

CHAPTER III

LITERATURE REVIEW

Several researchers had studied processes or methods for reclaiming waste lubricating oils. The example of the processes was the acid-clay process. In accordance with this process, waste oil was contacted with high concentration of sulfuric acid and contaminants were removed in an acid sludge. The oil was thereafter contacted with a decolorizing clay to absorb additional contaminants and color bodies. But this process introduced following problems. Firstly, the process produced large amounts of acid sludge which must be disposed of. Secondary, large volumes of corrosive acid were consumed by the process. Thirdly, up to 20% of the original waste oil was lost with the acid sludge (Johnson, 1983).

Other methods had been proposed, such as a method for purifying and reclaiming used lubricating oils containing additives which there were detergents, antioxidants, corrosion inhibitors, and other solid and liquid contaminants by preferably first column distilling the used oil to remove water and low boiling contaminants and treating the dried oil with solvent mixture of butanol, isopropanol and methyl ketone. This treatment caused the separation of a layer of sludge containing contaminants, unspent additives and oxidation products (Whisman et al., 1978). Vu et al. (1973) reported that used oil could be deasphalted by contacting the used oil with a light paraffinic hydrocarbon in the liquid state, for example propane, butane or pentane or mixture of these paraffinic hydrocarbon. The similar

step of contacting was studied by Cutler et al., 1968 quoting Norman G.R.. This process included the steps of dehydration, then mixing the oil with 1 to 15 times the volume of such oil of a solvent selected from the group consisting of ethane, propane, butane, pentane, hexane, and mixture thereof (preferred solvent being propane), scrubbing to remove heavy metal particulate. The oil-solvent mix was stripped, subjected to vacuum distillation, hydrogenation, another stripping process, and filtering.

Whisman et al., 1978 quoting Norman G.R. proposed a process in which mixture of isopropyl alcohol, methyl ethyl ketone and n-butyl alcohol was used as solvent. This solvent was used for dissolving the oil and precipitating metal compounds and oxidation products from the oil as sludge.

The other substance considered to be used for treating waste oil was amine. Gilson and Massicotte (1967) demonstrated that treating with diethylenediamine (DETA) 0.1 to 12% based on weight of used oil at 49 to 88 °C was sufficient to separate flocculated contaminants in the used oil. Mattox (1978) reported a process for removing particulate matter from lubricating oil in combustion engine which consisted the steps of diluting used oil with an equal volume of a light paraffinic hydrocarbon fraction, boiling in the approximate range of 95 to 145 °C, adding amine (oil soluble amine) to equal portion of the diluted used oil in an amount of equivalent to 10.8 parts by weight per 100 parts of used oil, mixing the solution, allowing to stand in glass container at ambient temperature, and separating solid contaminants. He also described that amine might be an aliphatic (saturated or unsaturated), alicyclic (saturated or unsaturated), aryl or aralkyl amine. This amine

could remove the contaminants by causing conglomeration of suspended contaminants and or making less soluble or insoluble the objectionable non-lubricating materials which might be in solution in the oil.

The chemical treatment processes studied by many researchers were found that they could remove the contaminants from the waste oil. Norman (1984) studied a process comprising the steps of: (1) contacting oil with an aqueous solution of basic salt of an alkali metal (the anion portion was preferably hydroxide, carbonate or hydrogen carbonate. The preferred alkali metals were sodium and potassium) which had a concentration in the range of about 3 to 10% wt/wt salt to precipitate metal contaminants, polar compounds or particulates from the oil and to neutralize acid that might be present in that oil; (2) separating bulk water and solid contaminants from the oil; (3) separating fine particulates and remaining suspended water from the oil; (4) vacuum drying the oil to remove dissolved water and light hydrocarbon; (5) contacting oil with a polyfunctional mineral acid or the anhydride of said acid, polyhydroxy compound; (6) separating the reaction products formed in step (5); (7) hydrotreating oil to remove residual polar materials and unsaturated compounds; and (8) stripping the oil to remove light hydrocarbons with boiling points below about 315 °C.

Johnson et al. (1981) described a process using a suitable ammonium salt as a treating agent. The examples of ammonium salt were ammonium sulfate, ammonium bisulfate, ammonium phosphate, diammonium hydrogen phosphate, ammonium dihydrogen phosphate, ammonium thiophosphate, and ammonium polyphosphate (such as ammonium metaphosphate, urea sulfate, guanidine sulfate,

urea phosphate, guanidine phosphate and mixture thereof). The concentration of treating agent in aqueous solution was using typically about 80% wt/wt. After contacting between the used oil and treating agent, the further steps consisted of removing a portion of the water, heating at a temperature of 320 to 420 °C for a period of time being sufficient to decompose at least a portion of any ammonium salts of sulfonic acid and dialkyl dithiophosphoric acid, cooling at a temperature of 100 to 180 °C, and separating solids were conducted. A process for reducing ash and metal contaminated in used motor oil by contacting the used oil with an aqueous solution of ammonium sulfate and or ammonium bisulfate was carried out by Johnson (1976). The other chemicals such as ammonium dihydrogen phosphate, diammonium phosphate, calcium hydrogen sulfate, phosphoric acid, calcium sulfate, aluminium sulfate, and magnesium sulfate had been chosen for pretreatment chemicals in several works (Johnson 1975; Johnson, 1980; Johnson, 1983). But obviously disadvantages of the process using chemical treatment were using high temperature and consuming large amounts of treating agent.

Friel and Hammond (1976) focused on a process of reclaiming lube oil which comprised the steps of treating spent lube oil with a surfactant (preferably anionic surfactant) in combination with amine (preferably a polyalkylene polyamine) at an elevated temperature (about 50 to 200 °C) and separating the settled impurities. In this research, the weight ratio of surfactant to amine was operated at 60 : 40 and the amount of treating agent was used at 0.1 to 2% wt/wt of the oil to be treated.

Salusinszky (1981) proposed a process for removing metals and water from used hydrocarbon lubricating oil characterized in that the used oil was treated with

an aqueous solution containing a surfactant and anion which formed a soluble salt or insoluble salts with at least one metal presented in the used oil followed by separation of an oil layer of reduced metal and water content.

In the surfactant-based separation, applications of micellar enhanced ultrafiltration (MEUF) were known that this technique could remove multivalent metal ions from aqueous stream. Since the surfactants formed micelles which could absorb or bound counterions onto its surface after CMC. So they were added to the aqueous stream containing the ion to be removed. In addition, it was found that an anionic surfactant was used for removing cationic metal ion and a cationic surfactant was used for removing anionic metal ion. The stream added the surfactant was treated in an ultrafiltration unit with membrane pore sizes small enough to block the passage of the micelles with their bound counterions. The surfactant was sodium dodecyl sulfate (SDS). It was used to remove divalent cation metal such as zinc and copper.

In 1994, Huang et al. studied a crossflow surfactant-based ultrafiltration of heavy metals from waste streams. They concluded that five heavy metals (cadmium, lead, copper, nickel and zinc) could be substantially removed by this technique.

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