Feb. 14, 1967 KIHEI KATSUTA ETAL 3,304,255

METHOD FOR CONTINUOUS REMOVAL OF CONTAMINANTS FROM LUBRICATING OIL AND APPARATUS THEREFOR

Filed Oct. 21, 1964

Fig. 1.

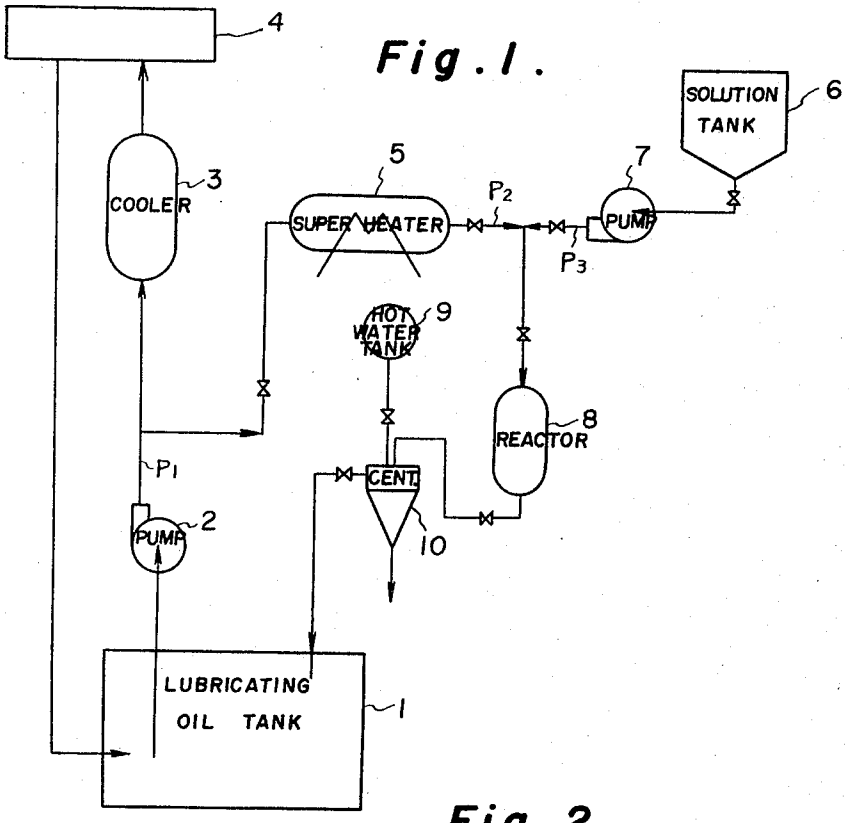
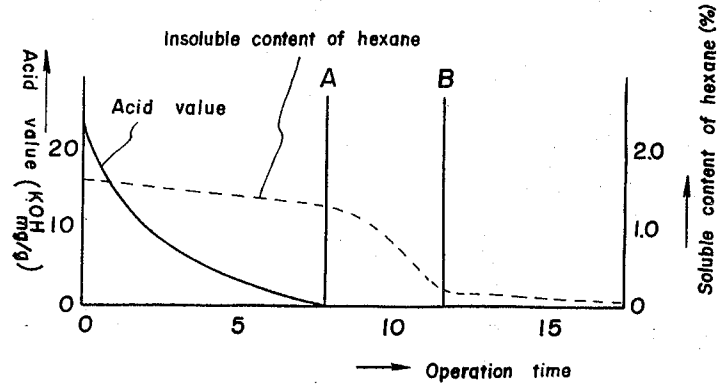


Fig. 2.



United States Patent Office

3,304,255

Patented Feb. 14, 1967

3,304,255

METHOD FOR CONTINUOUS REMOVAL OF CONTAMINANTS FROM LUBRICATING OIL AND APPARATUS THEREFOR

Kihei Katsuta, Akito Nakagawa, and Hideto Mitsutake, Nagasaki, Japan, assignors to Mitsubishi Jukogyo Kabushiki Kaisha, Tokyo, Japan

Filed Oct. 21, 1964, Ser. No. 405,509
Claims priority, application Japan, Oct. 23, 1963, 38/56,081
7 Claims. (Cl. 208—179)

This invention relates to methods and apparatus for continuously removing contaminants from tainted and deteriorated lubricating oil so that the oil may be constantly kept pure.

Lubricating oil used in an internal combustion engine, turbine, and the like will gradually deteriorate and become tainted until it has to be replaced. This is because foreign matter from the outside, particles of engine materials produced by friction and abrasion of inner surfaces, and unburned fuel are mixed with the oil, and also because the oil itself is oxidized and deteriorated by use for any prolonged period.

In an attempt to eliminate such deterioration as well as impurities, it has been the practice, for example in the case of large trunk-type diesel engines, to provide a purification system in addition to a lubricating system, whereby part of the lubricating oil is branched off and centrifuged or otherwise purified to remove the contaminants, the reclaimed oil being returned to the lubricating system for further use.

Recently, however, there has been a tendency to use more inferior fuel oils for engines, with the result that the amount of fuel left unburned in the combustion chamber and mixed with the lubricating oil is so large that it cannot be sufficiently purified by the aforementioned "side-flow" purification using a centrifuge. Consequently, the contaminated lubricating oil is more frequently the cause of premature abrasion of cylinder liners, burning of pistons, damage of piston rings, and other such engine troubles. To avoid such troubles, lubricating oil has to be replaced frequently by fresh oil.

In the light of this, improved methods of removing the contaminants have been proposed, which are roughly classified into two classes: one using a soap solution as a purifier and a second using a hydroxide of calcium, magnesium, or the like.

To be more precise, the first method consists of dispersing a higher fatty acid ester in tainted lubricating oil, reacting said dispersed ester with caustic soda thereby to prepare soap, and allowing the flocky material formed by the soap to envelop the contaminants as well as the deteriorated components of the oil. This method, however, has shortcomings in that it is a two-solution non-continuous process, and in that methanol must be used as the solvent for the reactants and has to be completely eliminated. Moreover, its cost is excessive. On the other hand, the second method is not very effective, and is believed to be useful merely in neutralizing acidic substances in the contaminated oil.

An object of the present invention is to obviate the disadvantages of the conventional processes, and to this end the invention provides a method for continuously separating and removing contaminants and deteriorated components from lubricating oil while the latter is in use, thereby keeping the oil in a purified state for a prolonged period.

More precisely, the method of the invention comprises continuously adding to lubricating oil an aqueous solution of strong alkali, in an amount of from 1 to 15 kg. (in terms of a 10% aqueous solution) to each ton of oil,

by means of which the particle size of the contaminants is increased due to cohesion of the fine particles of the contaminants. This procedure serves to facilitate separation of the impurities from the oil.

From analyses of lubricating oil sampled from a marine engine in operation, it was found that the grain size distribution of the contaminants in the lubricating oil which had been subjected to repeated side-flow purifications ranges from 0.5 to 5μ, centering around 1.7μ. Since the particle size of contaminants actually removable by a centrifuge installed aboard is presumed to be over 5μ, it follows that most of the contaminants remained in the oil.

According to the present invention, complete separation and removal of fine particles of contaminants from oil is accomplished by adding an aqueous solution of caustic alkali to lubricating oil thereby causing cohesion of the minute particles of contaminants in the oil.

The contaminants produced in lubricating oils are composed mostly of unburned fuel and, to a lesser extent, of metallic particles produced by abrasion of engine parts, and sulfates of said metallic particles. Most tainted oil also contains sulfuric acid. Some of these impurities are produced in the form of extremely minute particles. It is presumed that the metallic dust (for example, iron particles of engine materials produced by friction and abrasion of the inner surface) and sulfates, sulfuric acid, and other contaminants are absorbed around the unburned fuel, together with a small amount of water, to form incombustible particles.

Further, it is believed that these fine particles are electrically charged in a specific way, as in the case of colloid dispersion, such that they do not cohere.

Addition of caustic alkali according to the invention presumably neutralizes acidic substances adsorbed to the surfaces of the contaminants and produces metalic hydroxide, for example, iron hydroxide, according to which the electric charge on the minute particles is neutralized, and deteriorated and contaminating matter is adsorbed to the metalic hydroxide. This produces a remarkable increase in particle size.

The invention is illustrated by the following examples:

Example 1

On the basis of the formula

$$K=A+\alpha \text{ kg./ton of oil}$$

wherein A represents the acid value of the lubricating oil actually used in a diesel engine aboard a marine vessel, in KOH mg./g., and K represents the amount of caustic potash added to the oil, the additive was used with many different values of correction factor α, and the two were caused to contact each other thoroughly. The results of cohesion of deteriorated and contaminative ingredients were as shown in Table 1.

TABLE 1

Amount of caustic alkali K added (kg./ton oil)	Engine whose oil was tested				
	A	B	C	D	E
A−0.5	X	X	X	X	X
A−0.3	X	X	X	X	X
A	X	X	X	X	X
A+0.1	O	O	O	O	O
A+0.3	O	O	O	O	O
A+1	O	X	O	O	X

NOTE.—O indicates the case that cohesion occurred and the contaminants were removed, and X indicates the case in which the contaminants failed to cohere.

As is apparent from the table, cohesion takes place in the range of $\alpha=0.1$ to 0.3, but if the amount of additive is above or below that range, the cohesion which may result is not very satisfactory. The relation between the amount of caustic alkali in the specified range and the cohesion of contaminants remained substantially unchanged although the concentration of the aqueous alkali solution was changed considerably in the range around 10%.

As the acid value A varies within a range of from 1.2 to 0, the amount of alkali to be added may be from 1.5 to 0.1 kg. (preferably from 1.6 to 0.3 kg.) per ton of tainted lubricating oil. Further, the additive proves most effective when used as a 5% to 10% aqueous solution, although it is not objectionable to use other concentrations unless they exceed 20%.

It has become clear from inspections of engines aboard marine vessels that lubricating oil deteriorates and contaminates much faster than generally expected. For example, in a trunk-type diesel engine, an equilibrium condition in a certain concentration range which is dangerous to the engine is arrived at in 30 to 50 hours of engine operation.

Therefore, removal of sludge from lubricating oil will have little effect unless it is carried out continuously and at a rate corresponding to the rate of deterioration and contamination of the oil. No matter how excellent the separation may be, it will bring about no economic advantage if it does not involve continuous operation, because a very large amount of oil will have to be treated on a batch basis in order to keep pace with the rate of deterioration.

An object of this invention is to provide not only an improved method of separating and removing contaminants from lubricating oil, but also an apparatus which is capable of keeping lubricating oil in a pure state effectively by carrying out the above method continuously.

Another object of the invention is to provide a method of separating and removing contaminants from lubricating oil by adding a specific amount of strong alkaline solution to the oil.

A further object of the invention is to provide a method and apparatus for continuously separating and removing contaminants from lubricating oil.

A still further object of the invention is to provide an improved method and apparatus in which no particular reagent nor device need be used.

Other objects and advantages of the invention will be apparent to those skilled in the art from the following description taken in conjunction with the drawings, in which:

FIGURE 1 is a schematic view of an apparatus embodying the invention; and

FIGURE 2 shows the results of tests conducted with the apparatus shown in FIG. 1.

Referring now to the drawings, and particularly to FIG. 1, the lubricating oil system illustrated therein consists of a lubricating oil tank 1, a lubricating oil pump 2 which circulates the oil, a lubricating oil cooler 3, and the associated machine, e.g., a diesel engine 4. It has heretofore often been the practice to provide a purification system which is independent of the above circulatory lubrication system (1–2–3–4–1), so that lubricating oil is intermittently supplied from the oil tank to a centrifuge or the like through a lubricating oil superheater, the separated and purified oil being sent back to the oil tank.

However, as above described, better results are obtained by carrying out the purification treatment continuously and automatically at a velocity corresponding to the rate of deterioration of oil. It is for this reason that, according to the invention, lubricating oil is continuously supplied to the purification system, as shown, by means of the oil pump 2.

In the purification system branched from the piping P1 between the lubricating pump 2 and the cooler 3, lubricating oil is led through a superheater 5 into a reactor 8, the outlet port of which is coupled to a centrifuge 10. To the pipe P2 connecting the superheater 5 with the reactor 8 is connected, midway, a pipe P3 coupled to a chemical solution pump 7 for introducing a 10% caustic alkali solution at a certain ratio from a solution tank 6 into the lubricating oil. Indicated by numeral 9 is a hot water tank for supplying the centrifuge with hot water thereby to extract surplus alkaline residue from the lubricating oil.

As will be seen from FIG. 1, the apparatus according to the invention has advantageous features in that oil is continuously supplied to the purification system by means of the pump 2, and in that the chemical solution tank 6, chemical pump 7, and the reactor 8 are interposed between the lubricating oil heater 5 and centrifuge 10 in an ordinary purification system, so that the method of the invention can be put easily into practice.

The reactor 8 is intended for effecting reaction of acidic substances in the deteriorated components of the oil with the caustic alkali supplied and for subsequent formation of iron hydroxide, thereby to increase the particle size of the deteriorated components by cohesion. It is a cylindrical vessel provided with internal means, for example a rectifying plate (not shown), for permitting the fluid to stay within the reactor for a period of from 5 to 20 minutes (preferably 15 minutes) and to flow smoothly and uniformly. It may be modified to some extent without any substantially adverse effect, according to the location at which it is installed. Also, it is not at all objectionable to provide another pump for supplying oil to the purification system independently of the lubricating oil pump although, in the above embodiment, the purification system is branched from the outlet port of the lubricating oil pump.

The effect of the present invention achieved by the above apparatus is described hereunder.

Example 2

Lubricating oil used: Initial acid value, KOH mg./g.	2.24
Initial insoluble content of hexane, percent	1.29
Amount of oil passed through centrifuge, l./h.	100
Amount of sludge introduced (new oil mixed with 40% of engine sludge), g./h.	400
Amount of caustic soda used (in the form of a 10% aqueous solution), kg./ton/h.	6

The results obtained were as shown in FIG. 2. Despite continuous addition of engine sludge, a constant equilibrium was maintained and the oil retained good properties. Down to the point A in FIG. 2, the acid value gradually went on dropping while the concentration of contaminants (in terms of insoluble content of hexane) would not drop to any appreciable extent. When the acid value was reduced to almost zero, however, the concentration of the contaminants began to decrease rapidly, until an equilibrium was attained with a very low concentration of the point B. In this example, the sludge was additionally supplied to the purification system, but no adverse effect was observed whatsoever, and always normal values were obtained. The sludge was added in an amount several times more than the amount of sludge usually formed by a diesel engine in service.

The present invention is further characterized in that the contaminants separated by the method of the invention lack stiffness and contain little oil, and seldom stick to the separator plate of the centrifuge. Hence, the centrifuge can be cleaned with utmost ease, and the amount of oil wasted due to removal of the contaminants is very little. It is desirable for further improving the invention to use an additional centrifuge of known type which is capable of automatically discharging sludge, and any ordinary centrifuge usually installed aboard may be employed for that purpose.

What is claimed is:

1. A method for continuous removal of deteriorated and contaminative components of lubricating oil which comprises continuously adding to the lubricating oil an aqueous solution of less than about 20% of caustic alkali, thereby to increase the particle size of the deteriorated and contaminative components in the oil by cohesion, the alkali being added in an amount of 0.1 to 1.5 kg. per ton of oil, and thereafter separating and removing the thusly enlarged deteriorated and contaminative components.

2. A method as claimed in claim 1, wherein the alkali is caustic soda.

3. A method as claimed in claim 1, wherein the alkali is caustic potash.

4. A method as claimed in claim 1, wherein the solution is a 5–10% aqueous solution.

5. A method as claimed in claim 2 wherein the solution is a 5–10% aqueous solution.

6. A method as claimed in claim 3 wherein the solution is a 5–10% aqueous solution.

7. Apparatus for continuously removing deteriorated and contaminative components of lubricating oil which is conveyed through a circulating system between a tank and a utilization device, said apparatus comprising a pipe having one end connected to the circulating system for tapping a portion of said lubricating oil from the system, a

heater connected to said pipe at the other end thereof, supply means for supplying a constant amount of an aqueous solution of caustic alkali to said portion of oil heated by said heater, a reactor having one outlet and coupled to said heater and said supply means for effecting reaction of deteriorated and contaminative components in said portion of oil with the aqueous solution of caustic alkali, separating means connected to said outlet of said reactor for separating said components from said portion of oil, and a pipe connected to the separating means and to the circulating system for returning said portion of oil purified by separation of said components in said separating means to said circulating system.

References Cited by the Examiner

UNITED STATES PATENTS

1,318,086	10/1919	Kennedy	208—179
1,622,278	3/1927	Boyd	208—179
1,791,473	2/1931	Grisbaum	208—179
1,791,474	2/1931	Grisbaum	208—181
2,271,882	2/1942	Ambler	208—179
2,842,112	7/1958	Philips et al.	208—179

DELBERT E. GANTZ, *Primary Examiner.*

H. LEVINE, *Assistant Examiner.*