Background:
The Department of Defense (DoD) currently uses synthetic and petroleum based oils as carrier fluids for fluorescent dye penetrants (FDP) used during the nondestructive inspection (NDI) of in-service metal parts and during manufacture. Current DoD handling and disposal costs associated with these processes are estimated to be approximately $4 million per year. There is a need to minimize environmental impact and reduce the handling and disposal costs associated with the use of current FDP NDI techniques.

Objective:
The objective of this project was to develop environmentally acceptable FDPs for use in existing NDI techniques.

Process/Technology Description:
METSS Corporation drew on previous efforts related to the development of non-toxic, environmentally friendly oils and cleaners. Integration of this experience base facilitated the development of environmentally acceptable materials to support FDP NDI techniques in a timely and cost-effective manner. Based on the critical performance parameters of existing FDP materials, METSS formulated a series of alternative carrier fluids and cleaners for FDP materials and constructed a design matrix from which the viability of these FDP replacement formulations were evaluated for performance, environmental impact, and cost. The general physical and chemical requirements of the candidate materials determined the initial materials selection efforts. Subsequent formulation and optimization efforts were directed by a well-defined strategy for testing and evaluating the candidate FDP formulations. More extensive testing and evaluation of the most promising product formulations was conducted in conjunction with product experts at Magnaflux to identify FDP replacement formulations for full-scale development, testing and qualification. Testing and evaluation procedures were in accordance with MIL-I-25135E (Inspection Materials, Penetrants).

Results:
This project has clearly demonstrated the feasibility of developing a new environmentally friendly technology for FDPs. Tests performed by METSS, as well as Magnaflux laboratories, have shown that the new FDPs should be capable of meeting the SAE AMS 2644C performance standards with only minor modifications required. The environmentally friendly FDPs utilize biodegradable carrier fluids based on vegetable oils and their derivatives. These non-toxic materials, produced from renewable resources, are readily available, abundant, and cost-effective. Significant cost benefits are likely to be the key driving force in pushing these materials into the existing FDP market. Based on METSS' preliminary estimates, a cost comparison with comparable products could lead to a savings of up to 20% per year in materials costs alone. Additional cost savings should be realized due to the reduced hazardous waste disposal costs associated with displacement of the current FDP materials. The Final Report for this project is available in the SERDP and ESTCP Online Library at http://docs.serdp-estcp.org/.

Benefits/Implications:
The products developed under this project will not only be non-toxic, safe to use, and environmentally friendly, but will also be cost-effective. By emphasizing the development of direct replacement fluid technologies, METSS' efforts will have a significant and immediate impact on the reduction of waste streams generated by existing FDP techniques, while at the same time making it possible to use existing systems in a manner that is safer to personnel and the environment. (SEED Project Completed - 2003)

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