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LUBRICATING OIL COMPOSITIONS AND THE OPERATION OF INTERNAL COMBUSTION ENGINES

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This invention relates to lubricating compositions suitable for crankcase and cylinder lubrication of internal combustion engines, particularly diesel engines, and to the operation of such engines. The lubricating compositions according to the invention are especially suitable for lubricating the cylinders of internal combustion engines which are run on residual fuels, blends of residual and distillate fuels, or distillate fuels which form a high proportion of acidic products on combustion. Distillate fuels which form a high proportion of acidic products on combustion comprise those having a total sulphur content of at least 0.1% by weight.

The use of the above-mentioned fuels is attractive owing to their low cost, but it has been found that such use gives rise to abnormally high cylinder wear due to the presence in the fuel of various inorganic materials, such as sulphur and, in some cases, vanadium and sodium. The cleanliness of engines using such fuels is also unsatisfactory.

We have now discovered that the cylinder wear rate and cleanliness of engines running on such fuels can be considerably improved by using a particular type of lubricating composition for the cylinders.

According to the invention, there is provided a mobile lubricating composition comprising a lubricating oil having dissolved in it

(*a*) Up to 40%, preferably 5–25%, by weight of the composition, of an additive consisting of a mixture of polymeric organic aluminum compounds of the general formula

$$(OAlOOCR)_n \qquad I$$

where n is an integer greater than 1 and R is a saturated or unsaturated alkyl or aryl radical containing 6–30, especially 12–20, carbon atoms, and

(*b*) A minor amount, preferably 0.5–5% by weight of the composition, of cetyl alcohol.

It is to be understood that the additive (*a*) may consist of a mixture of molecues of different molecular weight. Preferably the predominating polymer is the one for which $n=3$. It is also to be understood that the additives (*a*) may contain different alkyl or aryl radicals even in the same molecule.

The lubricating oil used in the compositions according to the invention is preferably a mineral lubricating oil, especially an SAE 30, 40 or 50 grade oil.

The polymeric organic aluminium compounds used in the compositions according to the invention are compounds which react with water to form hydroxy aluminium acylates (i.e. compounds of the formula $(HO)_2AlOOCR$ or $HOAl(OOCR)_2$) and which have two or more aluminium atoms per molecule, the aluminium atoms being connected to each other via single oxygen atoms and each aluminium atom having at least one connection to an acylate group (i.e. a group having the formula RCOO—).

The polymeric organic aluminium compounds may be prepared by heating aluminium alcoholates with water and carboxylic acids (e.g. stearic, oleic or benzoic acids) in one or more stages and preferably in an inert, non-volatile diluent such as a light lubrication oil. This method of preparation is described in detail in U.K. Patent specification 825,878 and in published Australian patent application 29673/57. Alternatively, they may be prepared by heating aluminium alcoholates with carboxylic acids so as to liberate alcohol and form acyloxy aluminium alcoholate compounds, and further heating the latter compounds. This method of preparation is described in detail in the specification of U.K. Patent 806,113.

Certain of the polymeric organic aluminium compounds described above, when dissolved in lubricating oils, turn the oils to greases in the presence of water and when using such materials to prepare lubricating compositions according to the invention it is necessary to add an anti-gelling agent to ensure that the composition remains in a mobile condition in use. 8-hydroxyquinoline has been found to be a particularly suitable anti-gelling agent for this purpose.

Certain of the preferred polymeric organic aluminium compounds for use in the compositions according to the invention are available commercially under the trade name "Manalox." One such commercially available material (hereinafter called additive "M") was prepared as follows. One molecular proportion of aluminium isopropoxide was reacted with two molecular proportions of oleic acid at a temperature increasing to about 300° C. Two molecular proportions of isopropanol distilled over during the reaction, a slight vacuum being applied near the end of the reaction to remove the last traces of isopropanol. The product consisted of a mixture of approximately equal amounts by weight of isopropyl oleate and an aluminium compound believed to consist essentially of molecules of Formula I in which R is a radical such that the acid R.COOH is oleic acid and the predominating polymer is the one for which $n=3$.

The invention also consists in a method of operating an internal combustion engine, particularly a diesel engine, e.g. a marine diesel engine, which is running on a fuel having a total sulphur content of at least 0.1%, especially at least 0.5%, by weight, e.g. a residual fuel, in which the cylinder lubricating is effected by a mobile lubricating composition as specified above according to the invention.

An example of the invention will now be described.

EXAMPLE

A number of comparative tests were carried out on a Ruston engine (a horizontal, single cylinder, slow-speed diesel engine having separate cylinder lubrication), using in all cases a residual fuel having a viscosity at 100° F. of 1500 seconds Redwood I, a sulphur content of 3.49% by weight and an ash content of 0.027% by weight, and using in turn the following mobile lubricating compositions as the cylinder lubricant.

Base Oil P: An SAE 30 grade mineral lubricating oil having a Redwood I viscosity of 140 seconds at 140° F. and a viscosity index of 65.

Composition A:	Percent wt.
Base oil P	94.5
Calcium soap	1.5
Calcium carbonate	4.0

Composition B: A commercially available marine diesel oil consisting of a water-in-oil emulsion containing calcium acetate dissolved in the aqueous phase.

Composition C:	Percent wt.
Base oil P	85
Additive M	15
Composition D:	
Base oil P	85
Additive M	13
Cetyl alcohol	2

The results of the tests during runs of 100 hours each are given in the following table.

Table

Lubricant	Liner Wear, .001"/1,000 hr.	Top Ring Wear, g./1,000 hr.
Base oil P	27.2	40.0
Composition A	14.6	----------
Composition B	8.3	----------
Composition C	6.0	51
Composition D:		
Run 1	5.1	37
Run 2	3.2	31

It will be seen that when operating the Ruston engine using the lubricating composition according to the present invention (Composition D), the liner and top ring wear rates were lower than when using any of the other compositions.

We claim:

1. A mobile lubricating composition, suitable for use in the cylinders of an internal combustion engine operating on a fuel having a total sulphur content of at least 0.1% by weight, consisting essentially of a lubricating oil having dissolved in it,

(*a*) a sufficient amount of an aluminium additive to reduce, during such use, the corrosion caused by acids derived from the sulphur in the said fuel and to provide a maximum aluminium additive concentration of 40% by weight of the total composition, the aluminium additive consisting of a mixture of polymeric organic aluminium compounds of the general formula $(OAlOOCR)_n$, where n is greater than 1 and R represents at least one radical selected from the group consisting of saturated and unsaturated alkyl and aryl radicals containing 6–30 carbon atoms, and

(*b*) a minor amount of cetyl alcohol sufficient to enhance the cylinder wear inhibiting ability of said polymeric aluminium additive.

2. A lubricating composition according to claim 1, in which the amount of cetyl alcohol is 0.5–5% by weight of the total composition.

3. A lubricating composition according to claim 1, in which the amount of the additive is 5–25% by weight of the total composition.

4. A lubricating composition according to claim 1, in which the polymeric organic aluminium compound is one where the predominating polymer is the one for which $n=3$.

5. A lubricating composition according to claim 1, in which R contains 12–20 carbon atoms.

6. A lubricating composition according to claim 5, in which R is an unsaturated aliphatic radical derived from oleic acid.

7. A lubricating composition according to claim 1, in which the composition also contains 12-hydroxyquinoline as an anti-gelling agent.

8. A lubricating composition according to claim 1 in which the lubricating oil is a mineral lubricating oil.

9. A lubricating composition according to claim 8, in which the mineral lubricating oil is one having an SAE number between 30 and 50 inclusive.

10. A method of operating an internal combustion engine on a fuel having a total sulphur content of at least 0.1% by weight, in which the cylinder lubrication is effected by means of a lubricating composition according to claim 1.

11. A method according to claim 10, in which the fuel is a residual fuel.

12. A method according to claim 11 in which the fuel contains at least 0.5% by weight of sulphur.

13. A method according to claim 10, in which the engine is a diesel engine.

14. A method according to claim 13, in which the diesel engine is a marine diesel engine

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