise, the cleaning solution should be selected specific to the contaminants and cleaning needs of a particular facility.

Often when firms switch from vapor degreasing to aqueous cleaning they are faced with the treatment or disposal of an aqueous waste. This issue may be alleviated by installing 'closed loop' filtration systems such as the coalescing and cartridge system employed by LMDS, or membrane ultrafiltration systems. These systems not only further decrease the environmental impact of a firm's manufacturing process, they also decrease operating costs and hence shorten the payback period of a new aqueous system.(3)

This case study is part of the Toxics Use Reduction Institute's Cleaner Technology Demonstration Sites Program.

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