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LIQUID FUEL FOR INTERNAL COMBUSTION
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of New YorkNo Drawing. Application September 20, 1938,
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11 Claims. (Cl. 44-57)

This invention relates to improvements in liquid fuels suitable for use in internal combustion engines, and more especially in engines of the injector type.

A principal object of the invention is to increase the combustion quality of liquid fuels which have a high flash point and a high boiling point and which are used in Diesel engines or other types of engines where the principle of injection in contrast with that of carburetion is used.

Another object of the invention is to increase the cetene value of the fuels so that unit for unit they can stand higher compression and give greater power by combustion.

A further object of the invention is to produce better combustion so that the interior of the combustion chamber will be free from carbon deposits and the exhaust will be relatively freer from carbon monoxide.

A still further object of the invention is to produce a fuel of high ignition quality and yet relatively no more corrosive to the engine walls than the normal fuel itself.

It has been established by experiments that the ideal fuel for use in engines of the Diesel type, which operate on injected fuel, is cetene, a relatively heavy and non-volatile hydrocarbon oil containing between 16 and 18 carbon atoms. Pure cetene, however, is too expensive and difficult to produce for practical use, and as a result, there have been many attempts made to devise treatments for other similar fuels to increase their cetene rating. Such treatments are known as "doping" and comprise adding to the fuel oil compounds which contain oxygen in excess of the amount necessary for their own combustion. The compounds more commonly used for this purpose are various nitro compounds such as ethyl nitrate, amyl nitrate, and even nitroglycerine and picric acid, which is tri-nitrophenol.

Some of these nitro compounds are reasonably satisfactory for this purpose but their cost is prohibitive. Other nitro compounds such as picric acid and nitroglycerine are dangerous to handle, not to speak of their expensive price. All nitro compounds, dangerous or otherwise, produce during combustion nitric oxide gas which in combination with the water of the combustion produces the well known nitric acid. It is needless to speak further of the corrosiveness of this acid which is the strongest known to chemistry.

I am aware that other nitrogen compounds such as nitrites as well as amino compounds are used for this purpose either for "doping" or for

stabilizing. I am also aware that certain organic peroxides have been suggested for "doping" liquid fuels for use in the injector type of internal combustion engines.

The suggested compounds in the prior art are benzoyl peroxide, acetone peroxide, tetralene peroxide, naphthalene peroxide, and the peroxides produced in the Diesel oils themselves, which really are the ozonides, amylene peroxide, hydrogen peroxide and several peracid salts such as perborates, percarbonates, etc. These peroxides, while they have shown a certain usefulness in the raising of the cetene values, have found no practical use.

Substantially all of the above mentioned compounds suffer from many serious drawbacks for purposes of "doping" the liquid fuels. First, almost all of them are substantially insoluble in all oily materials such as Diesel fuels, vegetable, or animal oils, fatty acids, etc. Solubility to the extent of a small fraction of 1% is of no consequence, since in practice the "dopes" have to be used in proportions of approximately 1% to 5% to bring about practical results.

The second serious drawback of the suggested compounds is that with the exception of benzoyl peroxide, all others are relatively too unstable to be used as "dopes" in these fuels.

Thirdly, most of these compounds such as benzoyl peroxide, and naphthalene peroxide, etc., are sensitive both to heat and compression and consequently decompose or explode prematurely before they are injected with the fuel in the combustion chamber. Due to their lack of solubility, the unit injected fuel does not contain a uniform homogeneous amount of this "dope." This results in lack of uniformity in ignition.

According to the practice of this invention, it has been found that most of these drawbacks may be avoided and a fuel of high ignition quality, that is, high cetene value, may be prepared by using as "dopes" organic peroxides of the acyl or alkyl type, and particularly those that are oil- or fat-soluble.

The suitable peroxides for this purpose are those of butyric acid, caproic acid, lauric acid, myristic acid, palmitic acid, stearic acid, etc. Although the above are peroxides of the even carbon atom acids, it is to be understood that peroxides of the odd carbon atoms, as well as those that contain a ring and an attached side chain of no less than 5 carbon atoms, are understood to be included within the scope of the invention.

The higher fatty acids containing 10 or more carbon atoms, straight chain, branch chain, ring

with a side chain, saturated or unsaturated, odd or even carbon atoms, are to be preferred. It is to be understood, however, that alkyl peroxides containing 6 or more carbon atoms, saturated or unsaturated, odd or even carbon atoms, are definitely within the scope of the invention.

The acyl or alkyl peroxides used for "doping" in this invention are all soluble in liquid fuels to a sufficient extent so that 1% to 5% may be dissolved in these fuels. Secondly, they are quite stable and lose but a small portion of their value when stored as "doped" fuels for a period of at least about a year. Thirdly, they are not at all sensitive to heat and pressure and are substantially non-explosive under practical working conditions. For this reason they do not decompose or explode prematurely and due to their solubility do not produce non-uniform ignition.

The organic peroxides have another great advantage although in common with all other organic peroxides, and that is that in a normal production of combustion they are no more corrosive to the engine than the straight "undoped" fuels.

This use of organic peroxides in doping produces considerable unexpected behavior, one instance of which is that in homologous series, the rise of cetene value, instead of being proportional to the available oxygen of the peroxide, seems to increase first in inverse proportion to the peroxidic oxygen content, apparently reaches a peak, and then falls off as the number of carbon atoms increases.

The peroxides of lower carbon atoms do not increase the cetene value in proportion to the peroxidic oxygen they contain. The peroxides containing from 10 carbon atoms upward seem to have the optimum effect for this purpose and this is the reason why I prefer to use peroxides of acids or alkyls containing 10 or more carbon atoms, although those containing as few as 6 carbon atoms may be used. The optimum for this seems to lie somewhere between 16 to 20 carbon atoms, although this increase over 10, 12 or 14 carbon atoms is not appreciably very large. This is certainly a very strange behavior and quite unexpected according to principles of stoichiometry.

According to the practice of this invention, any suitable oleaginous compound may be used as a base. The usual requirements for suitability are non-volatility, water insolubility, high flash point and high boiling point. Either a mineral, vegetable, or animal oil may be used. Hydrocarbon oils or their derivatives are particularly suitable, especially their ester derivatives. To this oil base is added about 1% to 1.5% of a suitable peroxidic compound of the above specified types, and the resulting solution is used as the fuel.

The cetene values of the liquid fuel, particularly of the Diesel type, are increased by my invention from 25 to 50 units depending upon the original cetene value of the fuel. This is an extraordinary increase compared with the cetene increase as found by prior doping with organic peroxides or the nitro compounds.

In prior practice whether a nitro compound is used or an organic peroxide of the type mentioned above, the cetene increase has not been any more than 10 to 20 points by the addition of 1% to 1½% of the dopes. Thus acetone peroxide increases the cetene only 10 points. Tetralene peroxide increases the cetene value about 14 points, while with nitro compounds it also increases about 14 points.

According to this invention, when the fuel is doped with 1 to 1½% of a suitable peroxide, the cetene value rises 30 to 50 points when the original cetene value is lower than 30. When the original cetene is between 30 to 50, then the rise is between 40 to 20 respectively. And when the original cetene is above 50, the increase may be only 20, or in some cases may be even lower.

The acyl peroxides of the saturated acids increase the cloud point as well as the pour point of the fuel. This, of course, in some cases is undesirable, and in order to avoid this particular drawback some mutual solvent such as ether, acetone or lower hydrocarbons may be used. The peroxides of unsaturated acids are normally liquids at room temperature and are soluble in much larger proportion without in any way affecting the cloud or the pour point.

In speaking of the peroxides of the unsaturated acids, there is meant the true acyl peroxides and not peroxides or ozonides produced by the addition of oxygen at the point of the double or treble bonds. The peroxides produced from unsaturated compounds by the addition of oxygen at the double or treble bonds are normally solid and gummy and are not to be confused with the peroxides used in this invention.

Since certain changes in carrying out the above process, and certain modifications in the composition which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

It is to be understood also that the following claims are intended to cover all of the generic and specific features of the invention as herein described, and all statements of the scope of the invention which as a matter of language might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A liquid fuel suitable for internal combustion engines of the Diesel type, comprising a non-volatile oleaginous compound and a peroxidic compound selected from the group of peroxidic compounds consisting of only such alkyl peroxides and acyl peroxides as are soluble in said oleaginous compound and contain at least 6 carbon atoms in the radical.

2. A liquid fuel suitable for internal combustion engines of the Diesel type, comprising an organic, water-insoluble hydrocarbon compound or its derivatives, and a peroxidic compound selected from the group of peroxidic compounds consisting of only such alkyl peroxides and acyl peroxides as are soluble in said hydrocarbon compound and contain at least 6 carbon atoms in the radical.

3. A liquid fuel suitable for internal combustion engines of the Diesel type, comprising a hydrocarbon or its ester derivatives, and a peroxidic compound selected from the group of peroxidic compounds consisting of only such alkyl peroxides and acyl peroxides as are soluble in said hydrocarbon compound and contain at least 6 carbon atoms in the radical.

4. A liquid fuel suitable for internal combustion engines of the Diesel type, comprising an oil of mineral origin and a true peroxidic compound selected from the group of peroxidic compounds consisting of only such alkyl peroxides and acyl peroxides as are soluble in said oil and contain at least 6 carbon atoms in the radical.

5. A liquid fuel suitable for internal combustion engines of the Diesel type, comprising an oil of

vegetable origin and a true peroxidic compound selected from the group of peroxidic compounds consisting of only such alkyl peroxides and acyl peroxides as are soluble in said oil and contain at least 6 carbon atoms in the radical.

6. A liquid fuel suitable for internal combustion engines of the Diesel type, comprising an oil of animal origin and a true ozonidic peroxidic compound selected from the group of peroxidic compounds consisting of only such alkyl peroxides and acyl peroxides as are soluble in said oil and contain at least 6 carbon atoms in the radical.

7. A liquid fuel suitable for internal combustion engines, particularly of the Diesel type, comprising an organic combustible material of high flash and high boiling point and a true peroxidic compound of fatty acids containing at least 10 carbon atoms, which is soluble in the said oil.

8. A liquid fuel suitable for internal combustion engines, particularly of the Diesel type, comprising an organic combustible material of high flash

and high boiling point, and a true peroxidic compound of the alkyl type containing at least 10 carbon atoms, and which is soluble in the said oil.

9. A liquid fuel suitable for internal combustion engines, particularly of the Diesel type, comprising an organic combustible material of high flash and high boiling point, and a true peroxidic compound of an alicyclic acid, containing at least 10 carbon atoms, and which is soluble in said oil.

10. A liquid fuel suitable for internal combustion engines, particularly of the Diesel type, comprising an organic combustible material of high flash and high boiling point, and a true peroxidic compound of alicyclic fatty acid containing at least 10 carbon atoms, and which is soluble in said oil.

11. A Diesel fuel containing lauroyl peroxide in sufficient amount to increase the cetane number of the fuel base.

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CERTIFICATE OF CORRECTION.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, first column, line 8, claim 6, strike out the word "ozonidic"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 24th day of November, A. D. 1942.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)