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MOTOR FUEL

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This invention relates to fuels for internal combustion engines.

More specifically the invention relates to a fuel for internal combustion engines comprising hydrocarbon oils, ammonia and tetraethyl lead.

Ammonia has previously been investigated as to its effect as an anti-knock or anti-detonating compound in certain internal combustion engine fuel mixtures, but in the range of concentrations employed, ammonia was found to act, not as an anti-knock compound, or knock suppressor, but as a pro-knock or inducer of detonation as disclosed in Ind. and Eng. Chem. 16, 893 (1924), which reports the effect of various nitrogen compounds on detonation. The investigators apparently covered only a narrow range of concentrations and hence failed to discover the advantages which can be obtained under the conditions set forth below.

United States Patent No. 1,589,885, to Howard, discloses the use of ammonia absorbed in a hydrocarbon liquid either with or without alcohol, as an anti-knock or detonation suppressor. Applicants make no claim to the discovery of the use of ammonia as an anti-knock compound broadly. Their invention concerns the use of ammonia in various concentrations in combination with tetraethyl lead.

An object of applicants' invention is to increase the power output of an engine.

Another object of applicants' invention is the attainment of increased operating efficiency in an engine.

Still another object of applicants' invention is to attain the first mentioned objects without the usual increase in engine temperature accompanying such increases, particularly in the cylinder of the engine.

A further object of applicants' invention is the provision of an improved fuel for internal combustion engines.

A still further object of applicants' invention is to improve the anti-knock or anti-detonating effect of internal combustion engine fuels containing tetraethyl lead.

Other objects and advantages of applicants' invention will be apparent from the following specification and claims.

In the art of knock suppressors it is generally thought that the first portion of such substances added to a hydrocarbon fuel will produce a greater effect on the anti-knock characteristics of the fuel than the addition of any subsequent equivalent portion. Applicants have now found, however, that whereas ammonia at near zero concentrations has only slight effect on the octane number of a hydrocarbon fuel, that with increasing percentages of ammonia the effect increases rapidly with a resulting large gain in octane number. This discovery, therefore, is counter to the reaction obtained with the best knock suppressors in common use in which the greatest anti-knock response per unit increase occurs at the outset.

Applicants have also discovered that the addition of ammonia, in certain ranges of concentration, to hydrocarbon fuels containing tetraethyl lead, results in a motor fuel with superior anti-knock properties. The anti-knock suceptibility of fuels containing tetraethyl lead to the addition of ammonia in certain concentrations is well marked, as indicated from the results of a series of tests, in which quantities of ammonia were added to the intake mixture, the air-fuel ratio was correspondingly increased so as to provide oxygen for the combustion of ammonia, and the octane number of the fuel was determined. These relations, as shown in Table I, were determined on an ASTM-CFR (1934) test engine.

TABLE I

Fuel used	Ammonia as weight per cent fuel					
	0	1.3	2.7	4.0	5.3	6.6
A-3						
Octane number	43.6	44.4	45.6	47.4	49.2	51.4
Octane number increase	------	0.8	2.0	3.8	5.6	7.8
Alpha plus 2 cc. TEL						
Octane number	70.5	70.8	72.0	73.1	74.3	75.7
Octane number increase	------	0.3	1.5	2.6	3.8	5.2
C-8						
Octane number	76.8	77.3	78.0	78.6	79.2	79.9
Octane number increase	------	0.5	1.2	1.8	2.4	3.1
C-8 plus 3 cc. TEL						
Octane number	89.8	90.0	90.5	91.0	91.6	92.2
Octane number increase	------	0.2	0.7	1.2	1.8	2.4
I-O						
Octane number	100.0	100.2	100.4	100.8	101.2	101.7
Octane number increase	------	0.2	0.4	0.8	1.2	1.7

It is to be noted from the results set forth in the above table that the addition of ammonia to fuels containing tetraethyl lead was productive of a greater octane number response than the addition of ammonia to other fuels.

As is true of anti-detonants in general the greatest increase in octane number, for a given proportion of ammonia, is attained with the lowest octane fuels. This is, however, a characteristic of the octane scale rather than a measure of the advantages of such operation. A truer picture of the advantages in engine efficiencies, as measured by the increases in compression ratio, is given in the following Table II. In this tabulation the difference in behavior of leaded and unleaded fuels in response to the addition of ammonia is excellently brought out, as well as the relatively greater increases in efficiency made possible in the higher octane, or higher compression, ranges.

TABLE II

Permissible compression ratio increases

Motor fuel used	Increase in compression ratio resulting from addition of ammonia as weight per cent fuel					
	0	1.3	2.7	4.0	5.3	6.6
A-3 (43.6 original octane)	------	0.02	0.05	0.08	0.12	0.16
A-3 plus 2 cc. TEL (70.5 original octane)	------	0.04	0.08	0.13	0.18	0.26
C-8 (76.8 original octane)	------	0.03	0.06	0.10	0.14	0.19
C-8 plus 3 cc. TEL (89.9 original octane)	------	0.03	0.08	0.15	0.24	0.32
I-0 (100 original octane)	------	0.03	0.06	0.13	0.22	0.29

Applicants believe that the decrease in knocking tendency resulting from the introduction of a fuel containing ammonia and tetraethyl lead is due to specific effects of the combination tetraethyl lead and ammonia in the combustion characteristics of the original fuel and the lowered heat of combustion of the mixture. In power tests on fuel containing up to 10 per cent ammonia and up to 3 cc. of tetraethyl lead per gallon of the liquid fuel no appreciable decrease in power was observed at constant compression ratio despite the somewhat lowered combustion heat.

The fact that the addition of ammonia to a leaded fuel produces much more than the additive effect of the ammonia is clearly indicated in the above Table II, wherein the addition of ammonia to the fuel A-3 in varying quantities produces certain definite increases in compression ratio whereas with the addition of the same amounts to the same original fuel, containing, however, 2 cc. of tetraethyl lead the compression increase is much greater.

By utilizing the effective increase in octane number of the fuel in the form of increased compression pressure, markedly increased power output from an engine is secured. The increased compression pressure, of course, gives increased efficiency of the engine. By utilizing the addition of the mixture of ammonia and tetraethyl lead to hydrocarbon fuel in this manner, the corresponding temperature increase is diminished and the advantages of cooler engine operation are obtained.

The difficulty in securing fuels in high octane number, or fuels operating efficiently at high compression ratio, is very great. As disclosed above, however, ammonia used in conjunction with a fuel of high original octane number and containing tetraethyl lead gives very superior performance and economy. Fuel consisting of a mixture of ammonia and the leaded combustible hydrocarbons may be used continuously in an engine, permitting increased power and efficiency at all times, and operation at somewhat lower maximum temperatures or, if desired, it may be used for only short intermittent periods. Some engines, such as those used as power sources for airplanes, are subjected to very high power demand for short periods, and are operated at part-open throttle during a large part of the operation time. A fuel of superior antiknock character for use only during the period of high power demand would permit an increase of compression ratio to a condition of incipient knock on the hydrocarbon fuel without the mixture of ammonia and tetraethyl lead at part-throttle, or cruising speed, and thus a marked increase in efficiency.

Additional gains from the use of ammonia and tetraethyl lead in conjunction with hydrocarbon fuels as described above are secured when the charge is introduced at superatmospheric pressure.

Since there are many ways in which the mixture of hydrocarbon fuels, ammonia and tetraethyl lead may be introduced into the engine, the scope of this invention is limited only by the appended claims.

We claim:

1. As an anti-detonant for incorporation in hydrocarbon fuels boiling within the gasoline range, a composition of matter comprising tetraethyl lead and ammonia.

2. As an anti-detonant for incorporation in hydrocarbon fuels boiling within the gasoline range, a composition consisting of tetraethyl lead and ammonia.

3. An improved motor fuel for Otto-cycle engines comprising a hydrocarbon oil with an end point below that of kerosene, tetraethyl lead in an amount less than one per cent by weight and ammonia in an amount greater than one per cent by weight of the hydrocarbon oil.

4. An improved hydrocarbon motor fuel for Otto-cycle internal combustion engines comprising a hydrocarbon oil boiling in the gasoline range, tetraethyl lead in an amount less than one per cent by weight, and ammonia in an amount greater than one per cent by weight of the hydrocarbon oil.

5. An improved motor fuel for Otto-cycle internal combustion engines in which the charge is introduced at super-atmospheric pressure, comprising a hydrocarbon oil with an end point lower than that of kerosene, tetraethyl lead in an amount less than one per cent by weight and ammonia in an amount greater than one per cent by weight of the hydrocarbon oil.

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