Project ID: **64912**

Project Title: **Improved Decontamination: Interfacial, Transport, and Chemical Properties of Aqueous Surfactant Cleaners**

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Publication Date: June 15, 1999

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Progress Report

RESEARCH OBJECTIVE

This investigation is focused on decontamination using environmentally benign aqueous solutions, specifically the removal of organics and associated radionuclide and heavy-metal contaminants by surfactants. Aqueous-based solutions promise several advantages for decontamination processes, including low hazard potential, low cost, and reduced secondary waste volume through solvent recycle, solvent degradation, and/or incineration.

The work aims at gaining an understanding of interfacial, transport, and chemical processes that govern the effectiveness of aqueous-based surfactant solutions for decontamination of surfaces. In addition, efficient means for separation of waste materials from aqueous-based cleaners will be investigated. It is intended that the understanding developed in this work will be applied to decontamination/decommissioning tasks by laboratory testing of samples from DOE contaminated sites, and that the tests will provide the basis for improved approaches for removal of organic contamination.

RESEARCH PROGRESS AND IMPLICATIONS

Following is a summary of the work after 9 months of a 3-year project. Progress in this project has been made both in identifying relevant DOE EM problems and in technical investigations.

Relevance to DOE problems: R. M. Counce represented this project at the EMSP/D&D Workshop at Savannah River on November 17-18, 1998. This was a valuable meeting, describing in detail the problems associated with decontamination/decommissioning activities, and discussing the relevance of the EMSP projects to these problems. Although interest in this work was expressed by end-users, no ties to specific applications have yet been made.

Technical progress: Technical progress has been made in two areas: surface decontamination involving oil removal using aqueous-based surfactant solutions, and separation of waste from process materials. The first area deals with cleaning of surfaces, while the second addresses the subsequent task of treating the resultant solutions

to minimize waste volume.

Surface Decontamination – Bench-scale experiments were carried out to investigate the removal of oil from surfaces using aqueous surfactant solutions. The experiments employed anionic, cationic, and nonionic surfactants; the surfactants involved were SDS, CTAB, and Triton X-100, respectively. The studies involved measurements of detachment time of single oil droplets from stainless steel coupon surfaces with varied solution chemistry. These experiments were carried out in an apparatus capable of monitoring contact angle evolution, droplet shape, and detachment.

The following are highlights of the results obtained to date:
1) Droplet detachment time is significantly affected by pH, surfactant type, and surfactant concentration.
2) We have discovered a simple modification that drastically decreases droplet removal time (nearly two orders of magnitude faster detachment in SDS solutions). An invention disclosure on this approach is in preparation.
3) Similar trends were obtained with single-droplet bench experiments and tests conducted using prototypic commercial cleaning equipment.
4) The agreement between bench and pilot tests suggests that miniature single-droplet experiments can be used effectively in a manner similar to combinatorial chemistry for rapid optimization of cleaning strategies with minimal investment of time and equipment and with low waste production.

Separation of Waste from Process Materials – studies are underway using synthesized effluents from aqueous-based cleaning operations. Anionic, cationic, and nonionic surfactants were used – SDS, CTAB, and Triton X-100, respectively. Three surfactant concentrations have been studied: at sub-critical micelle levels, near the critical micelle point, and above the critical micelle point. Phase splitting involving agitated surfactant solution is more complicated than that with oil and water alone; typically, 3 phases result from the separation, an oil-rich phase, a water-rich phase, and a surfactant-modified phase. The goal of this part of the experimental program is to understand how to design separation systems and to better understand the nature of the recovered materials so that wastes are minimized and useful materials such as the surfactants may be reclaimed for reuse.

PLANNED ACTIVITIES

Planned activities include the following: (1) fundamental studies, (2) connection to applications, and (3) applicability studies. The fundamental studies will extend our current work and will be conducted to improve our understanding of the underlying mechanisms controlling both oil removal and phase disengagement. A particular focus will be placed on evaluating the effectiveness and feasibility of the simple process modification mentioned above, and comparison with other developed means of improving contaminant removal. Coupled studies will be aimed at further understanding ways to improve phase separation and media reuse, particularly taking advantage of knowledge gained in improving cleaning. Efforts will be continued in parallel to communicate the goals and results of this project with end-users at DOE facilities to determine pertinent applications. It is our intent to perform bench testing with surfaces and contaminants characteristic of such applications to determine whether the understanding developed in this project can help to improve DOE decontamination efforts.

INFORMATION ACCESS

No results have been published to date.