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FUEL

Carl S. Marvel, Urbana, Ill., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del., a corporation of Delaware

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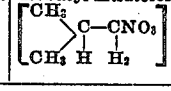
This invention relates to improvements in compression ignition fuels and it particularly relates to the use of novel ignition accelerators for the said fuels.

One object of this invention relates to improvements in Diesel engine fuels, and particularly in fuels adapted for use in high-speed compression ignition engines whereby to obtain reduction of the delay period between the injection and the ignition of the fuel oil, a reduction in the ignition temperature of the fuel oil and/or a lowering of the compression ratio of the engine. A more specific object relates to compression ignition fuels containing as an ignition accelerator an alkyl nitrate containing a branched carbon chain and corresponding to the nitrates of the higher alcohols produced by the catalytic hydrogenation of carbon monoxide. Other objects of the invention will become apparent from the following description.

In accordance with the present invention, it has been found that when the nitrates of branched chain alcohols obtainable by carbon monoxide hydrogenation are added to the fuel oil there is obtained a reduction in the delay period between injection and ignition of the fuel oil. This phenomenon is accomplished by a lowering of the ignition temperature of the fuel oil and/or a lowering of the compression ratio in the compression engine required to ignite the fuel. Alkyl nitrates of the character described have a substantial solubility in fuel oil.

The following table illustrates the effect of the use of these alkyl nitrates on the fuel oil characteristics. The properties of the doped and modified fuel oil are compared with those of the unmodified fuel oil:

Composition fuel	Accelerator	Second delay at 514° C.	Minimum ignition temperature	Minimum compression ratio
Fuel oil		0.94	500	9.5
Fuel oil+5% by wt.	Isobutyl nitrate	0.22	300	9.0



The method of test for determining the ignition delay and minimum ignition temperature consisted in injecting the fuel oil into air at atmospheric pressure into a heated chamber. The ignition delay is the elapsed time between injection and ignition of the fuel. The minimum ignition temperature is the lowest temperature at which a majority of a series of samples injected into the chamber ignite. The minimum compression ratio was determined according to the method described by Pope and Murdock in the Society of Automotive Engineers Journal, Transactions pages 136–142 for March, 1932.

Tertiary butyl nitrate may be used in lieu of isobutyl nitrate but the latter is preferred due to the fact that isobutyl alcohol is available in large quantities as a product of carbon monoxide hydrogenation.

In general, I have found that the nitrates of the branch chain alcohols produced by the hydrogenation of carbon monoxide are considerably superior to the ethyl and methyl nitrates which have hitherto been proposed as Diesel fuel accelerators in that they are less volatile and consequently reduce the hazards involved.

In addition to the branch chain butyl nitrates which can be used in accordance with the present invention, other useful compounds comprise the nitrates of alcohols other than isobutyl and likewise obtainable by the catalytic hydrogenation of carbon monoxide. Those nitrates of branched chain alcohols having at least six carbon atoms are particularly suitable since the use of these compounds in fuel oils involves substantially no hazard because of the fact that they have very low vapor pressures and also because of the fact that they are completely miscible in the oil and consequently can be stored and transported in concentrated solutions in the oil without danger of having them separate out during cold weather. In accordance with the present invention, I may use either the secondary or the primary alcohols or a mixture of these alcohols as formed in the hydrogenation of carbon monoxide.

The following illustrates one mode of preparing a nitrated product capable of use in accordance with the present invention:

Example

A fraction of alcohols obtained by the hydrogenation of carbon monoxide and boiling above 160° C. was nitrated by using a mixed acid containing 49.3% nitric acid and 51.44% sulfuric acid. The temperature was maintained at 8°–10° C. The alcohol was added cautiously to the nitrating mixture and when the reaction mixture began to fume off it was drowned in water and given the usual water and soda washes. The product was thus obtained as a dark greenish oil.

I prefer however to separate the primary alcohols and nitrate them separately inasmuch as the nitration of the individual primary alcohols

proceeds more smoothly. As specific examples of the primary branched chain alcohols other than isobutyl which are eminently suited for the preparation of nitrate accelerators, the following are mentioned: 2-methyl-1-pentanol, 2, 4-dimethyl-1-pentanol, 4-methyl-1-hexanol, 2, 4-dimethyl-1-hexanol, and 4-methyl-1-heptanol. These alcohols are characterized by the fact that they all contain methyl groups in the 2 and 4 position. As an example of a secondary alcohol, 2, 4-dimethyl-3-pentanol is satisfactory.

The proportion of ignition accelerator to be added to the fuel may range from a fraction of one per cent up to the limit of solubility in the fuel, but the preferred amount of accelerator ranges from one to five per cent of the fuel.

The branched chain aliphatic nitrates coming within the scope of the present invention include those having four or more carbon atoms, but preferably containing at least six carbons, the hydrocarbon content conferring on the compounds a high boiling point which increases generally with increased carbon content.

The advantages of the use of these accelerators in fuel oil for compression ignition engines are:

1. Elimination of knocking and rough-running by decreasing the ignition lag.

2. Reduction of engine wear by removing the cause of knocking and roughness.

3. Easier starting. The reduced spontaneous ignition temperatures of the doped oil enables it to ignite much more easily when starting from cold.

4. Improved exhaust. Owing to the more complete combustion the exhaust is cleaner especially at higher speeds. No harmful constituents are introduced into the exhaust gases by the combustion of the dope.

5. Possibility of use of inferior fuels. By the addition of dope, low grade fuels, at present quite unsuitable for compression ignition engines, can be rendered equal or superior to high grade undoped fuels.

6. Nature of dope. The dope has a neutral reaction, is non-toxic and soluble in the oil.

7. Improvements in engine design. Reduced engine stresses, resulting from the more gradually applied piston pressures, should make for lighter scantlings while the more readily ignited and rapidly burning fuel should render possible the construction of smaller and faster running engines.

8. Increased power and reduced fuel consumption. The improved combustion resulting from the explosive action of the dope enables a greater proportion of the air charge to be burnt, and further, as ignition takes place at once, the fuel can be injected during the compression stroke at a smaller crank angle near top dead center.

The specific utility of the present invention results from the higher boiling points and lower vapor pressures of the branched chain alkyl nitrates as compared with the nitrates described in the prior art. The boiling point of isobutyl primary nitrate (isopropyl methyl nitrate) is compared with the boiling points of straight chain lower alkyl nitrates:

Dope	Boiling point
	°C
Methyl nitrate	65
Ethyl nitrate	87
Propyl nitrate	110.5
Isobutyl primary nitrate	123

Further advantages are:

1. The increased boiling point prevents the formation of vapor locks in the fuel system of the engine.

2. Elimination of hazard in transportation and storage. The decreased vapor pressures eliminate the possibility of the formation of an explosive, dope-air mixture above the fuel in tank cars or storage tanks.

3. Decrease in objectionable physiological properties. The decreased vapor pressure of the dopes also decreases the physiological effects, such as headaches, which constitute an objection to lower alkyl nitrates.

The above description and examples are to be taken as illustrative only and not as limiting the scope of the invention. Any modification or variation therefrom which conforms to the spirit of the invention is intended to be included within the scope of the claims.

I claim:

1. A compression ignition fuel comprising a fuel oil boiling above the gasoline range containing the nitrates of the mixture of open branched chain aliphatic monohydric alcohols obtainable by the catalytic hydrogenation of carbon monoxide and having at least four carbon atoms and containing isobutyl alcohol.

2. A compression ignition fuel comprising a fuel oil boiling above the gasoline range containing isobutyl nitrate obtainable by the nitration of isobutyl alcohol, said alcohol being obtainable by the catalytic hydrogenation of carbon monoxide.

CARL S. MARVEL.