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AUTOMOTIVE FUEL

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This invention relates to automotive fuels suitable for use in modern high compression automotive engines. More particularly the invention relates to gasolines having high stability in storage and in use, which gasolines tend to reduce deposition of objectionable gums and/or carbonaceous materials in carburetors, intake manifolds, intake valves and the like without increasing combustion chamber and exhaust valve deposits.

Modern carburetors suitable for use on present day automobiles are highly developed intricate mechanisms which operate satisfactorily only as long as ports, valves, passages and the like remain free from desposits. It is observed that with many carburetors and particularly with multibarrel carburetors, engines often begin to operate in a rough manner after 2000–5000 or more miles. The first indication of unsatisfactory operation is generally observed during idling of the engine. When this occurs, or soon thereafter, it is necessary to adjust the carburetor so that the engine will not die when the foot throttle is released. After a few such adjustments the only way to obtain satisfactory operation is to disassemble and clean the carburetor.

The reason for the unsatisfactory operation of engines referred to is that deposits tend to build up at critical points in the carburetor and, as the deposits increase, the ability to adjust the carburetor to compensate for the deposits becomes difficult. Apparently the most strategic point at which deposits form, i.e., the one which appears to have the greatest effect on idling is the body wall of the carburetor opposite and possibly slightly below the closed or idle position of the throttle plate. In idle position there is normally a certain clearance between the throttle plate and the wall of the carburetor. As carbonaceous deposits build up at this point the clearance becomes less and less for a given setting of the throttle plate and as the clearance is reduced the amount of air going past the throttle plate for a given amount of fuel is greatly reduced and the air-fuel mixture reaching the combustion chamber is much richer than it should be for satisfactory engine operation. It will readily be seen that carburetors in which such deposits have formed must be cleaned before they can satisfactorily perform their intended function.

These carburetor deposits may be due in part to gums present in the gasoline but it is believed that they are due primarily to crankcase vapors vented from the crankcase, exhaust vapors, dust, smoke, etc. The air cleaner usually employed on automotive engines does not appear to effectively remove these contaminants. Regardless of the theory as to the source of these deposits it is found that the described deposits occur to the greatest extent in stop-and-go city traffic driving where the chances of pulling air contaminated with these vapors into the carburetor are greatest. The relationship between carburetor deposits and crankcase vapors entering the carburetor is more fully described below.

Carburetor deposits are not the only deposits which affect engine operation. It is observed for example that under certain conditions of operation deposits form to a highly objectionable degree on intake valves, particularly on the fillet or stem side of the valve head, i.e., where the stem joins the head, and enters on the stem area adjacent thereto. These deposits may result from the gasoline or the lubricating oil or more likely both the fuel and the oil contribute to the deposit. The heaviest intake valve deposits have been observed in engines in which multigrade oils are employed. It is thought that the polymerized additive materials employed to give the extremely high viscosity index (VI) required in such oils are primarily responsible for these heavy deposits.

Although it is possible to reduce or prevent excessive carburetor deposits by the use of surface active or so-called detergent additives in gasolines, such materials generally tend to increase objectionable deposits in other portions of the induction systems as well as in the combustion chambers, etc., of the engines. Thus while the addition of small amounts of certain metal or non-metal sulfonates, oil-soluble phosphorus compounds and the like to gasolines has been found to effectively reduce carburetor deposits, these same additives appear to increase the deposits on intake valves and/or in combustion chambers and in some cases have been found to cause excessive deposits on exhaust valves causing improper seating and even resulting in "burning" of the valves.

It is an object of this invention to provide an automotive fuel which will reduce or prevent the formation of objectionable deposits in carburetors.

It is another object of this invention to provide an automotive fuel which prevents carburetor deposits and also prevents the formation of excessive deposits on intake valves and in the combustion chambers of automotive engines.

It is another object of this invention to provide a gasoline suitable for use in modern high compression automotive engines which is stable in storage, which prevents the formation of and/or removes carburetor deposits, prevents the formation of objectionable amounts of deposits on intake valves and does not contribute to combustion chamber deposits to any objectionable degree.

It is still another object of this invention to provide an additive combination suitable for adding to automotive gasolines, which may contain lead and/or gum inhibitors, which additive combination imparts to the gasoline the ability to prevent or decrease the build-up of deposits in the induction systems of automotive engines.

A more specific object of this invention is to provide gasolines suitable for use in internal combustion engines which gasolines are storage stable, prevent the build-up of carburetor deposits, reduce the tendency for the formation of deposits in other portions of the induction systems, tend to reduce rather than increase the octane requirements of engines, as compared with ordinary gasolines and yet do not tend to form exhaust valve deposits.

These and other objects of this invention which will be apparent as the description proceeds, are attained by adding to gasolines which are deficient in the ability to

prevent the formation of induction system deposits and/or to permit the build-up of objectionable deposits in combustion chambers and on exhaust valves, a particular surface active agent, i.e., lecithin, in combination with a particular hydrocarbon oil. The latter material appears to function as a carrier for the lecithin and further appears to cooperate with the lecithin in preventing the build-up of deposits in induction systems, combustion chambers, etc. of engines in which such fuels are employed.

The lecithin may be a purified lecithin but preferably is a commercial lecithin such as one obtained from soya bean oil and referred to as a plastic lecithin which contains approximately 65% of lecithin in soya oil. Also available commercially is a liquid lecithin product containing about 60% of lecithin in soya bean oil and this product may be employed as the lecithin portion of the additive combination. Under any circumstance, the lecithin itself appears to be the active agent and the fatty oil with which it is associated in the various commercial products does not appear to have deleterious effects, at least in the amounts in which it is present. Moreover, it is to be noted that the material referred to herein as lecithin comprises a mixture of acetone-insoluble phosphatides and it is on the basis of acetone solubility that the percentage of lecithin in the commercial products is determined.

The second additive material, i.e., the hydrocarbon oil, which must be employed with the lecithin and which appears to cooperate with lecithin in imparting to the automotive fuel all of the desired properties and characteristics described hereinabove, is a paraffinic oil of about medium lubricating oil grade. The oil may be an untreated distillate oil providing it is of relatively low wax content or it may be a dewaxed distillate oil. Preferably the oil is a dewaxed, solvent-treated paraffinic type distillate oil of about medium to light lubricating oil grade. The following table sets forth the over-all characteristics of oils which are operative in the composition, and of oils falling within the preferred range of characteristics. Also included in the table are the characteristics of an oil which has been found to be particularly ideal.

TABLE I

Characteristics of hydrocarbon oils suitable for use with lecithin in gasoline

	Over-all Range	Preferred Range	Ideal
Gravity, °A.P.I. at 60° F.	34.0–26.0	32.0–26.5	28.6
Viscosity, SSU at 100° F.	150–1,000	250–500	318
Viscosity, SSU at 210° F.	42.3–77.5	45–75	52.2
Viscosity Index	>60	>80	85
Viscosity-gravity Constant	0.790–0.825	0.800–0.820	0.817
Flash point, COC, ° F.	410–500	425–475	445
Pour point, ° F.	<20	<20	5
Distillation,[a] ° F.:			
Initial	660–750	680–725	700
10%	690–815	720–790	760
50%	720–865	760–850	815
90%	765–970	800–930	892
Percent recovery	95–99	98–99	99

[a] Values calculated to atmospheric pressure from vacuum distillation data. Distillation made at 1 to 5 mm. Hg pressure.

Methods of dewaxing and solvent treating lubricating oil fractions are well known and need not be described herein except to point out that the dewaxing, which may be effected by substantially any method, with or without the aid of a dewaxing solvent, should produce a finished oil having a pour point not higher than about 20° F. Moreover, the solvent treatment may be carried out using any of the well-known selective solvents which remove the more aromatic fractions leaving the more paraffinic fractions. Suitable oils are obtained from waxy or paraffinic Western crude oils, from mid-continent type oils or from Eastern or Pennsylvania type crude oils.

It is essential that the hydrocarbon oil employed as the second additive of our additive combination have a viscosity of between about 42 and about 78 S.S.U. at 210° F. since lighter oils do not appear to be effective in reducing or preventing intake valve deposits and heavier oils tend to increase combustion chamber and exhaust valve deposits. Moreover it is desirable that the oil have a flash point of at least about 400° F.

The total amount of the additive combination and the relative amounts of lecithin and oil used in gasolines appear to be extremely important. In the case of lecithin, between about 0.002% and about 0.1% by weight of commercial lecithin containing approximately 65% of lecithin is found to be effective. The preferred amount is between about 0.01% and about 0.04% of the commercial lecithin and about 0.02% is found to be ideal. Correspondingly, between about 0.0013% and about 0.065% of pure lecithin, i.e., acetone-insoluble phosphatides from soya oil, is effective, the preferred amount is between about 0.0065% and about 0.026% and about 0.013% is the ideal amount. The amount of hydrocarbon oil employed as the secondary additive material will be between about 0.01% and about 1.5% by weight of the finished composition. Preferably between about 0.05% and about 0.6% by weight of the oil will be employed and an ideal amount is about 0.23%. The ratio of percent of hydrocarbon oil to percent of commercial lecithin is important. Although the reason for this is not completely understood it is believed that at least a part of the function of the hydrocarbon oil is that it acts as a carrier for the lecithin and prevents deposition of the lecithin on the induction system at a point where the fuel is vaporized. The amount of hydrocarbon oil used will generally be between about 5 and about 15 times the amount of the commercial 65% lecithin employed, or on the basis of actual lecithin, the amount of oil would be between 3.25 and 9.75 times the amount of lecithin. Preferably about 10 to 12 times as much oil as plastic lecithin, calculated on the weight basis, will be employed. In the following disclosure, unless otherwise indicated, the term lecithin will be used to designate the commercial lecithin which contains about 65% lecithin.

Gasolines or automotive fuels to which the lecithin and oil may be added and in which this additive combination is effective include substantially all grades of gasoline presently being employed in automotive and internal combustion aircraft engines. Such gasolines may be prepared from saturated hydrocarbons, e.g., straight-run stocks, alkylation products, and the like, with or without gum inhibitors, and with or without soluble lead compounds as for example tetraethyl lead, T.E.L., or ethyl fluid. The gasolines may be made wholly or partially from cracked stocks which stocks may be obtained by thermal and/or catalytic cracking methods. In such case, the gasolines will contain gum inhibitors and may or may not contain T.E.L. Generally automotive and aircraft gasolines contain both straight-run and cracked stocks with or without alkylated hydrocarbons, reformed hydrocarbons and the like. The preparation of straight-run, alkylated, reformed and cracked stocks for blending in the preparation of automotive gasolines, aircraft gasolines, and the like, are well-known and need not be further described. Gasolines suitable for use in present day automotive engines with which this invention is primarily concerned will generally have the characteristics shown in Table II and it is primarily to gasolines of the character indicated to which the additive combination of this invention is added and found to be effective.

TABLE II

Properties of typical automotive gasolines

Test	Premium Gasolines	Regular Gasolines
Gravity ° API	58–61	56–58
ASTM Gum,[a] mg./100 ml.	Less than 1.0	1.7
Octane Rating:		
Motor method	81–84	79–81
Research method	94–97	84–88
Distillation, ° F.[b]:		
10%	135	137
50%	222	254
90%	320	364
End Point	367	408

[a] Determined by ASTM method D-381.
[b] ASTM method D-86.

The above data were obtained on two commercial gasolines of the grades indicated and are believed to be typical of commercial gasolines marketed at the present time. These gasolines contain 2–3 ml. of ethyl fluid per gallon and 5 to 15 pounds of a phenolic type gum inhibitor per 1000 gallons. It is to be pointed out that the usefulness of the additive combination of this invention is not limited to gasolines of the types indicated as would be understood in the art. The same additive combination is effective in gasolines of lower or higher volatility as well as gasolines having lower or higher knock rating, many of which gasolines are presently commercially available. Gasolines which contain gum inhibitors may contain single materials or combinations of inhibitors. The use of gum inhibitors is well-known in the art and need not be further described. It might be pointed out that the inhibitors are generally aromatic compounds containing amino and/or hydroxyl groups and it should be mentioned further that the particular gum inhibitor or inhibitors employed does not appear to have any appreciable effect on the ability of the described additive combination to perform the functions described herein.

Since both the lecithin and the hydrocarbon oil employed are readily soluble in gasoline no difficulty is encountered in preparing the improved fuels of this invention. These two materials may be separately added to and dissolved in the fuel or they may first be combined, the lecithin being dissolved in the oil and the resulting solution added to the gasoline. Moreover the separate materials or the oil solution of lecithin may be dissolved in a small portion of the gasoline or in a small amount of one of the stocks used in preparing the finished gasoline and the resulting concentrate used in preparing the finished gasoline. Preferably the additives will be added and mixed into the gasoline during the blending operations or at the time of incorporating lead and/or gum inhibitor in the gasoline or gasoline stocks. It is to be noted that the lecithin at least must not be added to the stocks or gasoline prior to a sweetening treatment in which caustic or the like is employed.

The additive combination when separately prepared prior to addition to the gasoline or gasoline stocks will consist of a hydrocarbon oil solution of lecithin containing, based on the total composition, between about 6.25% and about 16.67% by weight of the plastic lecithin consisting of 65% so-called pure lecithin or correspondingly between about 4.1% and about 10.8% of the pure lecithin. The hydrocarbon oil will of course be a medium grade paraffinic oil as described herein. The amount of this oil solution of lecithin to be added will be that amount necessary to give the desired quantity of lecithin and oil.

Stability tests on gasolines with and without the additive combination of this invention indicate that there is substantially no change in octane number rating upon adding the lecithin and oil and that samples of the additive-containing gasolines exposed to sunlight in closed glass containers remained clear for 48 or more hours and the aged gasolines maintained the same octane number rating.

The base gasolines became very cloudy after 3.5–6 hours.

Since the effectiveness of the lecithin-oil additive combination is best shown by tests in automotive engines, a series of test procedures have been developed to evaluate the gasolines of this invention. In this testing, two different types of automotive engines have been employed and these engines have been operated under various conditions devised to accelerate the formation of deposits normally produced when the engine is operated using gasolines which do not contain the additive composition described herein. Since the test procedures have not been described in publications and since in order to evaluate the results it is important that the types of engines and conditions of operation are known, a description of each of the tests is presented herein. Following the descriptions of each engine test, the results obtained using typical automotive gasolines and using the same gasolines to which various amounts of additives have been added are shown and discussed.

CARBURETOR DEPOSIT TEST

This test is an accelerated test designed to show the tendency of a fuel to prevent the formation of deposits in the throat or throttle section of a carburetor.

A standard 1951, 216 cubic inch, six cylinder Chevrolet passenger car engine, modified in certain respects as described below, is employed in this test. The carburetor is modified by removing a 1.5 by 1.5 inch section of the throat wall directly opposite the idle jet and replacing this section with a Pyrex glass section of the same size and shape so that its inner surface follows accurately the contour of the inside wall of the carburetor throat. This permits observing the type and amount of deposits formed during the test. A 1-inch diameter flexible metal hose is substituted for the conventional breather tube. This hose carries crankcase vapors to the air intake of the carburetor.

The engine is modified and operated in a manner such as to increase the amount of crankcase vapors. External heating is used to maintain a crankcase oil temperature of 200° F.±5° F. Both rings in the compression ring grooves on each of 3 pistons are grooved to permit a greater than normal amount of blowby. Each ring has 4 vertical grooves milled on the outer face of the ring. The grooves are ⅛ inch wide and 0.01 inch deep and are equally spaced around the circumference of the ring. The crankcase oil employed is a naphthenic, 30 V.I. SAE 20 grade uncompounded mineral oil. At the start of a series of tests a used oil of the above type is placed in the crankcase and as test runs proceed the oil level is maintained by adding required amounts of fresh oil of the same type.

In order to simulate driving in heavy traffic the engine is operated 3 minutes at idle with an engine speed of about 400 r.p.m. followed by 2 minutes at part-open-throttle with an engine speed of approximately 1500 r.p.m. This operation is then repeated 3 times requiring a total of 20 minutes for the test.

At the end of the test the deposits on the glass insert or "window" are rated visually according to location and density. A striated deposit which starts just opposite the edge of the throttle-plate in the part-open-throttle position, and which may extend to the bottom of the window, is rated on an arbitrary scale of 0–7 in which 0 represents a perfectly clean window and 7 represents a window completely covered with deposits below the part-open-throttle position. The numerical rating is further modified by plus or minus signs to indicate density or apparent thickness of the deposits.

The ring of deposit which forms opposite the edge of the throttle plate at idle position, which will be referred to as the idle-ring deposit, is rated in terms of percent unbroken line, percent smudged line and percent perfectly clean. This deposit is further described as to thickness or density as faint, slight, medium and heavy. Results in Table III are averages of at least 2 runs. In

some instances test runs have been made for 40 minutes, i.e., 8 cycles. The longer runs are especially useful in obtaining relatively idle-ring deposit data.

In Table III are shown the results of tests on gasolines with and without the additives of this invention. Lecithin refers to the commercial plastic lecithin.

TABLE III

Carburetor deposit test

Fuel		Glass Carburetor Rating	
No.	Composition	Curtain Rating	Idle Ring Appearance
1	Base Fuel [a]	6	Complete ring line with smudging.
2	Fuel No. 1 plus 0.02% lecithin.	0	50% Clean. 50% Very Faint Film.
3	Fuel No. 1 plus 0.2% oil [b]	6–	90% Ring line. 10% Smudge.
4	Fuel No. 1 plus 0.02% lecithin and 0.20% oil.	0	30% Very faint ring line. 70% Clean.
5	Fuel No. 1 plus 0.005% lecithin.	0	Very faint ring line.
6	Fuel No. 1 plus 0.005% lecithin and 0.05% oil [b].	0	50% faint ring line. 50% Clean.
7	Base fuel X [c]	6	Complete ring line with smudging.
8	Fuel No. 7 plus 0.02% lecithin.	0	10% very faint ring line. 90% clean.
9	Fuel No. 7 plus 0.02% lecithin and 0.23% oil [b].	0	10% very faint ring line. 90% clean.

[a] A premium gasoline of 95 octane rating containing straight-run and catalytically cracked hydrocarbon base stocks, 3 ml. of lead per gallon and .005% by weight of a phenolic type gum inhibitor. This fuel has characteristics similar to those shown in Table II in the column headed "Premium Gasolines."

[b] A dewaxed, solvent extracted, Western paraffinic mineral oil having the characteristics set forth in Table I, last column.

[c] A regular grade gasoline having an octane rating of 84 and containing cracked and straight-run base stocks, 2 ml. of lead per gallon and .0035% by weight of a phenolic type gum inhibitor. This gasoline has characteristics similar to those shown in Table II in the column headed "Regular Gasolines."

The above data show that lecithin in the proportions indicated appears to remove and/or prevent the formation of carburetor deposits particularly at the throttle plate area which, from examination of automotive carburetors after use for 2,000–10,000 miles in ordinary service, appears to be the most critical part of the carburetor. Examination of the carburetor following each test failed to reveal objectionable deposits elsewhere in the carburetor.

CHEVROLET ENGINE ACCELERATED INTAKE VALVE DEPOSIT TEST

This is an accelerated test used to evaluate gasolines with respect to their abilities to prevent the formation of deposits on intake valves. Under the conditions of test it is believed that the deposits are formed primarily from the crankcase oil. The test is run using a 216 cubic inch 1952 Chevrolet automobile engine modified to increase the amount of oil supplied to the intake valves. This is accomplished by drilling a 1/16-inch diameter hole in the intake valve rocker arm, on the valve side of the rocker arm bearing, so that oil supplied by this hole travels to the end of the rocker arm and runs down the valve stem. With this modification the intake valve stems are constantly flushed with oil. Also the intake valve guides are reamed to give a clearance, stem diameter to guide bore, of 0.003–0.0035 inch.

In this test the engine is operated continuously for a period of 40 hours with a coolant water temperature of approximately 150° F. and an oil temperature of 200° F. ±5° F. The engine is operated for 80 seconds at 3150 r.p.m. with a load of 30 brake horsepower and then for 40 seconds at 1500 r.p.m. without load and this cycle is repeated to the end of the run. At the end of the 40-hour run the intake valves are removed and the deposits removed from the combustion chamber side of the valve head. The valve is then washed with naphtha to remove naphtha-soluble materials and the deposit remaining is determined by weighing. It is generally the practice to report "naphtha-insoluble deposit per valve" based on all 6 valves or based on the 4 valves having the greatest amount of deposit.

In this test it is believed that the intake valve deposits result primarily from the crankcase oil employed. The variations in amounts of deposit using the same fuel but varying the lubricating oil tend to substantiate this observation. Table IV shows the results of tests using standard fuels, and standard fuels containing the lecithin-oil additive of this invention with a single-grade heavy duty lubricating oil, i.e., SAE 20 grade, and with a multigrade, i.e., SAE 10–30, grade heavy duty lubricating oil. For purposes of comparison, the results of tests made with a commercial detergent premium gasoline are presented. In the table, the term lecithin is used to indicate commercial plastic lecithin and the oil used as a fuel additive is the oil described in footnote *b*, Table III.

TABLE IV

Chevrolet engine accelerated intake valve deposit test

Fuel		Crankcase Oil (Heavy Duty)		Deposits,[a] grams per Valve	
No.	Composition	No.	SAE Grade	Based on 6 Valves	Based on Worst 4 Valves
1	Base fuel [b]	1	20	0.55	0.72
2	Fuel 1 plus 0.02% lecithin and 0.23% oil.	1	20	0.27	0.34
3	Commercial Premium Gasoline A.[c]	1	20	0.82	1.00
1	Base fuel	2	10–30	0.97	1.25
4	Fuel 1 plus 0.02% lecithin and 0.10% oil.	2	10–30	0.65	0.72
5	Fuel 1 plus 0.02% lecithin and 0.23% oil.	2	10–30	0.57	0.67
3	Commercial Premium Gasoline A.	2	10–30	1.49	1.65

[a] Naphtha-insoluble deposits.

[b] See footnote (a), Table III.

[c] A commercial 93 knock rating premium gasoline containing lead, gum inhibitor and a detergent additive.

Data in Table IV show that intake valve deposits produced using a preimum gasoline, Fuel 1, with either a single grade or multigrade crankcase oil are greatly reduced by adding lecithin and oil of the type described herein to the fuel. With a single grade lubricating oil the deposits amount to approximately one-half those produced with the fuel which does not contain the additives of this invention and with a multigrade crankcase oil the deposits are reduced 33 to 41% or more depending upon the amounts of additives employed. It is to be noted also that the commercial detergent gasoline, although having the ability to prevent to a great extent at least the deposition of objectionable material in the carburetor, permitted the deposition of larger amounts of material on intake valves in this test than did the premium gasoline (base fuel) which did not contain detergent additives. It appears therefore that this gasoline either contributed heavily to the valve deposits or that it did not have the ability to remove deposits or to prevent deposition normally occurring from the crankcase oil.

ROAD LOAD DETERGENCY TEST

This test is run in a standard 1952 Chevrolet 216 cubic inch automobile engine with a standard carburetor and is used to determine the relative amounts of deposits on intake valves, which valves operate relatively dry, i.e., without oil flooding, using various fuels. The engine is operated for 40 hours at 2500 r.p.m. with a load of 20 brake horsepower. Cooling water is circulated through the cooling system of the engine at a rate such that with 110° F. water entering the engine, the water leaving the engine is 120° F.±5° F. The oil is maintained at a temperature of 170° F.±5° F.

Following completion of the 40-hour run the intake

valves are removed, the surfaces of the valves facing the combustion chamber are scraped and/or buffed free of deposits and the valves are then washed with naphtha to remove naphtha-soluble materials. The amounts of naphtha-insoluble deposits on the fillet and adjacent stem area is determined by weighing. This test, although it does not give absolute values, does give comparative data from which the effectiveness of various gasoline additives in preventing or reducing deposition on intake valves can be evaluated. The results are reported as naphtha-insoluble deposits per 6 valves.

In this test it is believed that the deposits are largely from the fuel rather than the crankcase oil. This conclusion is reached since the intake valves operate with a minimum of lubrication and therefore very little crankcase oil reaches the valve tulips. For this reason the data shown in the following Table V were obtained using an SAE 20 heavy duty crankcase oil. The only variations were in the fuel.

In Table V the base fuel is the same as the base fuel described in footnote *a*, Table III and the oil used as a fuel additive unless otherwise indicated is the oil described in footnote *b*, Table III.

TABLE V

Road load detergenecy test

PART 1

Fuel		Naphtha-insoluble deposits, All 6 Intake Valves, grams
No.	Composition	
1	Base fuel	0.53
2	Commercial Premium Gasoline A [a]	2.44
3	Commercial Premium Gasoline B [b]	4.29

PART 2

4	Fuel 1+0.02% lecithin	4.30
5	Fuel 4+0.10% oil	3.34
6	Fuel 4+0.23% oil	1.78
7	Fuel 4+0.48% oil	1.65

PART 3

8	Fuel 1+0.23% oil	1.87
9	Fuel 8+0.01% lecithin	1.73
10	Fuel 8+0.02% lecithin (Fuel 6)	1.78

PART 4

11	Fuel 4+0.23% oil (Fuel 6)	1.78
12	Fuel 4+0.23% (22% Naphthenic Raff. 60 [c], 78% Spray oil distillate [d]).	4.65
13	Fuel 4+0.23% (50% Naphthenic Raff. 40 [e], 50% Naphthenic Raff. 10 [f]).	3.37
14	Fuel 4+0.23% Naphthenic Raff. 40 [e]	3.28

[a] A commercial gasoline of 93 knock rating containing a detergent additive (see footnote (c) Table IV).

[b] A commercial premium gasoline of 94 knock rating containing phosphorus additive, for modifying combustion chamber deposits, and gum reducing additives.

[c] A naphthenic base SAE 60 solvent raffinate having a VI of 19, a VGC of .857 and a viscosity at 210° F. of 120 SSU.

[d] An untreated naphthenic distillate oil having a viscosity at 100° F. of 108 SSU and of 37.9 SSU at 210° F., a VI of −21 and a flash point of 305° F.

[e] A naphthenic base SAE 40 solvent raffinate of −5 VI, .860 VGC and having a viscosity at 210° F. of 64 SSU.

[f] A naphthenic base SAE 10 solvent raffinate of 25 VI, .858 VGC and having a viscosity at 210° F. of 44 SSU and 220 SSU at 100° F.

Part 1 of Table V shows that whereas a premium gasoline which does not contain additives other than the conventional additives such as tetraethyl lead and gum inhibitor permits the formation of but relatively small amounts of intake valve deposits, a commercial gasoline containing detergent additives and a second commercial gasoline containing a phosphorus additive designed to modify combustion chamber deposits give relatively large amounts of such deposits.

In Part 2 of the table the addition of lecithin to a non-additive gasoline is shown to permit rather large amounts of intake valve deposits. The data show, however, that when a medium viscosity paraffinic hydrocarbon oil is added to the fuel containing lecithin the amounts of deposits on intake valves are decreased. Optimum results are obtained with about 0.23% of oil when 0.02% of lecithin is present. Although greater amounts of oil give slightly decreased amounts of deposits the amount of decrease over that obtained with the 0.23% does not appear to justify the use of greater amounts of oil. It is to be noted that the amount of deposit formed with Fuel No. 6 containing lecithin and oil was appreciably less than that formed with either of the commercial gasolines tested.

Variations in lecithin content of a fuel in the presence of hydrocarbon oil of the type described herein as being most suitable do not appear to have any appreciable effect on intake valve deposits as shown in Part 3 of the table. In fact the gasoline containing 0.23% of hydrocarbon oil produces at least as much deposition as does the same fuel containing amounts of lecithin found to be necessary for other purposes, e.g., preventing the formation of carburetor deposits.

Tests on Fuels 11–14, inclusive, in Part 4 of Table V, show the necessity for using a medium viscosity paraffinic oil of the type described herein. When naphthenic oils of varying grades are employed, the intake valve deposits are shown to be 186–260% greater than those obtained with the preferred oil of this invention.

OCTANE REQUIREMENT INCREASE TEST

This test which will be referred to herein as the ORI test is employed to evaluate combustion chamber deposits as reflected by the increase in octane requirement of an engine following operation for a given period of time using various types of fuels.

A standard 1952 Oldsmobile V8, 160 B.H.P. engine is used in this test. The engine is operated continuously for a total of about 160 hours alternating between high and low engine speeds. An inertia wheel on the drive assembly, representing the inertia of a 3000 pound automobile permits operation according to the following schedule. The engine speed is increased to 2000 r.p.m. with a 23 brake horsepower load over a period of 40 seconds and then the speed is reduced to 1100 r.p.m. at 8 brake horsepower over a period of 80 seconds. This cycle is repeated to the end of the run. Temperatures maintained are: cooling water in, 140° F.±5° F., cooling water out 160° F.±5° F., and crankcase oil temperature 175° F.±5° F.

Following the completion of the run the octane number requirement of the engine is determined and compared with the octane number requirement determined after removing all of the combustion chamber deposits. Also, the intake valves are examined and naphtha-insoluble gum on the fillet and adjacent stem area is determined. Generally the intake valve deposits are reported as total naphtha-insoluble deposit per 2 dirtiest valves per 100 hours of operation. Following each test the carburetor is examined for deposits and the amounts of deposits compared with those produced by the base fuel.

The crankcase oil used in the ORI tests, the results of which are shown in TABLE VI was a heavy duty SAE 10–30 grade paraffinic base lubricating oil. This type of oil has been observed to produce intake valve deposits at a greater rate than a single grade oil of similar composition except for the viscosity index improver used in the multigrade oil. The base fuel is the same premium gasoline described in footnote *a*, Table III.

TABLE VI

Octane requirement increase test

Fuel		Carburetor Appearance	Valve Deposits,[a] g./2 Worst Valves per 100 hrs.	Octane Requirement Increase
No.	Composition			
1	Base fuel	Moderate deposits.	1.63	8.2
2	Fuel 1+0.02% lecithin and 0.23% oil.[b]	Markedly improved.	0.53	6.1
3	Fuel 1+0.02% lecithin and 0.23% naphthenic oil A.[c]	do	0.76	7.0
4	Fuel 1+0.02% lecithin and 0.23% naphthenic oil B.[d]	do	1.27	7.4

[a] Naphtha insoluble.
[b] See footnote [b], Table III.
[c] A blend of 21.8% SAE 60 naphthenic base solvent raffinate and 78.2% of a naphthenic base spray oil distillate having a viscosity at 100° F. of 108 SSU (see Table V, footnote [(f)].
[d] A blend of 9.5% SAE 60 naphthenic base solvent raffinate and 90% of a naphthenic base spray oil distillate (see footnote [(c)] above).

From the data in Table VI it will be seen that in the ORI test the use of lecithin and hydrocarbon oil reduces the ORI of the test engine as compared with the base fuel. Moreover it will be seen that the medium viscosity paraffin base solvent treated oil (Fuel 2) gives a smaller increase in octane requirement than was obtained with naphthenic base oils (Fuels 3 and 4). It will also be observed that intake valve deposits are far lower in the case of Fuel 2 than with the fuel without lecithin and oil. The naphthenic oils employed, in combination with lecithin, appear to have some value in reducing valve deposits but they are not nearly as effective as the paraffinic base oil.

Related testing work in the test engines described above indicates that the use of a high viscosity paraffin base lubricating oil, e.g., a bright stock of 148 SSU viscosity at 210° F., or a lower viscosity paraffin base oil, e.g., paraffinic oil having a viscosity of 90 SSU at 100° F., in place of the medium viscosity paraffinic oil defined herein shows that intake valve deposits are appreciably increased with the lighter oil and combustion chamber deposits are increased with the high viscosity oil.

A road test was carried out in a 1953 Chevrolet automobile used in ordinary service for approximately 1700 miles with (1) a premium fuel of the type described in Table II to which was added 0.02% lecithin and 0.23% of a medium viscosity paraffinic lubricating oil and (2) the same base fuel containing 0.02% of lecithin and 0.23% of a naphthenic oil described in footnote *b* of Table VI. The carburetor was found to be substantially clean after testing each of these oils but greater intake valve deposits were formed with fuel 2. Thus, fuel 2 permitted deposits amounting to 0.27 g./valve/1000 miles whereas with fuel 1 the deposits amounted to 0.21 g./valve/1000 miles. In the same automobile, operation for the same mileage with base fuel permitted the build-up of appreciable deposits in the carburetor, particularly in the area of the throttle valve.

Although the above described engine tests were made with a gasoline containing tetraethyl lead and gum inhibitor, the advantageous effects of the lecithin and paraffinic hydrocarbon oil are observed as well in gasolines which do not contain tetraethyl lead and/or gum inhibitors. Thus engine tests on gasolines which do not contain lead and/or gum inhibitor substantiate this position. The amount of lead which may be employed in preparing gasolines to which the additives of this invention may be added may thus vary from 0 to as high as about 5 ml. of tetraethyl lead per gallon. Generally, automotive gasolines will contain 1 to 3 ml. of T.E.L. per gallon and aviation fuels may contain as high as 4.5 or 5 ml. per gallon.

Gum inhibitors which may be employed in amounts generally ranging from about 5 pounds to about 25 pounds per 1000 barrels of gasoline include substantially any of the gum inhibitors which are now universally employed in the preparation of automotive and aviation gasolines. The particularly preferred gum inhibitors are aromatic ring compounds having aliphatic and hydroxyl substituents. Dibutyl paracresol has been found to be very satisfactory. In view of the fact that gasoline inhibitors are well-known in the art and are universally employed in today's gasolines, a further description of these materials is considered to be unnecessary.

The above description and examples of our invention are illustrative of the broader aspects of this invention and are not to be taken as limiting the invention as set forth in the following claims.

We claim:

1. An internal combustion engine fuel consisting essentially of hydrocarbons boiling in the gasoline boiling range containing between about 0.0013% and about 0.065% by weight of lecithin and between about 0.01% and about 1.5% by weight of a paraffinic hydrocarbon oil of medium lubricating oil grade having a viscosity at 210° F. of between about 42 and about 78 S.S.U., a flash point between 410° F. and 500° F., and a viscosity index greater than 60, the amount of mineral lubricating oil being between 3.25 and 9.75 times the amount of lecithin present.

2. A motor fuel according to claim 1 in which said hydrocarbon oil is a dewaxed, solvent-treated paraffinic hydrocarbon oil.

3. An internal combustion engine fuel consisting essentially of hydrocarbons boiling in the gasoline boiling range and containing between about 0.002% and about 0.1% by weight of a lecithin concentrate containing approximately 65% of acetone-insoluble phosphatides in soya oil and between about 0.01% and about 1.5% by weight of a medium grade paraffinic lubricating oil having a viscosity at 210° F. of between about 42 and about 78 S.S.U., a flash point between 410° F. and 500° F., and a viscosity index greater than 60, the amount of mineral lubricating oil being between 3.25 and 9.75 times the amount of lecithin present.

4. An internal combustion engine fuel consisting essentially of hydrocarbons boiling in the gasoline boiling range and containing up to about 5 ml. of tetraethyl lead per gallon, between about 5 and about 25 pounds per 1000 barrels of a gum inhibitor, between about 0.0013% and about 0.065% by weight of lecithin and between about 0.01% and about 1.5% by weight of a paraffinic hydrocarbon oil of medium lubricating oil grade having a viscosity at 210° F. of between about 42 and about 78 S.S.U., a flash point between 410° F. and 500° F., and a viscosity index greater than 60, the amount of mineral lubricating oil being between 3.25 and 9.75 times the amount of lecithin present.

5. An internal combustion engine fuel according to claim 4 in which said gum inhibitor is an alkyl substituted phenol.

6. An internal combustion engine fuel according to claim 4 in which said gum inhibitor is dibutyl paracresol.

7. An internal combustion engine fuel suitable for use in high compression automotive engines consisting essentially of a hydrocarbon fuel boiling in the gasoline boiling range and containing about 1 to about 3 ml. of tetraethyl lead per gallon, between about 5 and about 25 pounds of a gum inhibitor, between about 0.01% and about 0.04% by weight of a lecithin concentrate containing about 65% by weight of lecithin and between about 0.05% and about 0.6% by weight of a medium viscosity paraffinic mineral lubricating oil having a viscosity at 210° F. of between about 42 and about 78 S.S.U., a flash point between 410° F. and 500° F., and a viscosity index greater than 60, the amount of mineral lubricating oil being between 3.25 and 9.75 times the amount of lecithin present.

8. An internal combustion engine fuel consisting es-

sentially of hydrocarbons boiling in the gasoline boiling range containing between about 0.01% and about 1.5% by weight of a paraffinic hydrocarbon oil of medium lubricating oil grade and an amount of lecithin less than about 0.1% by weight which in combination with said hydrocarbon oil is sufficient to reduce carburetor deposits and prevent the formation of excessive deposits on intake valves of internal combustion engines, said hydrocarbon oil having a viscosity at 210° F. of between about 42 and about 78 S.S.U., a flash point between 400 and 500° F. and a viscosity index greater than 60.

9. An internal combustion engine fuel consisting essentially of hydrocarbons boiling in the gasoline boiling range and containing up to about 5 ml. of tetraethyl lead per gallon, between about 5 and about 25 pounds per 1000 barrels of a gum inhibitor, said fuel containing between about 0.01% and 1.5% by weight of a paraffinic hydrocarbon oil and an amount of lecithin less than about 0.1% by weight which in combination with said hydrocarbon oil is sufficient to reduce the formation of carburetor deposits and prevent the formation of excessive deposits on the intake valves of internal combustion engines, said hydrocarbon oil having a viscosity at 210° F. of between about 42 and about 78 S.S.U., a flash point between 400 and 500° F. and a viscosity index greater than 60.

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