United States Patent Office 2,901,336
Patented Aug. 25, 1959

2,901,336

ANTIKNOCK COMPOSITIONS

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No Drawing. Application May 15, 1957
Serial No. 659,222

6 Claims. (Cl. 44—69)

This invention relates to a fundamental advance in the antiknock art. More particularly, this invention relates to gasoline compositions having markedly improved performance characteristics, notably very high octane quality and reduced engine wear tendencies.

It has long been known that lead alkyls have the highly important property of raising the octane quality of gasoline. For over 30 years, tetraethyllead has been used as the commercial antiknock agent. Over the years, improvements in refinery technology have also contributed in large measure to continuous increases in gasoline quality. In fact, the conjoint use of tetraethyllead with progressively higher octane base stocks resulting from these refinery improvements has raised the average research octane number of all premium motor fuels marketed in the United States from 86 in 1946 to 96 in 1956. By the same token, the average research octane number of all non-premium motor fuel sold in the United States went from 80 to 89 in this same period. The provision of these higher octane gasolines has, in turn, enabled the progressive development of more efficient engines. For example, the average compression ratio of passenger car engines made in this country was 50 percent higher in 1946 than it was in 1925, whereas by 1956 it was 93 percent higher than in 1925. This upward trend in engine compression ratios continues. However, a new problem has arisen in attempting to provide still higher octane quality fuels to satisfy the forthcoming higher compression engines.

To gain additional octane numbers by relying on refining methods alone has become increasingly expensive since these octane numbers are being superimposed upon fuels which already are at very high octane levels. In other words, it costs much more to refine into a fuel an incremental gain of an octane number starting with a 96 octane fuel than it does with an 86 octane fuel. Thus, the use of higher concentrations of tetraethyllead has become an economic necessity. Accordingly, the average tetraethyllead content of premium motor fuels sold in the United States has gone up from 1.5 cc. per gallon in 1946 to 2.5 cc. per gallon in 1954. In the same time period, the average tetraethyllead content of non-premium motor fuels sold in the United States has risen from 1.1 to 2.2 cc. per gallon. It is evident, therefore, that the petroleum industry is rapidly approaching the maximum permissible tetraethyllead concentration—3 cc. per gallon of motor fuel. Consequently the need exists for a new way of still further increasing fuel octane quality in an economical manner.

An object of this invention is to fulfill the foregoing need. Another object of this invention is to provide

extremely high octane quality gasolines containing a highly effective additive complement. A particular object of this invention is to provide novel gasoline compositions containing, inter alia, a minute concentration of iron pentacarbonyl which cooperates with the remainder of my novel additive complement and with the base fuel to provide especially high octane qualities. Other important objects of this invention will be apparent from the ensuing description.

The above and other objects of this invention are accomplished by providing gasoline having a motor octane number when clear (unleaded) of at least about 76 containing an organolead antiknock agent, preferably a tetraalkyllead compound containing from 1 to about 8 carbon atoms in each alkyl group, from about 0.4 to about 0.6 theory based on the lead of bromine as a bromine-containing scavenger, from about 0.8 to about 1.2 theory based on the lead of chlorine as a chlorine-containing scavenger, and iron pentacarbonyl, there being present in the gasoline an amount of said agent equivalent to from about 1.58 to about 3.17 grams of elemental lead per gallon and an amount of iron pentacarbonyl equivalent to from about 0.005 to 0.2 and preferably from about 0.02 to 0.1 gram of iron per gallon. These extremely small concentrations of iron pentacarbonyl—insufficient in themselves to materially raise the octane number of the unleaded base gasoline—bring about tremendous improvements in the antiknock effectiveness of the lead alkyl antiknock agent contained in the fuels of this invention. In other words, the specified amount of lead alkyl is caused by these minute concentrations of iron pentacarbonyl to exert the antiknock effectiveness that would ordinarily be exerted only by a much larger amount of lead alkyl in the absence of iron pentacarbonyl. In short, these concentrations of iron pentacarbonyl render a given quantity of lead alkyl much more effective as an antiknock than it otherwise would be. Hence, in the compositions of this invention, the iron pentacarbonyl acts as a promoter of the antiknock effectiveness of the lead alkyl.

Iron pentacarbonyl when used pursuant to this invention is also an effective inhibitor of engine wear.

As an example of the astonishing behavior of the compositions of this invention, a paraffinic fuel having a motor octane number according to ASTM Test Procedure D-357 when clear of 80 containing 3 milliliters of tetraethyllead per gallon (3.17 grams of lead per gallon), 0.5 theory of bromine as ethylene dibromide, 1.0 theory of chlorine as ethylene dichloride and only 0.05 gram of iron per gallon as iron pentacarbonyl possessed a motor performance number of 102.1 (a motor octane number of 100.7). The corresponding fuel in the absence of iron pentacarbonyl had a motor performance number of 93.3 (a motor octane number of 98.0). Thus, this minute amount of iron pentacarbonyl (0.12 cc. per gallon) in a fuel of this invention promoted the antiknock effectiveness of the tetraethyllead to such an extent that an improvement of over 8.5 performance numbers (2.7 motor octane numbers) was realized. To achieve this same gain in this fuel by the use of tetraethyllead in the absence of iron pentacarbonyl, it is necessary to use 4.6 milliliters of tetraethyllead per gallon. Therefore, this extremely small concentration of iron pentacarbonyl in a fuel of this invention made 3.0 milliliters per gallon of tetraethyllead act as if 4.6 milliliters per gallon were

present. Moreover, this enormous improvement in octane quality was achieved in a leaded gasoline composition which, in the absence of this small concentration of iron pentacarbonyl, already had a particularly high octane quality—a performance number of over 93 (a motor octane number of 98.0). The attainment of such an improvement in this high octane region by refinery methods is extremely difficult and costly. It will also be seen that the attainment of this octane improvement could not have been accomplished in commercial practice by the sole use of additional tetraethyllead since the maximum tetraethyllead concentration currently considered permissible would have to have been exceeded by a substantial margin.

Such results are totally unexpected. It had been established heretofore that mixtures of tetraethyllead and iron pentacarbonyl were in most proportions mutually antagonistic to each other. Many mixtures of tetraethyllead and iron pentacarbonyl actually gave a lower octane number than the corresponding amount of tetraethyllead alone. Thus, in U.S. Patent 2,398,282, it was shown that in a motor fuel containing 1.32 grams of lead (1.25 cc. of tetraethyllead) per gallon, the presence of 0.21 gram of iron (0.5 cc. of iron pentacarbonyl) per gallon decreased the effectiveness of the tetraethyllead and more than 1.32 grams of lead had to be used to obtain an antiknock effect equal to that of 1.32 grams of lead alone per gallon. Furthermore, this patent shows that relatively low concentrations of iron pentacarbonyl in motor gasoline containing from less than 1 to 3.0 cc. of tetraethyllead per gallon conferred decidedly inferior antiknock qualities upon the fuel as compared with the corresponding leaded fuel not containing iron pentacarbonyl. Therefore, small amounts of iron pentacarbonyl and varying amounts of tetraethyllead were so mutually toxic that there resulted a loss of antiknock value and, therefore, the addition of iron pentacarbonyl was detrimental. In fact, it is stated in the above patent that no value was obtained from the iron pentacarbonyl until more than 0.55 gram of iron per gallon was used. This has been verified in the past by other investigators. In each instance, the addition of iron pentacarbonyl to the leaded fuel either gave the adverse effect described in the above patent or gave no benefit whatsoever. This is attributed to the fact that these prior investigators were working with entirely different gasolines (e.g., low octane fuels) and/or additive complements from those with which the present invention deals.

The unexpectedness of this invention is further shown by another series of engine tests. In these tests, two different base gasolines were used. One had a motor octane number clear of 60, whereas the other had a motor octane number clear of 80. To each of these fuels were added 3 milliliters of tetraethyllead per gallon, 0.5 theory of bromine as ethylene dibromide, and 1.0 theory of chlorine as ethylene dichloride. Portions of each of these leaded fuels were further treated with small concentrations of iron pentacarbonyl. The various fuels were then subjected to the ASTM Research Octane Number Test—ASTM Test Procedure D-908. The results are shown in Table I.

TABLE I.—EFFECT OF FUEL ADDITIVES ON FUEL ANTIKNOCK QUALITY USING DIFFERENT OCTANE NUMBER BASE FUELS

Conc. of $Fe(CO)_5$, g. Fe/gal.	Octane Quality Using 60 Octane Base Fuel				Octane Quality Using 80 Octane Base Fuel			
	PN [1]	ΔPN [2]	ON [3]	ΔON [4]	PN [1]	ΔPN [2]	ON [3]	ΔON [4]
None	63.9		84.2		85.9		95.4	
0.05	63.4	−0.5	83.8	−0.4	87.5	+1.6	96.0	+0.6
0.1	62.8	−1.1	83.4	−0.8	88.9	+3.0	96.5	+1.1
0.2	62.8	−1.1	83.4	−0.8	89.5	+3.6	96.7	+1.3

[1] Performance number.
[2] Change in performance number.
[3] Octane number.
[4] Change in octane number.

Referring to the above data, the very small quantities of iron pentacarbonyl in the leaded fuel made from the 60 octane number base stock poisoned the tetraethyllead effectiveness so that in all cases a reduction in octane quality resulted. This directly corroborates the findings described in U.S. Patent 2,398,282. However, with the fuels of this invention—made from the 80 octane number base fuel—diametrically opposite results were achieved. Thus, very large increases in antiknock quality were effected in these fuels via the promoter effect of the small amounts of iron pentacarbonyl on the tetraethyllead antiknock mixture.

Another striking feature of this invention is that in the concentrations used to give the promoter effect, iron pentacarbonyl is an effective inhibitor of engine wear, particularly when the engines are operated under very severe conditions. It is well known that heretofore the high engine wear caused by iron pentacarbonyl had made its use in fuel impractical. See, for example, U.S. Patents 2,546,421 and 2,546,422. Surprisingly, however, substantial reductions in engine wear under drastic engine operating conditions are the direct result of the use of the extremely small concentrations of iron pentacarbonyl pursuant to this invention. This was demonstrated by a large number of engine tests.

Gasoline (100 motor octane number clear) containing 3 milliliters of tetraethyllead per gallon as the antiknock mixture described above was used to operate a single-cylinder engine having a displacement of 35 cubic inches at a speed of 2500 r.p.m. and a jacket temperature of 180° F. The intake air was filtered to prevent atmospheric dust from entering the combustion chamber. The amount of wear was determined by the method described in the December 1956 edition of Nucleonics at page 70. The criterion of engine wear was the rate of loss in weight of the upper piston ring during the test period in milligrams per hour. The piston ring was a commercial chrome-plated cast iron product containing radioactive isotopes. As the surfaces of this ring were subjected to wear during engine operation, the wear debris was carried into the lubricating oil where its concentration was measured by determining the radioactivity of the oil using a gamma-spectrometer. The observed count of radioactivity of the oil was directly correlated to the loss in weight of the piston ring surfaces due to wear in the operation of the engine. Because of the technique employed, direct measurements were made of the chrome face wear and the iron side wear of the top piston ring. A plurality of such tests established baseline values for these two types of engine wear.

The above tests were then repeated under identical test conditions and using an identical leaded fuel to which had been added either 0.1 or 0.2 gram of iron per gallon as iron pentacarbonyl. These individual tests were carried out at the 0.1 gram of iron concentration, whereas two tests were made at the 0.2 gram concentration. The results of this series of engine tests expressed in terms of percent of baseline are shown in Table II.

TABLE II.—EFFECT OF IRON PENTACARBONYL ON ENGINE WEAR

Iron Conc., g./gal.	Percent of Baseline	
	Chrome Face Wear	Iron Side Wear
None (baseline)	100	100
0.1	60	78
0.2	35	58

As shown by the data in Table II, the fuels of this invention exhibit markedly reduced engine wear tendencies despite the expectancy based on the prior art that increased engine wear would result. The test conditions used were extremely severe and thus represent the amount of engine wear which occurs in actual service only under the most drastic operating conditions. Under milder operating conditions, the engine wear problem with conventional fuels is virtually non-existent. However, it is clear that my compositions are ideally suited for all types of engine service because under the milder operating conditions the compositions of this invention pose absolutely no engine wear problems and, as shown above, effectively reduce the wear problem under severe operating conditions. When higher concentrations of iron pentacarbonyl are used—e.g., 0.4 to 0.5 gram of iron per gallon and higher—the wear rate exceeds that of the baseline and thereby becomes excessive.

As stated above, it is preferable to use iron pentacarbonyl at concentrations from about 0.02 to 0.1 gram of iron per gallon. These concentrations take full advantage of the tremendous effectiveness of the iron pentacarbonyl as a promoter of the lead alkyl antiknock effectiveness and an inhibitor of engine wear. However, excellent results are achieved throughout the concentration range of from about 0.005 to 0.2 gram of iron per gallon as iron pentacarbonyl. At the lower end of this range, the promoter and wear inhibiting effects of iron pentacarbonyl are significant, whereas at the upper end of this range they are normally of a larger magnitude. Generally speaking, on the basis of the promoter and wear inhibiting effects and taking economic factors into consideration, the ideal concentration of iron pentacarbonyl is about 0.1 gram of iron per gallon.

To formulate the fuels of this invention, the constituents of my additive complement are blended in appropriate quantity with gasoline having a motor octane number clear of at least about 76. The order of addition of the ingredients is not critical. Thus, they can be blended separately in any order or in various sub-combinations. Because the iron pentacarbonyl concentrations are so small, it is helpful to prepare a concentrated gasoline solution containing the correct proportions of the ingredients of my additive complement and then dilute this formulation with additional gasoline to the desired concentration. Another method is to first prepare an antiknock fluid composition made up of the lead alkyl antiknock agent, the bromine-containing scavenger, the chlorine-containing scavenger, and the iron pentacarbonyl in appropriate proportions. This, in turn, is bended with the appropriate base fuel.

The following are examples of the compositions of this invention. The octane numbers of the fuels are

motor octane numbers clear. By definition, a theory of bromine or chlorine equals two atoms of halogen per atom of lead.

Example I

79.7 octane gasoline blend containing per gallon:
- 3.17 grams of lead as tetraethyllead
- 0.5 theory of bromine as ethylene dibromide
- 1.0 theory of chlorine as ethylene dichloride
- 0.05 gram of iron as iron pentacarbonyl

Example II

79.7 octane gasoline blend containing per gallon:
- 3.17 grams of lead as tetraethyllead
- 0.5 theory of bromine as ethylene dibromide
- 1.0 theory of chlorine as ethylene dichloride
- 0.1 gram of iron as iron pentacarbonyl

Example III

79.7 octane gasoline blend containing per gallon:
- 3.17 grams of lead as tetraethyllead
- 0.5 theory of bromine as ethylene dibromide
- 1.0 theory of chlorine as ethylene dichloride
- 0.2 gram of iron as iron pentacarbonyl

Example IV

Premium motor gasoline (81.5 octane) containing per gallon:
- 1.58 grams of lead as tetraethyllead
- 0.5 theory of bromine as ethylene dibromide
- 0.9 theory of chlorine as 1,4-dichlorobutane
- 0.1 gram of iron as iron pentacarbonyl

Example V

76 octane gasoline containing per gallon:
- 2.12 grams of lead as mixed methylethyllead compounds
- 0.6 theory of bromine as ethylene dibromide
- 1.0 theory of chlorine as ethylene dichloride
- 0.15 gram of iron as iron pentacarbonyl

Example VI

80 octane paraffinic gasoline containing per gallon:
- 3.17 grams of lead as tetraethyllead
- 0.5 theory of bromine as ethylene dibromide
- 1.0 theory of chlorine as ethylene dichloride
- 0.005 gram of iron as iron pentacarbonyl

Example VII

80 octane paraffinic gasoline containing per gallon:
- 3.17 grams of lead as tetraethyllead
- 0.5 theory of bromine as ethylene dibromide
- 1.0 theory of chlorine as ethylene dichloride
- 0.02 gram of iron as iron pentacarbonyl

Example VIII

80 octane paraffinic gasoline containing per gallon:
- 3.17 grams of lead as tetraethyllead
- 0.5 theory of bromine as ethylene dibromide
- 1.0 theory of chlorine as ethylene dichloride
- 0.1 gram of iron as iron pentacarbonyl

Example IX

80.8 octane premium fuel containing per gallon:
- 2.64 grams of lead as tetraethyllead
- 0.45 theory of bromine as 2,3-dibromobutane
- 1.0 theory of chlorine as ethylene dichloride
- 0.04 gram of 2,6-di-tert-butyl phenol (stabilizer)
- 0.1 gram of iron as iron pentacarbonyl

Example X

88 octane gasoline containing per gallon:
- 1.9 grams of lead as tetraethyllead
- 0.4 theory of bromine as dibromotoluene (mixed isomers)
- 0.8 theory of chlorine as 1,2,4-trichlorobenzene
- 0.05 grams of iron as iron pentacarbonyl

Example XI

Isooctane (100 octane) containing per gallon:
3.0 grams of lead as tetraethyllead
0.4 theory of bromine as β,β'-dibromodiethyl ether
1.2 theory of chlorine as β,β'-dichlorodiethyl ether
0.2 gram of iron as iron pentacarbonyl

Example XII

96 octane gasoline containing per gallon:
2.0 grams of lead as tetramethyllead
0.6 theory of bromine as acetylene tetrabromide
0.8 theory of chlorine as hexachlorobutadiene
0.03 gram of 4-methyl-2,6-di-tert-butyl phenol (stabilizer)
0.1 gram of iron as iron pentacarbonyl

Example XIII

85.6 octane gasoline containing per gallon:
2.5 grams of lead as tetrabutyllead
0.6 theory of bromine as bromoxylenes (mixed)
1.2 theory of chlorine as hexachloropropylene
0.2 gram of iron as iron pentacarbonyl

Example XIV

79.7 octane gasoline containing per gallon:
3.17 grams of lead as tetraethyllead
0.5 theory of bromine as ethylene dibromide
1.0 theory of chlorine as ethylene dichloride
0.03 gram of iron as iron pentacarbonyl

Example XV

79.7 octane gasoline containing per gallon:
3.17 grams of lead as tetraethyllead
0.5 theory of bromine as ethylene dibromide
1.0 theory of chlorine as ethylene dichloride
0.06 gram of iron as iron pentacarbonyl

Example XVI

79.7 octane gasoline containing per gallon:
3.17 grams of lead as tetraethyllead
0.5 theory of bromine as ethylene dibromide
1.0 theory of chlorine as ethylene dichloride
0.125 gram of iron as iron pentacarbonyl

Excellent antiknock qualities are exhibited by the fuels of this invention, such as those shown in the above illustrative examples. To illustrate, the fuels of Examples I through III were compared with an identical leaded fuel not containing iron pentacarbonyl using the Research Method (ASTM D-908). The results of these tests are shown in Table III.

TABLE III—EFFECT OF FUEL ADDITIVES ON FUEL ANTIKNOCK QUALITY

Example	Conc. of $Fe(CO)_5$, g. Fe/gal.	Octane Quality		Octane Quality Improvement Due to Promoter		
		PN	ON	ΔPN	ΔON	cc. TEL[1]
	None	91.5	97.4			
I	0.05	94.9	98.5	3.4	1.1	4.3
II	0.1	95.6	98.7	4.1	1.3	4.6
III	0.2	95.2	98.6	3.7	1.2	4.4

[1] Total amount of tetraethyllead (cc.) required in the fuel in the absence of $Fe(CO)_5$ to provide the same octane quality.

In every case the fuel of this invention had a much higher octane quality due to the presence therein of the minute amount of iron pentacarbonyl.

Similarly, the fuels of Examples VI through VIII were compared with identical fuel not containing iron pentacarbonyl using the Motor Method (ASTM D-357). The data are shown in Table IV.

TABLE IV.—EFFECT OF FUEL ADDITIVES ON FUEL ANTIKNOCK QUALITY

Example	Conc. of $Fe(CO)_5$, g. Fe/gal.	Octane Quality		Octane Quality Improvement Due to Promoter		
		PN	ON	ΔPN	ΔON	cc. TEL
	None	93.3	98.0			
VI	0.005	94.2	98.3	0.9	0.3	3.1
VII	0.02	97.0	99.1	3.7	1.1	3.6
VIII	0.1	102.4	100.8	9.1	2.8	4.7

To further illustrate the striking octane improvements of this invention, the fuels of Examples XIV–XVI were compared with an identical fuel not containing iron pentacarbonyl using the Borderline Rating technique. The 11.3:1 compression ratio engine used in these tests was operated at 1200 r.p.m., the fuel/air ratio being 0.08 and the air and jacket temperatures being respectively 100±5 and 160±5° F. The results are shown in Table V.

TABLE V.—EFFECT OF FUEL ADDITIVES ON FUEL ANTIKNOCK QUALITY

Example	Conc. of $Fe(CO)_5$, g. Fe/gal.	Octane Quality		Octane Quality Improvement Due to Promoter		
		PN	ON	ΔPN	ΔON	cc. TEL
	None	100.2	100.1			
XIV	0.03	103.0	101.0	2.8	0.9	3.3
XV	0.06	104.0	101.3	3.8	1.2	4.0
XVI	0.125	104.0	101.3	3.8	1.2	4.0

Lead alkyls which can be used in the compositions of this invention include tetramethyllead, tetraethyllead, tetrapropyllead, tetraisopropyllead, tetrabutyllead, methyltriethyllead, dimethyldiethyllead, trimethylethyllead, tetraoctyllead and the like, or mixtures thereof. Thus each alkyl group can contain from 1 to about 8 carbon atoms and be straight or branched chain. The use of tetraethyllead is preferred because of its superior performance qualities, commercial availability, and lower cost.

The bromine-containing and chlorine-containing scavengers used in the fuels of this invention are organic halide compounds which react with the lead during combustion in the engine to form volatile lead halides. It is preferable that the bromine-containing scavenger contain no chlorine and that the chlorine-containing scavenger contain no bromine, although a scavenger containing both halogens can be used, provided the scavenger mixture contains a total of bromine and chlorine within the ranges specified above. Halohydrocarbon scavengers—especially those having a vapor pressure of 0.1 to 250 millimeters of mercury at 50° F.—are preferred because of their generally superior storage stability although other scavengers can be employed successfully. Useful scavengers include ethylene dichloride, ethylene dibromide, carbon tetrachloride, propylene dibromide, 2-chloro-2,3-dibromobutane, 1,2,3- tribromopropane, hexachloropropylene, mixed bromoxylenes, 1,4-dibromobutane, 1,4-dichloropentane, β,β'-dibromodiisopropyl ether, β,β'-dichlorodiethyl ether; trichlorobenzene; dibromotoluenes; tert-butyl bromide; 2-methyl-2-bromobutane; 2,3,3-trimethyl-2-bromobutane; tert-butyl chloride; 2,3-dimethyl-2,3-dibromobutane; 2,5-dimethyl-2,5-dibromohexane; 2-methyl-2,3-dibromobutane; 2-methyl - 2,3 - dichloroheptane; 2-methyl-2,4-dibromohexane; 2,4-dibromopentane; 2,5-dichlorohexane; 3-methyl - 2,4 - dibromopentane; 1-phenyl-1-bromoethane; 1-phenyl-1-chloroethane; ethyl-α-bromoacetate; diethyl-dibromomalonate; propyl-α-chlorobutyrate; 1,1-dichloro-1-nitroethane; 1,1-dichloro-2-nitroethane; 1,1-dibromo-1-nitrobutane; 2-chloro-4-nitropentane; 2,4-dibromo-3-nitropentane; 1-chloro-2-hydroxyeth-

ane; 1-bromo-3-hydroxypropane; 1-bromo-3-hydroxybutane; 3-methyl-2-bromo-4-hydroxypentane; 3,4-dimethyl-2-bromo-4-hydroxypentane and, in general, scavengers (and lead alkyl antiknock agents) disclosed in U.S. Patents 1,592,954; 1,668,022; 2,364,921; 2,479,900; 2,479,902; 2,479,903; and 2,496,983.

Particularly preferred scavenger mixtures are 0.5 theory of bromine as ethylene dibromide and 1.0 theory of chlorine as ethylene dichloride; 0.6 theory of bromine as ethylene dibromide and 1.0 theory of chlorine as ethylene dichloride; and 0.45 theory of bromine as 2,3-dibromobutane and 1.0 theory of chlorine as ethylene dichloride. These mixtures effectively control the amount of deposits formed in the engine during operation and bring about this desirable result at a minimum cost.

The methods for making the above lead alkyls and scavengers, as well as iron pentacarbonyl, are well known to those skilled in the art and can be found in the literature.

Other ingredients which can be used with advantage in the fuels of this invention include dyes for identification purposes; metal deactivators, such as N,N' - di - salicylidene-1,2-diaminopropane; anti-icing and anti-rust additives; surface ignition control additives, such as tricresylphosphate, tri(β-chloropropyl)-thionophosphate, dimethyltolylphosphate, dimethylxylylphosphate, trimethylphosphate, dixylylphosphoramidate, trialkylphosphines, etc.; antioxidants; and the like.

The gasoline base stocks employed in this invention are preferably those which boil within or throughout the motor gasoline boiling range. This range is from about 85 to about 420° F. For best results the motor fuel should have a 90 percent boiling point of at least about 310° F. and an endpoint of at least about 375° F. These fuel base stocks are derived from a variety of refinery processes and include straight-run gasoline, catalytically or thermally cracked stocks, or gasoline hydrocarbons resulting from such processes as reforming, polymerization, isomerization, and the like. Individual gasoline hydrocarbons or various blends thereof can be used successfully. As stated above, the chief requisite of the gasoline base stock is that it have a motor octane number clear of at least 76.

I claim:

1. Gasoline having a motor octane number when clear of at least about 76 containing a lead alkyl antiknock agent, from about 0.4 to about 0.6 theory based on the lead of bromine as a bromine-containing scavenger, from about 0.8 to about 1.2 theory based on the lead of chlorine as a chlorine-containing scavenger, and iron pentacarbonyl, there being present in the gasoline an amount of said agent equivalent to from about 1.58 to about 3.17 grams of elemental lead per gallon, and an amount of iron pentacarbonyl equivalent to from about 0.005 to 0.2 gram of iron per gallon.

2. The gasoline composition of claim 1 wherein said bromine-containing scavenger is a bromohydrocarbon and said chlorine-containing scavenger is a chlorohydrocarbon.

3. Gasoline having a motor octane number when clear of at least about 76 containing a lead alkyl antiknock agent, from about 0.4 to about 0.6 theory based on the lead of bromine as a bromine-containing scavenger, from about 0.8 to about 1.2 theory based on the lead of chlorine as a chlorine-containing scavenger, and iron pentacarbonyl, there being present in the gasoline an amount of said agent equivalent to from about 1.58 to about 3.17 grams of elemental lead per gallon, and an amount of iron pentacarbonyl equivalent to from about 0.02 to 0.1 gram of iron per gallon.

4. The gasoline composition of claim 3 wherein said bromine-containing scavenger is a bromohydrocarbon and said chlorine-containing scavenger is a chlorohydrocarbon.

5. Gasoline having a motor octane number when clear of at least about 76 containing a lead alkyl antiknock agent, about 0.5 theory based on the lead of bromine as ethylene dibromide, about 1.0 theory based on the lead of chlorine as ethylene dichloride, and iron pentacarbonyl, there being present in the gasoline an amount of said agent equivalent to from about 1.58 to about 3.17 grams of elemental lead per gallon and an amount of iron pentacarbonyl equivalent to from about 0.02 to 0.1 gram of iron per gallon.

6. The gasoline composition of claim 5 wherein said agent is tetraethyllead.

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