Manufacture of Palm Oil-Based Degreaser for Metal Cleaning

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ABSTRACT

Degreaser is widely used as a cleaning agent especially for metal parts in oil and gas industries. Most of these products contain chlorinated solvents such as 1,1,1-trichloroethane or non-chlorinated solvents such as methyl ethyl ketone and used as degreaser for removing contaminants from metals surface. Chlorinated and non- chlorinated solvents have been found to be environmentally unfriendly due to groundwater contamination or volatile organic compound (VOC) emission. The use of halogen, carbon tetrachloride and CFCs as degreasing agents increase overall risks to human health and also contributes to the enhancement of ozone-depletion. The main objective of this project is to develop palm-oil based degreaser (POD) as an alternative product that provide the same degreasing effect as conventional commercial degreaser. The materials were selected mainly from plant- based derivatives such as fatty acids ester. POD has been compared with conventional commercial degreaser for performance testing. The results showed that the percentage of oily soil removed after cleaning process by POD was 97.27 per cent at level surfactant addition of 14 per cent. The comparative study of oily soil removal for POD decreased from 94.30 per cent to 45.22 per cent with increasing number of panels. Meanwhile, the commercial degreasers such as hydrocarbon, citrus and alkaline-based decreased of oily soil removal from 95.45 per cent to 51.74 per cent, 80.45 per cent to 40.66 per cent and 95.51 per cent to 51.36 per cent respectively with increasing number of panels.

Keywords: *manufacture, metal cleaning, palm oil-based*

Introduction

Detergent is a compound, or a mixture of compounds, intended to assist cleaning. The term is often used to differentiate between soap and other chemical surfactants used for cleaning purposes. The term 'detergent' will include soap and the non-soapy types that will be called non-soapy detergents (NSDs). NSDs were also known as soapless detergents or synthetic detergents.

Detergents act mainly on the oily films that trap dirt particles. The detergent molecules contain a hydrocarbon portion soluble in oil and an ionic portion soluble in water. The detergent acts as an emulsifier by bridging the water and oil phases- it breaks the oil into tiny droplets suspended in water. The disruption of the oil film allows the dirt particles to become solubilized. Detergents are classified as anionic or negatively charged substances for example soaps and cationic or positively charged substances for example tetra alkyl ammonium chloride used as fabric softeners. The other classes of detergents are nonionic for example certain esters made from oil used as degreasing agents in industry, and zwitterionic which contains both positive and negative ions in the same molecule (Woollatt, 1987).

Detergency can be defined as the removal of undesirable substances from solid surface brought into contact with a liquid. The removal of these undesirable substances, called soils, from solid surface depends on several factors such as the detergent, mechanical action during cleaning, and the substrate (Eric & Culter, 1987).

Problem Statement

The Environment Quality (Air Clean) Regulation, 1978 identifies alternatives and replaces, to the

maximum extent practicable, hazardous chemicals include chlorofluoro carbons (CFCs), halons, carbon tetrachloride, methyl chloroform and methyl bromide. Ozone-depleting chemicals include CFCs, halons, carbon tetrachloride, methyl chloroform, methyl bromide, and hydrogen bromidefluoro carbons (HBFCs) are to be replaced with chemicals, product substitutes, or alternative manufacturing processes that reduce overall risks to human health and the environment (Anon., 1994).

Traditionally, chlorinated solvents such as 1,1,1-trichloroethane (TCA) , or trichloroethylene (TCE), or tetrachloroethane were used in high concentration (100%) for removing contaminants from metal surfaces. Non-chlorinated solvents such as methyl ethyl ketone and toluene were also used for cleaning metallic parts.

These chlorinated and nonchlorinated solvents have been found to be environmentally unfriendly. This is due to groundwater contamination or volatile organic compound (VOC) emissions belong to CFCs, halons, carbon tetrachloride, methyl chloroform, methyl bromide and ozone-depletion by CFCs, halons, carbon tetrachloride, methyl chloroform, methyl bromide, and HBFCs.

Therefore, this study will find an alternative to replace environmentally unfriendly substances, chlorinated, nonchlorinated and petroleum- based organic solvents with more environmentally friendly cleaners such as aqueous-based cleaners.

Objectives

This study embarks on the following objectives:

a. To develop Palm Oil- Based Degreaser (POD) using biodegradable materials.
b. To evaluate and compare the effectiveness of percent oily soil removed of POD as a substitute to conventional commercial cleaners and solvent cleaning agents.

Methodology

Materials

Conventional Degreaser Selection
The commercial degreasers used for metals cleaning were selected to be used in this research. The products were hydrocarbon-based, alkaline-based, and citrus-based degreasers selected for comparative study against palm-oil based degreaser (POD).

Selection of cleaning object
Standard 1010 steel panels were chosen as the metallic object to be cleaned. Steel, in general, is a good representative of metal used in industries for equipment and parts manufacture. The test panels had nominal dimensions of 70.2 mm x 49.5 mm x 0.5 mm (length x width x thickness) as shown in Figure 1. The distance between panels was 3 mm to ensure contaminant was uniformly coated and rinse water could flow smoothly in the cleaning process.

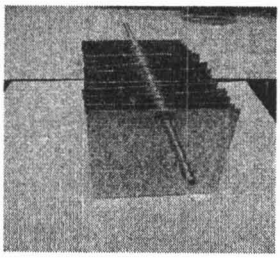

Figure 1: Steel Panels Testing

Contaminant Selection

Mixed oil was the contaminant selected because it had properties that allow for consistent coating of the panel surfaces as shown in Figure 2. The mixed oil contaminant was layed on the metal surface without forming strong chemical bonds and could be observed when coated on the steel surface.

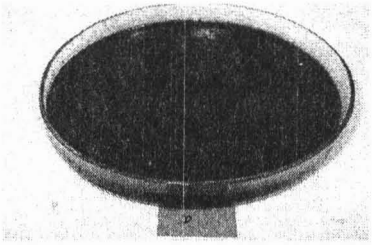

Figure 2: Mixed Oil as Contaminant

Raw Materials for POD

The raw materials were selected mainly from plant derivatives namely; methyl esters and surfactant from palm oil, limonene from citrus (lime) juice, and polymer from fresh musa peel. Other constituents selected as additives were isopropyl alcohol (IPA), sodium metasilicate and sodium ethylenediaminetetracacetic acid (EDTA).

Preparation of Palm Oil Based Degreaser

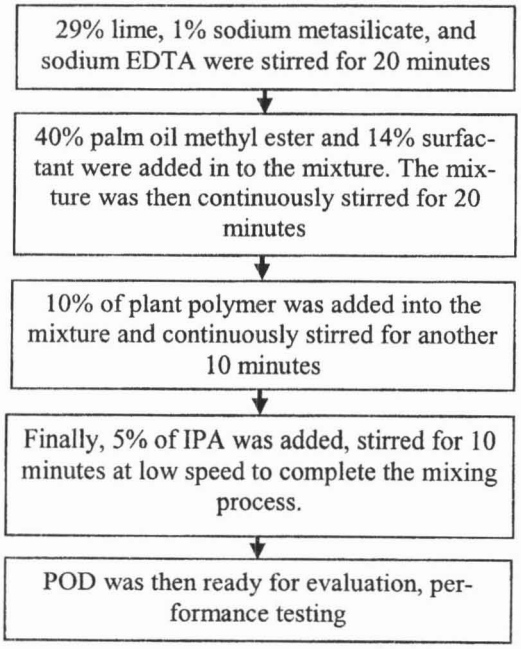

Figure 3: Preparation of Palm Oil Based Degreaser

Method of Metal Cleaning and Performance Testing

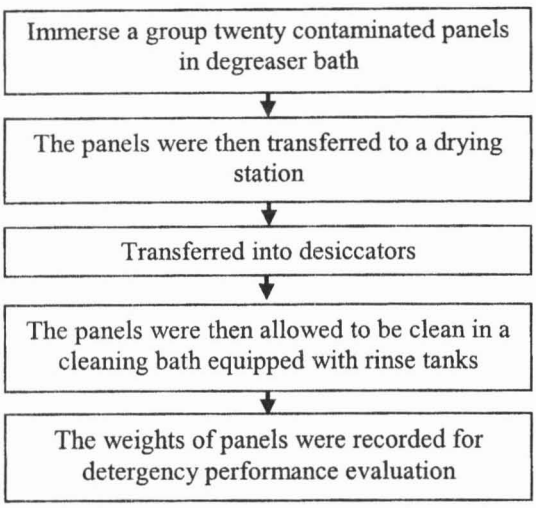

Figure 4: Method of Metal Cleaning and Performance Testing

Result And Discussion

Soil Removal (Percent) on Formulation 1

Detergency performance of formula 1 is 73.71%. Then, formula 2, increasing surfactant percentage show that soil removal on the test pieces increased to 82.81%, and further, the addition of surfactant as shown by formula 3 gradually increase the percentage of the soil removed to 90.45%. The layer of oily soil contaminant was observed left on the surface of the test pieces for formula 1, 2 and 3. This formula indicates that surfactant is closely related to detergency performance of developed POD. Further increment of detergency performances was obtained in formulation 4 and 5 with the percentage of soil removal of 97.27 and 96.17, respectively. Higher percentage of soil removal is 97.27 % at level 14% of surfactant addition as shown in Figure 5.

The results were obtained that formula 4 and 5 shows higher percentage of soil removal (detergency performance) due to surfactants that play the key role in removing oily soil which are present in POD.

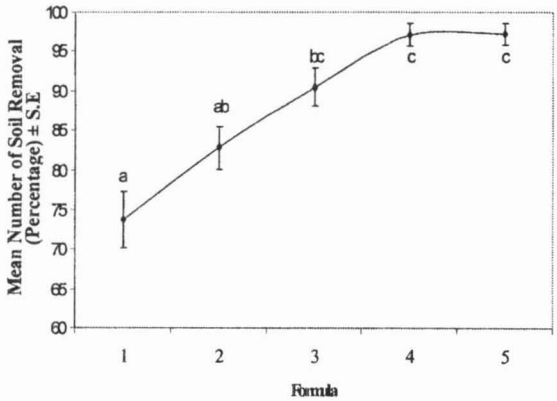

Figure 5: Means Number of Soil Removal (percent) in Five Formulas (Treatment 1)

Soil Removal (Percent) on Formulation 2

Soil removal of formulation 6 was 94.30% (26% limonene) compared to 95.83% removal by formulation 7 (28% limonene). Gradual increase of limonene (lime juice) as in formulation 8 (30%), 9 (32%), and 10 (34%) showed insignificant effect on the percentages of soil removal which were 94.61%, 94.86% and 94.25% respectively. The results of percentages of soil removal obtained at maximum range of 28% to 32% of lime juice (limonene) have been selected in development of POD. The range of lime juice (limonene) is 28% to 32% which satisfies percentage of soil removal. Therefore, lime juice (limonene) increment in formulations had no significant effect on percentage of soil removal (Figure 6).

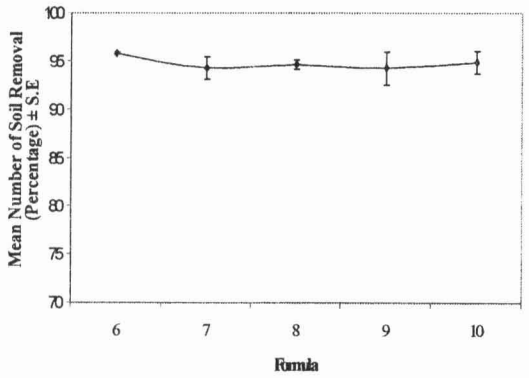

Figure 6: Means Number of Soil Removal (percent) in Five Formulas (Treatment 2)

Soil Removal (Percent) on Formulation 3

The maximum percentage of soil removal is 98.40% from 40% of methyl ester used as a solvent in POD. Therefore, methyl ester concentration in the formulations (Figure 7) shows a significant effect on the percentage of soil removal. Reducing some of surfactant and increasing concentration methyl ester in the degreaser lowered degreaser capability in the removal of oily soil as shows in Figure 7.

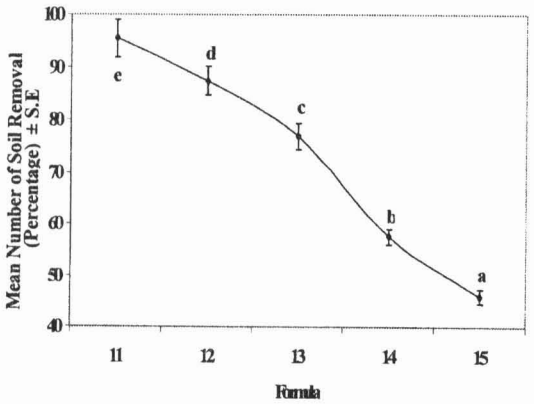

Figure 7: Detergency Performance (% Soil Removal) by Different Concentration of Methyl Ester in Formulations

Comparative Study of POD with Commercial Degreaser

The comparison of POD with commercial degreasers was to identify the effectiveness degreasing performance in cleaning of metal parts for industrial purposes. The three types of degreaser selected were as follows:

An alkaline- based degreaser
Hydrocarbon- based degreaser
Citrus- based degreaser

The selected formula of POD with optimum percentage soil removal was chosen to determine degreasing performance between three different types of degreaser. The results indicated that the degreasing power of POD had slightly lower effect on soil removal compared to the commercial degreasers as shown in Table 1.

Table 1: Soil Removal Effect by Various Degreasers on Ranging Number of Test Panels

Number of Plate	% Soil Removal			
	Hydrocarbon-based	Citrus-based	Palm Oil-based	Alkaline-based
20	95.45	80.45	94.30	95.51
40	79.67	71.01	75.78	82.75
60	70.86	60.56	61.90	74.81
80	60.28	50.20	52.37	61.07
100	51.74	40.66	45.22	51.36

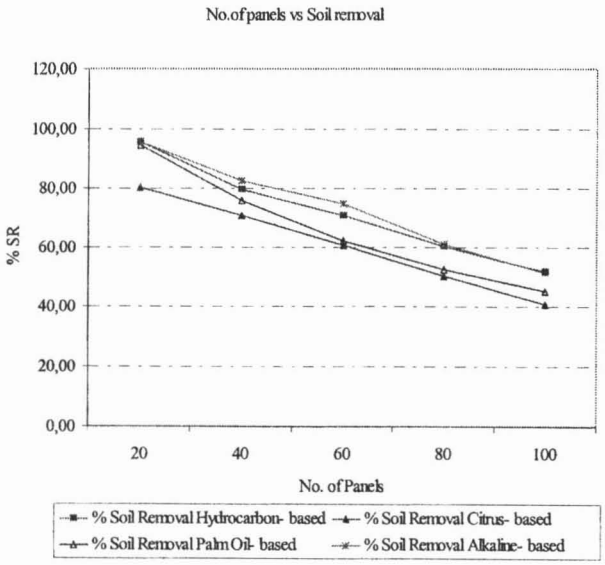

Figure 8: Shows the Percentage Oily Soil Removal Reduction Inversely by Various Degreasers with Increased the number of Panels

Figure 8 shows relationship between number of panels and amount of soil removal by four different degreasers.

Conclusion

Soil Removal (percent) on formulation 1 (treatment 1) was obtained that formula 4 shows higher percentage of soil removal (detergency performance) due to surfactants that indicate significant effect in removing oily soil from the test panels.

Palm oil based degreaser (POD) has potential as metal cleaning agent and is an alternative to other conventional products such as an alkaline, petroleum, halogenated and chlorinated based degreasers. POD is the most competitive metal cleaner that can be used in various industries, especially in the oil and gas industry.

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