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LIQUID FUEL

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3 Claims. (Cl. 44-9)

This invention relates to an improvement in fuels for internal combustion engines and more particularly fuels for engines of the direct injection type wherein the fuel is forced, under high pressure, directly into the combustion zone. Examples of such engines are the well-known Diesel and semi-Diesel engines employing either the high pressure fuel system or the injection pump system.

In the operation of these engines, especially with the lighter grades of distillate fuel oils such as are commonly used for engines of the high speed type, a great deal of difficulty has been encountered with erosion of fuel valves and fuel pumps. This difficulty has been traced to the low viscosity of the fuel, especially at the somewhat elevated temperatures at which it is used, under which conditions the rubbing metal surfaces of pump plungers and valves rapidly become worn. Even a slight amount of wear of these parts of the engine leads to serious consequences because of the very small clearances between operating parts required in handling and injecting the minute quantities of fuel necessary for the operation of these engines. Thus, in a multi-cylinder high speed, automotive Diesel engine the amount of fuel injected per stroke is only a small fraction of a cubic centimeter and consequently a very little wear in the fuel valve or pump results in erratic operation of the engine by varying the volume of the fuel injected per stroke.

Attempts to overcome this difficulty have heretofore been made by increasing the viscosity of the fuel employed. However, any benefit obtained by so doing is more than offset by improper distribution and unsatisfactory combustion of the more viscous fuel as a result of its correspondingly decreased volatility. I have now discovered a means by which the viscosity of the fuel may be significantly increased while at the same time maintaining substantially the same volatility and combustion characteristics. In fact, I am even able to increase the volatility beyond that previously employed and simultaneously increase the viscosity, with resulting improvement in lubrication of fuel pumps and valves as hereinafter described.

My new Diesel fuel oil comprises a distillate fuel of the desired volatility and combustion characteristics, together with a small amount of a special viscosity producing agent which is a resinous product produced by the polymerization of olefin hydrocarbons. The resinous product which I employ is a non-crystalline plastic hydrocarbon material, soluble in hydrocarbon oils and plastic at all ordinary temperatures, from well below 0° F. to temperatures above 300° F. and even as high as 400° F. where the material still retains its "body" or viscosity to a large degree.

It is characterized by light color, high stability and high molecular weight, usually between 1,000 and 12,000. The empirical formula of the resin is substantially C_nH_{2n} and on heating to decomposition temperature it depolymerizes without the formation of undesirable coke and other residues.

The plastic resin may be most conveniently made by polymerization of liquid isobutylene at low temperatures, below 0° F. and preferably -40 to -100° F. In carrying out the polymerization, a suitable catalyst is necessary and boron fluoride or aluminum chloride may be used for this purpose, the amount required being from about 0.1 to 5%. If boron fluoride, which is a gas, is used it may be conveniently bubbled into the cold isobutylene while the latter is rapidly agitated. The reaction requires from several minutes to a half hour, the isobutylene being converted to a plastic mass at the end of that time. For convenience in handling and agitating it is usually desired to employ a diluent, which may conveniently be hexane, butane, propane, or in the case of very low temperature operations, liquid ethane. The diluent may be readily removed from the product by evaporation, preferably after the product has been neutralized and washed to remove the catalyst. If desired, the isobutylene may be polymerized directly in the presence of the distillate fuel oil in which it is desired to be used.

Other olefins besides isobutylene may be employed as starting materials for making the plastic resin; for example, normal butylene, amylene, hexylene and mixed olefinic hydrocarbons and saturated hydrocarbons condensed from cracking still gases, preferably those boiling in the range of 20 to 50° F.

The amount of plastic resin required to make the product of this invention may be from 1 to 10% of the weight of the oil treated and amounts of about 2 to 5% are usually preferred. A suitable fuel oil employed for the purpose possessed the following distillation characteristics as determined by A. S. T. M. distillation:

	Degrees Fahrenheit
Initial	444
10%	487
20%	503
30%	516
40%	530
50%	546
60%	565
70%	589
80%	617
90%	654
98%	700

This oil was blended with 2% and 5% of a plastic resin from isobutylene polymerization and tested with a Diesel engine of the high speed type. The

non-volatile plastic resin did not interfere in any way with the combustion of the fuel in the engine, and improved lubrication of the fuel valve was obtained. The viscosity of the fuel was increased from 39 seconds Saybolt at 100° F. to 42.2 seconds Saybolt at 100° F. by the addition of 2% of the resin and to 48.3 seconds Saybolt at 100° F. by the addition of 5% of the resin. The cetene number of the fuel which was 64 before the addition of the resin, remained unchanged.

The amount of resin added will vary with the initial viscosity and volatility of the fuel. Thus a light, low boiling fuel will require more resin to raise the viscosity to the desired extent. It is preferred to increase the viscosity above 45 seconds Saybolt, and a range of 45 to 60 seconds Saybolt is desirable. Higher viscosities may be employed however.

As previously mentioned, the use of the plastic resin in Diesel fuels is especially applicable to the lighter fuels such as petroleum distillate fuel having the following characteristics:

Flash point	°F.	154
Pour point	do.	35
Distillation	A. S. T. M.	
10% point	°F.	395
90% point	do.	450
Maximum	do.	490
Viscosity—Saybolt at 100° F.	sec.	32

The term "plastic hydrocarbon resin" as used

in this application means the specific type of resin described, resulting from the polymerization of olefin hydrocarbons at low temperatures.

Having thus described my invention, what I claim is:

1. The method of operating a high speed Diesel engine of the type normally operated with light Diesel fuel oils which are characterized by a 10% distillation point above about 395° F. and a 90% point below about 650° F., said oils tending to cause such excessive wear on the fuel pump and valves as to render them inoperative in worn condition for such fuels, comprising adding to the said light Diesel fuel oil sufficient isobutylene polymer, between 1 and 10%, to raise the viscosity to a pump and valve sealing and lubricating consistency without substantially adversely affecting the combustion characteristics of the said light Diesel fuel oil, and then injecting the fuel into said engine through said pump.

2. The method of claim 1 wherein the viscosity of the said light Diesel fuel oil before the addition of isobutylene polymer is about 32 to 39 seconds Saybolt at 100° F.

3. The method of claim 1 wherein the said isobutylene polymer is a plastic hydrocarbon resulting from the polymerization of isobutylene at low temperatures below 0° F. in the presence of a metal halide catalyst.

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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 2, first column, line 24, in the table, for "35" read -35; 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 16th day of November, A. D. 1937.

(Seal).

Henry Van Arsdale,
Acting Commissioner of Patents.