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FUEL

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The invention relates to a fuel suitable for use in internal combustion engines. More particularly it relates to a motor fuel containing a hydrocarbon composition and an alcohol, and includes correlated improvements and discoveries whereby the properties of such a motor fuel are enhanced.

It is an object of the invention to provide a fuel for internal combustion engines which will not become cloudy at a low temperature, in which frosting during carburetion is obviated and formation of ice crystals inhibited.

A further object of the invention is to provide a motor fuel containing a hydrocarbon composition and an alcohol, which motor fuel has a relatively high tolerance as to water content.

An additional object of the invention is to provide a motor fuel containing a hydrocarbon composition, an alcohol, and a stabilizing agent which increases the stability of the fuel.

A specific object of the invention is to provide a fuel for aviation motors containing an aviation naphtha, ethyl alcohol, and a stabilizing agent, and which is characterized by its stability and lack of cloudiness at the temperature of  $-20^{\circ}$  F.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises a motor fuel possessing the characteristics, properties and the relation of constituents which will be exemplified in the composition hereinafter described, and the scope of the invention will be indicated in the claims.

In the practice of the invention a liquid fuel adapted for use in internal combustion engines, as aviation motors, may be produced by effecting an admixture of a non-benzenoid hydrocarbon composition boiling within the gasoline range e. g. a petroleum distillate and a substantial quantity of an alcohol containing not more than three carbon atoms i. e., a low molecular weight alcohol, said alcohol containing a substantial quantity of water. The admixture of the hydrocarbon and the alcohol may be facilitated and the mixture stabilized by including in the fuel as a stabilizing agent therefor a saturated aliphatic ether containing at least five carbon atoms and an ether miscible mono-hydric alcohol having a higher molecular weight than the alcohol admixed with the hydrocarbon in a quantity sufficient to maintain a homogeneous mixture or blend at sub-zero temperatures.

It has been found that the stability of the fuel and its tolerance relative to water content

is augmented by including in the admixture a higher saturated aliphatic alcohol containing not more than ten carbon atoms. Preparation of the fuel may be effected by a bringing together and admixture of the various desired ingredients, as a naphtha, ethyl alcohol, and a saturated aliphatic ether having at least five carbon atoms, and a higher alcohol, preferably a higher molecular weight aliphatic alcohol, as butyl alcohol, and a cyclic alcohol, e. g., hexahydrophenol, fenchyl alcohol, etc., as a stabilizing agent. The proportion in which the various constituents of the fuel may be present varies somewhat, and satisfactory results have been obtained when an alcohol in an amount of from 5 to 34% by volume, a saturated aliphatic ether in an amount of from 2 to 10% by volume, and a higher aliphatic alcohol in an amount from 2 to 12% by volume were used. The compositions thus obtained are characterized by having a cloud point lower than  $-20^{\circ}$  F., and by possessing a relatively high tolerance with respect to water content. As will be illustrated later a stabilized fuel may be produced in accordance with the invention which contains as much as 12% of water and which is stable at  $-20^{\circ}$  F. The quantity of stabilizing agent is that which is sufficient to maintain a homogeneous mixture at sub-zero temperatures.

Hydrocarbon compositions which may be utilized in producing the motor fuel having a low cloud point include a gasoline, as casing head gasoline, straight run gasoline, cracked gasolines and admixtures thereof, a naphtha, as aviation naphtha, and other fuels, as iso-octaine fuels. These various hydrocarbon compositions may include lead tetra-ethyl, aniline, and other antidetonants if so desired without altering the influence and effects of the stabilizing agent having a higher alcohol content. Further, the hydrocarbon composition may contain benzol as a part thereof and its inclusion augments the anti-knock characteristics or qualities of the fuel. Large quantities of benzol, however, will crystallize out at low temperatures, and hence are without the contemplation of the invention.

The stabilizing agent for the fuel may contain ethyl ether of ethylene glycol, butyl ether of ethylene glycol, ethyl ether of diethylene glycol, butyl ether of diethylene glycol, other ethers as iso-propyl, normal butyl, iso-butyl, various amyls, for example, iso-amyl, or a mixed ether, as phenyl ethyl ether. It will be understood that the expression "saturated aliphatic ether containing at least five carbon atoms" includes the ethyl ether of ethylene glycol. The higher aliphatic alcohols

preferably used are the propyl, butyl and amyl alcohols. However, various other alcohols containing up to ten carbon atoms may be utilized. The fuel may contain the higher alcohols, in either the primary, secondary or tertiary form. The primary and tertiary types are preferred and more specifically the iso-type of the primary. The alcohols admixed with the hydrocarbon composition may be ethyl alcohol, either as 95% or absolute, iso-propyl alcohol and methyl alcohol. These various constituents may be employed either per se or in compatible admixtures.

As illustrative embodiments of a manner in which the invention may be carried out in practice, the following examples are presented. The percentages are by volume:

*Example 1*

	Percent
Aviation naphtha.....	84
Ethyl alcohol (95%).....	10
Butyl ether of ethylene glycol.....	2
Butyl alcohol.....	4

*Example 2*

	Percent
Gasoline.....	80
Ethyl alcohol (95%).....	9
Saturated aliphatic ether.....	2
Higher aliphatic alcohol.....	9

*Example 3*

	Percent
Gasoline.....	88
Ethyl alcohol (95%).....	6
Butyl ether of ethylene glycol.....	4
Butyl alcohol.....	2

*Example 4*

	Percent
Gasoline.....	44
Ethyl alcohol (95%).....	34
Iso-amyl ether.....	10
Butyl alcohol.....	12

When absolute ethyl alcohol is used in the motor fuel in the place of 95% ethyl alcohol, the system permits of the absorption of a greater volume of water prior to its becoming unstable or clouding at  $-20^{\circ}$  F. Such additional amount of water will be that which would be sufficient to convert or reduce the absolute ethyl alcohol to a strength of 95%.

Furthermore, I have found, as above indicated, that when higher saturated aliphatic alcohols containing not more than ten carbon atoms are utilized, such as the butyls, amyls, hexyls, octyls, in producing the various mixes of a hydrocarbon composition, as gasoline, with alcohol containing a relatively small amount of a stabilizing agent, the water tolerance of the fuel is decidedly increased and beyond that which is the normal expectation. This unexpected result appears to be due to a coupling action which occurs in the stabilizing agent-higher alcohol mixture, and is illustrated by the following examples. A fuel containing 88% aviation naphtha, 10% absolute ethyl alcohol and 2% butyl ether of ethylene glycol has a water tolerance of about 2% at  $-20^{\circ}$  F., whereas a similar fuel containing 4% butyl alcohol has a 1.5% water tolerance at  $-20^{\circ}$  F., and a fuel which contains 2% butyl ether of ethylene glycol and 4% butyl alcohol gives a fuel having a 6% water tolerance at  $-20^{\circ}$  F.

It is clearly indicated by these results that the effect produced by including a stabilizing agent, as butyl ether of ethylene glycol and a higher

aliphatic alcohol, as butyl alcohol, in combination, is not merely an additive one. If this were the case then the water tolerance should be only 3.5% instead of 6%. The last instance is that which is found in Example 1 above, and this fuel has been found to be stable at about  $-40^{\circ}$  F. A fuel produced in accordance with the foregoing procedures is characterized by being stable at a temperature of  $-20^{\circ}$  F., i. e., it does not separate into layers at this temperature, nor is there any apparent clouding. The water tolerance may be increased or decreased as desired, and such tolerance may be as high as 12% based on the alcohol present at a temperature of  $-20^{\circ}$  F. The variation in tolerance may be obtained by varying the amount of stabilizing agent and/or higher alcohol present. It has thus been found that a fuel may be produced which is stable at  $-20^{\circ}$  F., and which will contain as much as 4 gallons of water per 100 gals. of the fuel. Such a fuel is illustrated above by Example 4.

Another advantage accruing through utilization of the fuels herein described is that the employment of the various stabilizing agents facilitates the admixing or incorporation of the constituents, and a fuel is obtained in which icing in the carburetor, which adds to the hazards of flying in atmospheres saturated with water vapor, is substantially eliminated, and the possibility of having to make a forced landing is materially minimized inasmuch as accumulation of water in the fuel tanks and lines is in a large measure obviated. In addition, frosting is materially reduced and the formation of ice crystals inhibited.

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

1. A liquid motor fuel for internal combustion engines comprising a non-benzenoid petroleum distillate boiling within the gasoline range and a substantial quantity of a low molecular weight alcohol, and as a stabilizing agent therefor in a small quantity sufficient to maintain a homogeneous admixture at sub-zero temperatures, a saturated aliphatic ether containing at least five carbon atoms and a gasoline miscible mono-hydric alcohol having a higher molecular weight than the alcohol admixed, said fuel having a water tolerance of about 12%.

2. A liquid motor fuel for internal combustion engines comprising a mixture of a non-benzenoid petroleum distillate boiling within the gasoline range and a substantial quantity of a low molecular weight alcohol, said alcohol containing a substantial quantity of water up to about 12%, and as a stabilizing agent therefor, a saturated aliphatic ether containing at least five carbon atoms and a gasoline miscible mono-hydric alcohol having a higher molecular weight than the alcohol admixed, said stabilizing agent being present in a small quantity sufficient to maintain a homogeneous admixture at sub-zero temperatures.

3. A liquid motor fuel for internal combustion engines comprising a mixture of a non-benzenoid petroleum distillate boiling within the gasoline range and a substantial quantity of ethyl alcohol, said alcohol containing a substantial quantity of water up to about 12%, and as a stabilizing agent therefor, a saturated aliphatic ether containing at least five carbon atoms and a gasoline miscible mono-hydric alcohol having a higher molecular weight than the alcohol admixed, said stabilizing agent being present in a small quantity sufficient to maintain a homogeneous admixture at sub-zero temperatures.

4. A liquid motor fuel for internal combustion engines comprising a mixture of a non-benzenoid petroleum distillate boiling within the gasoline range and a substantial quantity of ethyl alcohol, said alcohol containing a substantial quantity of water up to about 12%, and as a stabilizing agent therefor, a butyl ether of ethylene glycol and a butyl alcohol, said stabilizing agent being present in a small quantity sufficient to maintain a homogeneous admixture at sub-zero temperatures.

5. A liquid motor fuel for internal combustion engines comprising a mixture of a non-benzenoid petroleum distillate boiling within the gasoline range, ethyl alcohol 5 to 34% by volume, said alcohol containing a substantial quantity of water up to about 12%, and as a stabilizing agent therefor butyl ether of ethylene glycol 2 to 10% by volume and butyl alcohol 2 to 12% by volume, the quantity of said stabilizing agent being sufficient to maintain a homogeneous admixture at sub-zero temperatures.

6. A liquid motor fuel for internal combustion engines comprising a mixture of an aviation naphtha and a substantial quantity of a low molecular weight alcohol, said alcohol containing a substantial quantity of water up to about 12%; and as a stabilizing agent therefor, a saturated aliphatic ether containing at least five carbon atoms and a gasoline miscible mono-hydric alcohol having a higher molecular weight than the alcohol admixed, said stabilizing agent being present in a small quantity sufficient to maintain a homogeneous admixture at sub-zero temperatures.

7. A liquid motor fuel for internal combustion engines comprising a mixture of an aviation naphtha and a substantial quantity of ethyl alcohol, said alcohol containing a substantial quantity of water up to about 12%, and as a stabilizing agent therefor, a saturated aliphatic ether containing at least five carbon atoms and a gasoline miscible mono-hydric alcohol having a higher molecular weight than the alcohol admixed, said stabilizing agent being present in a small quantity sufficient to maintain a homogeneous admixture at sub-zero temperatures.

8. A liquid motor fuel for internal combustion engines comprising a mixture of an aviation naphtha and a substantial quantity of ethyl alcohol, said alcohol containing a substantial quan-

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tity of water up to about 12%, and as a stabilizing agent therefor, a butyl ether of ethylene glycol and a butyl alcohol, said stabilizing agent being present in a small quantity sufficient to maintain a homogeneous admixture at sub-zero temperatures.

9. A liquid motor fuel for internal combustion engines comprising a mixture of an aviation naphtha and ethyl alcohol about 10% by volume, said alcohol containing a substantial quantity of water up to about 12%, and as a stabilizing agent therefor butyl ether of ethylene glycol about 2% by volume and butyl alcohol about 4% by volume, the quantity of said stabilizing agent being sufficient to maintain a homogeneous admixture at sub-zero temperatures.

10. A liquid motor fuel for internal combustion engines comprising a mixture of a gasoline and a substantial quantity of a low molecular weight alcohol, said alcohol containing a substantial quantity of water up to about 12%, and as a stabilizing agent therefor, a saturated aliphatic ether containing at least five carbon atoms and a gasoline miscible mono-hydric alcohol having a higher molecular weight than the alcohol admixed, said stabilizing agent being present in a small quantity sufficient to maintain a homogeneous admixture at sub-zero temperatures.

11. A liquid motor fuel for internal combustion engines comprising a mixture of a gasoline and a substantial quantity of ethyl alcohol, said alcohol containing a substantial quantity of water up to about 12%, and as a stabilizing agent a butyl ether of ethylene glycol and a butyl alcohol, said stabilizing agent being present in a small quantity sufficient to maintain a homogeneous admixture at sub-zero temperatures.

12. A liquid motor fuel for internal combustion engines comprising a non-benzenoid light liquid petroleum distillate and a substantial quantity of a low molecular weight alcohol, and as a stabilizing agent therefor in a small quantity sufficient to maintain a homogeneous admixture at sub-zero temperatures, a saturated aliphatic ether containing at least five carbon atoms and a gasoline miscible mono-hydric alcohol having a higher molecular weight than the alcohol admixed, said fuel having a water tolerance of about 12%.