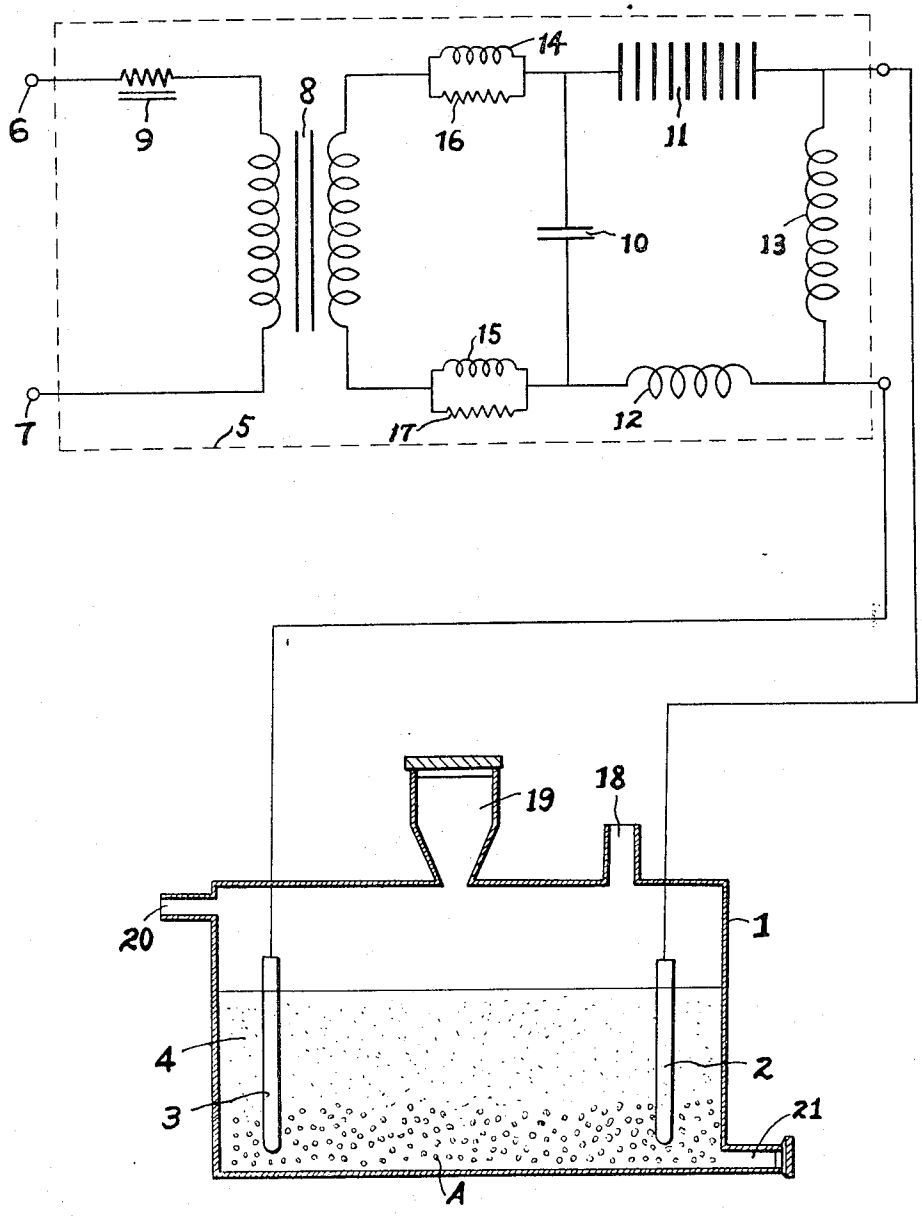
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METHOD OF REFINING WASTE OILS

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METHOD OF REFINING WASTE OILS

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ABSTRACT OF THE DISCLOSURE

The removal of solid particle impurities from waste oils is performed by conventional means after the impurities have been brought together into a mass to such an extent as to be capable of filtering, the aggregation being effected by an electric spark taking place in the waste oil having a dielectric medium therein.

This invention relates to a method of refining waste oils, and more particularly to a method of removing from waste oils, solid particle impurities in suspension, such as residual carbon and ash contents, by aggregating them into a mass by means of spark discharges taking place in the oil, whereby to ensure ready removal by ordinary means, such as a filter.

In general, a used oil, such as a lubricant, contains carbonaceous particles (residual carbon) and broken pieces of metal (ash contents). There have been prior proposals for removing such impurities, among which are the following: Firstly, a physical or mechanical method has been proposed, in which a mechanical device such as a centrifugal separator, a filter press, or a distiller is employed. Secondly, a chemical method has been proposed, in which a particular solution is used, such as an aqueous solution of a mineral acid (e.g. sulfuric acid), an aqueous solution of chlorine, caustic alkali, or ammonia. The former method has disadvantages in that the degree of refinement and the yield are insufficient and inadequate for commercial uses, and the latter method has problems of danger and difficulty involved in operation of the equipment and the performance thereof, particularly in the case where sulfuric acid is used, which undesirably tends to react with the additive contained in the lubricant.

It has been found that the carbon particles present in the oil can be brought together into a mass when spark discharges take place between electrodes through a medium of grains of electrically conductive material immersed in the oil to be refined, the thus aggregated mass of carbon particles being readily removable by ordinary means such as a centrifugal separator or a filter press, thus eliminating the problem of remainders.

More specifically, in accordance with the invention, a pair of electrodes are immersed in the oil to be refined, the oil being charged with grains of electrically conductive material such as carbon particles immersed in the oil. A sparking voltage is impressed across the electrodes by a high frequency oscillating circuit, thus causing sparks between the grains. The grains are mutually in contact through respective coverings of thin oily film. The oily film is broken down by the spark impacts, causing decomposition (cracking) of the oil, carbon being segregated and gases formed. Simultaneously the surfaces of the grains are electrically eroded to small pieces by dint of the spark impact and spark discharge energy. As a result, the segregated carbon and the peeled-off carbon thus produced (hereinafter called "carbon particles") are gradually brought together in the electrical field where the spark discharges take place, in addition to which the residual carbon and ash contents originally present in the oil are aggregated into a mass to such an extent as to be readily

filtered and separated from the refined oil by conventional means, which fact has been confirmed through an electron microscope. The oil may contain active powders such as active alumina or active clay, around which the aggregation will take place.

The principle underlying the present invention has not been clarified in respect to the reason why the carbon particles newly produced by the spark discharges in the oil participate in the aggregation with the carbonaceous particles originally present in the oil, but according to the known theory that a substance in the nascent state is relatively active, it can be postulated that the carbon particles are active immediately after segregation and separation from the grain surfaces, and that they participate in the aggregation with the carbonaceous particles originally present in the oil. Additionally, in view of the large impact pressures involved in the spark discharges, these pressures serving to disperse the carbon particles newly produced in the reactive system, and to distribute and mix all the substances present therein, it is believed that the spark discharge provide favourable conditions under which the carbon particles are sure to collide with each other, resulting in smooth aggregation of the substances into a mass. It can further be reasoned that in the present apparatus the spark discharges take place in a pulse pattern in the oil to be treated, as the result of the use of an oscillating circuit of high frequency, the carbon particles being placed under the electromagnetic influence while in a potentially very aggregative state. It will be understood, as well, that as the carbon particles are produced in the oil in the absence of air, they are protected from the reduced reactivity otherwise caused by air, which factor results in further facilitation of their aggregation.

The invention will now be more particularly described by way of example, with reference to the accompanying drawing which schematically shows an example of equipment employed in carrying out the present invention.

A pair of electrodes **2** and **3** are installed in an oil tank **1** made of an electrically insulating material and into which oil **4** is placed for refinement, such oil containing residual carbon and ash contents to be removed. The oil tank **1** is connected to a high frequency oscillating circuit **5** outside the tank.

In the preferred example illustrated, a quenched spark-gap oscillator is employed in order to ensure an increased frequency of discharges per unit time. Spark gaps **11** are connected in series with the electrodes **2** and **3**. The circuit **5** has terminals **6** and **7** for connection to a commercially available power supply, a step-up transformer **8**, a limiting resistor **9**, a charge-discharge capacitor **10**, the spark discharge gaps **11**, an oscillating inductance **12**, an inductance **13** connected in parallel with the electrodes **2** and **3** to ensure effective spark discharges, choke coils **14**, **15** and resistors **16** and **17**.

In the tank **1** there is a gas outlet duct **18** to vent gas generated by the refining of the oil. Grains A of electrically conductive material are supplied to form a dielectric medium through a hopper **19**, the oil being introduced through an inlet opening **20**. The treated oil is discharged through an outlet opening **21**.

In the system thus constructed, the oil tank **1** receives carbonaceous coarse grains A, whose size ranges from 5 mm. to 20 mm., immersed in the oil to be refined. Subsequently, a discharge voltage of high frequency is impressed across the electrodes **2**, **3** by the oscillating circuit **5** to cause sparks between the grains A, so that powder-like carbon particles are separated from the surface of each grain under the urging of the spark energy. Simultaneously, further carbon particles are segregated through decomposition of the oil, together with gases, the latter being evacuated from the system through the

duct **18**, the former being deposited in the oil within the tank **1**. The two kinds of carbon are violently agitated and mixed under the impact pressure of the sparks, which pressure causes individual grains to move to and fro in a continuous manner. This action causes changes of flash-points continuously, thereby preventing problems of local overheating and permitting uniform admixture of the carbon particles, which effect constitutes a valuable feature of the present invention in which spark discharge are used. As the sparks are repeatedly generated in a pulse pattern, the carbon particles increase in amount with time. Consequently, aggregation of them progresses as time advances.

EXAMPLE 1

In all the examples given hereinafter, a motor oil was used as the waste oil to be refined.

Dimensions of the oil tank: 200 mm. (diameter) by 1000 mm. length
Material of the oil tank: polypropylene
Material of the electrodes: graphite
Size of the electrodes: 20 mm. by 100 mm.
Spacing of the electrodes: 800 mm.
Source voltage: 220 v.
Discharge voltage: 20 kv.
Discharge frequency: 40 khy.
Freqencies of discharges: 6 per ½ cycle
Electricity consumed: 40 kwh.
Amount of carbonaceous grains: 15 kg. (substantially immersed in the oil)
Average size of the grains: 9.5 mm.
Amount of refinement: 600 l./hr.
Amount of oil consumed through cracking: 3.3 l./hr.
Amount of segregated carbon through cracking: 1.3 kg./hr.
Amount of separated carbon from the grain surface: 1.5 kg./hr.
Size of particles in suspension in the waste oil: 25 millimicrons to 2.5 micron
Size of particles in suspension after treatment: 15 micron to 40 micron

The following is a comparison of properties between the starting material, waste oil and the refined oil, where "refined oil" means oil free from suspended particles of impurities that were removed by a filter press after treatment by spark discharges.

	Waste oil	Refined oil
Residual carbon (percent)	2.810	0.159
Ash contents (percent)	0.525	0.005
Density 15 (4° C.)	0.899	0.889
Viscosity (centistoke, 50° C.)	57.0	46.7

EXAMPLE 2

Dimensions of the oil tank: 200 mm. (diameter) by 1000 mm. length
Material of the oil tank: polypropylene
Material of the electrodes: graphite
Size of the electrodes: 20 mm. by 100 mm.
Spacing of the electrodes: 800 mm.
Source voltage: 220 v.
Discharge voltage: 20 kv.
Discharge frequency: 40 khy.
Frequencies of discharges: 6 per ½ cycle (confirmed through an oscilloscope)
Electricity consumed: 40 kwh.
Active powder: gamma-alumina

Average size of the active powder: 40 micron
Amount of the active powder added to the waste oil: 5% of the oil (by weight)
Dielectric medium: sintered graphite
Amount of the dielectric medium: 15 kg. (immersed in the oil)
Average size of the dielectric medium: 10 mm.
Amount of refinement: 1000 l./hr.
Amount of the material oil consumed through cracking: 3.1 l./hr.
Amount of segregated carbon through cracking: 1.2 kg./hr.
Size of particles in suspension in the waste oil: 25 millimicron to 2.0 micron (confirmed through an electron microscope)
Average size of particles in suspension after treatment (aggregated particle): 45 micron
Amount of separated carbon from the grain surface: 1.5 kg./hr.

The refinement characteristics are as follows, comparing the results derived from the method according to the invention, with those from the prior art method where sulfuric acid is used, wherein the property of the starting material oil is this:

Ash contents: 0.525%
Residual carbon: 1.201%
Water: trace
Elementary analysis: C, (84.89%), H_2, (12.82%)

Properties	Method: Present invention	Method: Sulfuric acid method
Specific gravity 15 (4° C.)	0.892	0.8902
Color union	2½	3
Viscosity (210° F., centistoke)	10.86	11.08
Viscosity (100° F., centistoke)	102.31	102.98
Viscosity index	100.90	90.53
Pour/point (° C.)	−25	−10
Neutral value (KOH, mg./gr.)	0.003	0.07
Stability (170° C., 12 hours	pass	pass

The contrasting data is derived from the sulfuric acid method where the waste oil was heated at 185° under a pressure of −20 mm. Hg, to which sulfuric acid was added in the proportion of 50 kg. to 1 kl., and kept as it was for 24 hours, so that sulfuric acid sludge was formed in deposits, which, subsequently, was stirred at a temperature of 150° centigrade in the presence of activated clay in the proportion of 45 kg. to 1 kl., the latter being removed by means of a filter press.

The embodiments of the invention in which an exclusive property of privilege is claimed are defined as follows:

1. A method of refining waste oil containing solid particle impurities therein which method comprises the steps of:

(a) Immersing a pair of electrodes into the waste oil to be refined;
(b) Charging the waste oil with coarse grains of electrically conductive material,
(c) Impressing a pulsating discharge voltage of high frequency across the electrodes such that sparking is effected between said coarse grains so that carbon particles are formed thereby with said carbon particles causing aggregation of the solid particle impurities contained within the waste oil, and
(d) Separating the aggregated particles of impurities from the refined waste oil.

2. A method according to claim **1** wherein the coarse grains are powdered carbon.

3. A method according to claim 1 wherein an active powder is added to the waste oil.

4. A method according to claim 1 wherein an activated clay is added to the waste oil as an active powder.

5. A method according to claim 3 wherein the active powder is an active alumina.

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