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2,725,856

METHOD OF REDUCING THE OCTANE REQUIREMENT OF AN ENGINE

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5 Claims. (Cl. 123—1)

The present invention relates to a method of and composition for reducing the tendency of an internal combustion engine to knock.

It is well known that deposits quickly accumulate in the combustion chambers of internal combustion engines such as those used in automobiles. An engine containing deposits is said to have a higher octane requirement than a clean engine because it requires a gasoline with a higher octane rating if the engine is not to knock. This becomes apparent to the driver of an automobile having a dirty engine by the tendency of the engine to knock while accelerating, climbing a hill or otherwise operating the engine under greater than normal load. The deleterious effects of such accumulations of deposits are particularly noticeable in engines having a high compression ratio because the margin between the octane numbers of gasolines on the market and the octane requirement of the engine when clean is narrower than for engines having lower compression ratios. When such an engine becomes dirty the octane number of the gasoline required by the engine in order not to knock is increased and often reaches a value higher than the octane rating of gasolines generally available.

When the fuel used in an internal combustion engine contains tetraethyl lead, an agent which in effect raises the octane rating of the fuel, the increase in octane requirement of the engine with continued use becomes greater than when non-leaded fuels are used, especially under mild conditions simulating ordinary driving. Thus, whereas the octane requirement of an internal combustion engine operating on non-leaded fuel under the conditions of a standard engine test described hereinafter may increase from say 70 for a clean engine to 78 for a dirty engine and then level off at that figure, the octane requirement in the same engine, if run on leaded fuel, will increase to 82 or more for a dirty engine before levelling off.

It has been found that the deposits in the combustion chambers in internal combustion engines run on leaded fuel are different on different surfaces, apparently because of their different average temperatures. In an aviation engine, for example, the metal temperatures of the piston, cylinder intake valve and exhaust valve are 300 to 500, 400 to 600, 600 to 800 and 1000 to 1200° F., respectively. The composition of the deposits appears to depend on the metal temperature of the particular surface. Where the metal temperature is of the order of about 400° F. the deposits analyze about 50–60% lead and consist of from about 25 to 30% lead sulfite and lead sulfate, 20% lead monoxide, 35 to 40% lead bromide and about 15% carbon. Where the metal temperature is considerably higher, i. e., of the order of 1000 to 1200° F., the lead content is about 70% and the deposits are composed almost entirely of lead sulfate, lead sulfite and lead monoxide, the concentration of lead bromide being extremely small and the amount of carbon being practically zero. These observations are recorded in ASTM Bulletin, No. 154, October 1948, page 53, "Better Lead

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Scavenging Needed for Aviation Gasoline," by E. A. Droege Mueller.

It is well known, of course, that ordinarily the octane requirement of an engine, whether it be an automobile, marine or airplane engine, is reduced in order to restore or at least to approach its original efficiency by the process of removing a cylinder head and grinding or abrading off the deposits found on the various surfaces of the combustion chamber, such as the piston top, the cylinder wall, cylinder head and the intake and exhaust valves. This method, while quite effective, has the disadvantage of requiring skilled labor and a considerable amount of time to dismantle, clean and reassemble the engine. It is therefore responsible, when carried out on engines of commercial vehicles, for making it necessary to withdraw the vehicle completely from service while the engine is being overhauled.

A great number of other methods have been proposed heretofore for cleaning the combustion chambers of an engine without removing the cylinder head. One of these methods is that of introducing a liquid solvent into the carburetor while the engine is running. Although this method produces great billows of smoke at the exhaust, it has been found, upon taking apart an engine so treated, that little of the deposits are actually removed.

In accordance with this invention the octane requirement of a dirty internal combustion engine, which term is intended to include spark ignition and fuel injection type engines, is reduced by coating the deposit-bearing surfaces of the combustion chambers of a dirty engine with a composition containing an inorganic boron compound selected from the group consisting of borates, borides and boranes of the alkali and alkaline earth metals. The coating of the combustion chamber wall surfaces may be accomplished in any desirable manner, such as by spraying or squirting the composition into the combustion chamber through an opening such as that provided by removal of the spark plug or injection nozzle. The composition to be applied to the dirty combustion chamber walls essentially comprises two components. One component is chemically reactive with lead or its compounds under the conditions within the combustion chambers of a running internal combustion engine and comprises one or more borates, borides or boranes of alkali or alkaline earth metals. The other essential component performs the purely physical function of adhering the reactive component to the combustion chamber walls and is a thick, tacky, metal-adhering material or mixture of materials that is fairly viscous or non-flowable at ambient temperatures, non-corrosive to the engine parts, and preferably readily removable from the combustion chamber by eventual volatilization and/or combustion under the conditions in the combustion chamber.

While it is to be understood that the scope of the invention is not to be limited by any theory advanced herein, it is believed that the lead in the lead sulfate, lead sulfite and lead oxides forming the combustion chamber deposits is, by reason of its variable valence, in an active state and probably exerts an unfavorable catalytic effect on the combustion of the fuel in the engine. It is believed that by treating these lead salts with an inorganic boron compound, a binary compound is formed in the deposits in which the lead is comparatively inactive, since it can no longer move freely from one valence state to another, and its catalytic action is thereby inhibited.

It is, of course, desirable that the composition contain the highest possible concentration of boron consistent with the requirements that the composition be fairly viscous and capable of adhering to the combustion chamber walls and particularly to the deposits on the walls.

Generally, the composition should contain at least

about 10% by weight boron compound to be effective and up to about 90% by weight to retain viscosity, stability and adhering power.

Borax is preferred as the boron-containing inorganic compound for the purposes of this invention, chiefly because of its high boron content and its availability and low cost. It is to be understood, however, that other compounds of boron with alkali and alkaline earth metals, while perhaps not as readily available or as inexpensive, may likewise be used in the method of this invention. Such other boron compounds include:

Sodium metaborate NaBO_2
Sodium perborate NaBO_3
Sodium tetraboranide $\text{Na}_2\text{B}_4\text{H}_{10}$
Potassium metaborate KBO_2
Potassium tetraborate $\text{K}_2\text{B}_4\text{O}_7$
Potassium pentaborate KB_5O_8
Potassium perborate KBO_3
Potassium diborane $\text{K}_2\text{B}_2\text{H}_6$
Potassium dihydroxy-diborane $\text{K}_2\text{B}_2\text{H}_6\text{O}_2$
Potassium pentaborane $\text{K}_2\text{B}_5\text{H}_9$
Lithium metaborate LiBO_2
Lithium tetraborate $\text{Li}_2\text{B}_4\text{O}_7$
Calcium metaborate $\text{Ca}(\text{BO}_2)_2$
Calcium tetraborate CaB_4O_7
Calcium boride CaB_6
Barium boride BaB_6
Strontium tetraborate SrB_4O_7
Strontium boride SrB_6

Because of the purely physical function of the vehicle or carrier component, its chemical composition and structure are not particularly critical so long as it is capable of carrying the boron compound, adhering to metal and combustion chamber deposits, and does not damage the engine. Generally, viscous and tacky hydrocarbons that are capable of being volatilized or consumed under the conditions of combustion in the combustion chamber of a running engine and thereby removed, are preferred as vehicles in the composition. Such vehicles or carriers include petroleum bright stocks, polybutenes, petrolatums, hydrocarbon oils thickened, if desired, to gel form with suitable thickening agents such as hydrogenated castor oil, and greases, particularly the softer greases. One type of vehicle that has been found particularly useful is a 50-50 mixture of a petroleum bright stock having a viscosity of about 700-2300 SSU at 100° F. and a viscous synthetic polybutene having a molecular weight of about 1185.

The advantages and utility of the invention will become more apparent from the examples included herein for illustrative purposes only.

The following compositions, in which the proportions are by weight, are spread on piston tops having appreciable amounts of deposits covering the surface:

Composition No.	Borate	Vehicle
1-----	10% sodium perborate-----	90% White Petrolatum.
2-----	90% sodium perborate-----	10% White Petrolatum.
3-----	10% sodium metaborate-----	90% White Petrolatum.
4-----	90% sodium metaborate-----	10% White Petrolatum.
5-----	do-----	10% Penn. Bright Stock.
6-----	50% sodium tetraborate-----	50% Equal parts of Penn. Bright Stock and Polybutene.

Satisfactory adherence of these compositions to the deposits is demonstrated by the fact that although the coated pistons are laid on their sides for three weeks and maintained at room temperature, the compositions do not flow or run off to any appreciable degree.

A standard, clean, six-cylinder Chevrolet automobile engine was run on gasoline containing 3 cc. per gallon tetraethyl lead under a standard procedure designed to

approximate ordinary driving conditions and dirty the engine. This procedure involves running the engine for five minutes at 2000 R. P. M., corresponding to a road speed of 40 M. P. H. with standard spark advance, an oil temperature of 190° F., and a water temperature at the jacket outlet of 160° F., and then running the engine for one minute at 500 R. P. M. under idling conditions. This six minute cycle was repeated until the octane requirement of the engine had arrived at an equilibrium value. In measuring the octane requirement at intervals of about eight hours, the engine was operated under the following conditions:

Speed, R. P. M.----- 1000
Load throttle----- full
Jacket outlet----- 160°
Oil temperature----- 190°
Spark advance----- 11° BTDC
Air fuel ratio----- 13.5

After the octane requirement had risen from an initial of 70 to an equilibrium value of 79, Composition No. 6 listed above, consisting of a mixture of 25% petroleum bright stock having a viscosity of 1550 SSU at 100° F., 25% of a viscous synthetic polybutene (available commercially as "oronite polybutene No. 32") having a molecular weight of about 1185, and 50% borax was coated on the combustion chamber walls of the dirty engine to a thickness of about 1/8".

The engine testing procedure previously described was then resumed and the octane requirement of the engine was measured after 1, 30 and 58 hours of operation alternately at 2000 and 500 R. P. M. It was found that the octane requirement of the engine was 81 after the first hour, 70 after 30 hours, and 74 after 58 hours.

These tests show that the borax effected a significant reduction in octane requirements, thus indicating effectiveness in inhibiting undesirable catalytic action on the part of the engine deposits. It also demonstrates the prolonged effects of the treatment in that even after 58 hours of engine operation, which is equivalent to 2320 miles, the octane requirement had risen only four octane units. It was observed that the decrease in octane requirement was accompanied by improved compression and a 10% increase in engine power output.

It is to be expected that variations and modifications of this invention will readily occur to those skilled in the art upon reading the present description. All such modifications are intended to be included within the scope of the invention as defined in the accompanying claims.

I claim:

1. A method of reducing the octane requirement of a dirty internal combustion engine having lead-containing deposits on the surfaces forming the combustion chambers which comprises coating the deposit-bearing combustion chamber surfaces with a composition essentially comprising from about 10 to 90% by weight of a viscous, metal-adhering vehicle that is non-corrosive to the engine parts and contains from about 90 to 10% of an inorganic boron compound selected from the group consisting of borates, borides and boranes of the alkali and alkaline earth metals, and then running the engine.

2. The method defined in claim 1 in which the composition is sprayed into the combustion chambers of the engine through the spark plug openings thereof and the vehicle component of the composition is a hydrocarbon.

3. The method defined in claim 1 in which the composition is sprayed into the combustion chambers of the engine through the spark plug openings thereof and wherein the vehicle component of the composition is a mixture of equal parts by weight of a bright stock having a viscosity of about 700-2300 SSU at 100° F. and a viscous synthetic polybutene having a molecular weight of about 1185.

4. The method defined in claim 1 in which the composition is sprayed into the combustion chambers of the

engine through the spark plug openings thereof and in which the inorganic boron compound is borax.

5. A method of reducing the octane requirement of a dirty internal combustion engine having lead-containing deposits on the surfaces forming the combustion chambers which comprises coating the deposit-bearing combustion chamber surfaces with a composition essentially comprising from about 10 to 90% by weight borax and from about 90 to 10% by weight of a mixture of equal parts by weight of bright stock having a viscosity of about 700-2300 SSU at 100° F. and a polybutene having a molecular weight about 1185, and then running the engine.

1,749,312
2,089,580
2,460,700
2,578,585
2,614,985

5

Blair ----- Mar. 4, 1930
Schulze ----- Aug. 10, 1937
Lyons ----- Feb. 1, 1949
Orozco ----- Dec. 11, 1951
Cook ----- Oct. 21, 1952

OTHER REFERENCES

"Pharmaceutical Formulas," vol. I, 12th Ed., 1953.
Pub. by The Chemist and Druggist, London, pages 839
and 848 pertinent.

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References Cited in the file of this patent

15

UNITED STATES PATENTS

154,130 Eggleston ----- Aug. 18, 1874