Project Accomplishment Summary
for
Project Number 91-Y12P-056-A1

ENVIRONMENTALLY COMPLIANT MANUFACTURING

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Various Industrial Partners

April 10, 1997

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Prepared by the
Oak Ridge Y-12 Plant
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400
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Project Accomplishment Summary

Title: Environmentally Compliant Manufacturing
DOE TTI Number: 91-Y12P-056-A1
Partner: Various Industrial Partners

Background:
The metal working industry needs to reduce the waste associated with scrap, worn tools, degradation of metal working fluids, and etc. One task in this project concerned metal working fluids (MWF), which typically consists of surfactants, anti-microbial agents, lubricating agents, complexing agents, and a number of other components. The waste stream volume from the MWF can be reduced by judiciously (1) recycling, (2) selective replacement of expended components, and (3) protecting against microbial contamination. This activity consists of developing an analytical method, amenable to automation, which addresses all three of the methods of extending the MWF lifetime, thereby reducing the waste stream.

The technology for determining key components in MWF on-line (at the machine tool) did not exist. The Y-12 Plant's collaboration was selected for this particular endeavor because of its ongoing machining operations and expertise in automation.

In addition, concerns have been raised regarding chronic exposure of machine shop personnel to metal working fluid mists generated during routine machining operations. The chemical composition of metal working fluids is fairly well known, however, the chemical and physical characteristics of the resulting aerosols (mists) are not as well known. Machinists exposed to these aerosols by inhalation and skin contact sometimes develop unpleasant reactions. The second task involved efforts to characterize mists generated from candidate cutting fluids.

Description:
One project goal was to develop an automated method of detecting selected compounds in metal working fluids. This technology would allow the effective lifetime of MWFs to be extended, thereby reducing a waste stream. As an added benefit, on-line assessment of MWF quality should reduce rework and improve product quality.

This particular effort consisted of two phases: development of an analytical method (Y-12) and testing of the analytical method (industrial partners). The Y-12 Plant demonstrated a fully automated analytical method to the industrial partners and has completed its technical work.

Another major objective was to more completely characterize the chemical, physical, and biological properties of the aerosols generated from cutting fluids of interest to the industrial partners. This effort involved mist particulate phase characterization of seventeen cutting fluids, provided by the industrial partners, and vapor phase characterization on a selected subset of these fluids. Several fluid classes were included in these studies. Particle size distribution was determined on all fluid formulations. The chemical complexity of the different cutting fluids required the development of fluid specific analytical protocols. Chemical components in the mist particulate and vapor phases were characterized as well as a determination of the
partitioning of targeted chemicals over the particle size distribution range. The mass median aerodynamic diameter (MMAD) of each MWF mist were measured and the geometric standard deviation of the given particle size distribution determined.

These results were entered into a mist sensory irritation response model, which was previously developed by a partner, from the results in small mammal MWF mist inhalation toxicology studies. Short chain fatty acids (carboxylic acids) were targeted as a class of sensory irritants. These species were monitored in the particle and vapor phases of selected synthetic fluids. Vapor phase/particle phase distribution for target irritants in aerosols from three synthetic fluids generated by both the generator used in the animal inhalation toxicology studies and by a bubbler system were compared.

Actual machine shop mists were also sampled from two occupational settings as part of the workplace characterizations task coordinated through the industrial partners’ and LMES’ staff. This included a limited field test by LMES personnel, at an industrial site in Iowa, to characterize the vapor phase/particle phase irritants generated under actual metal working conditions. The industrial partners are very interested in a continuation of this work.

**Benefits To DOE:**
DOE benefits from the first task in its new ability to reduce a very expensive waste stream--metal working fluids arising from machining hazardous and radioactive materials. The cost of dealing with mixed (radioactive and hazardous) wastes varies considerably across the weapons complex, but a figure of about $100/cubic foot is about average. On average, about one cubic foot of waste is generated per machined item. Currently, thousands of cubic feet of mixed waste could be generated -- the disposal cost would be in the hundreds of thousands of dollars.

A second benefit to DOE, as well as to all other manufacturers, is the improved environmental condition of the workplace and well being of those employees exposed to metal working fluid mists, which will result from this mist characterization work.

**Economic Impact:**
The industrial partners have yet to decide if they wish to commercialize the developed sensor technology. If implemented, the principal benefits will be cost reduction through waste reduction--this does not create jobs but does make for a better environment. The actual cost reduction (savings potential) would vary widely, depending on local municipal sewer regulations. Often the cost of disposing of MWF is nearly equal to its creation.

The economic impact of the mist characterization work is less well defined. The impact here will be more in the health and well being of the employees exposed to metal working fluid mists and this will take a much longer time to be realized in terms of future health costs.

**Project Status:**
The project is complete.

**Doe Facility Point(S) Of Contact For Project Information:**
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**Project Examples:**
None, all developments are still considered Protected CRADA Information by the industrial partners at this time.

**Technology Commercialization:**
The sensor technology developed in this project is undergoing testing at one of the industrial partners at this writing. Patent documents have been drafted by LMES. Any commercialization is contingent on market studies and licensing negotiations.

The mist work will not be commercialized as such, but will have an impact on the content and commercialization of metal working fluids in the future.
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