United States Patent Office 2,904,458
Patented Sept. 15, 1959

2,904,458

REMOVING COMBUSTION CHAMBER DEPOSITS FROM INTERNAL COMBUSTION ENGINES AND COMPOSITIONS

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No Drawing. Application September 2, 1954
Serial No. 453,948

6 Claims. (Cl. 134—20)

This invention relates to improved multicomponent compositions for removing engine deposits and is a continuation-in-part of application, Serial No. 239,614, filed July 31, 1951, and now abandoned.

Operation of internal combustion engines on present day commercial fuels and lubricants results in the formation of different types of deposits in various parts of the engine. These deposits often interfere with the proper and efficient operation of the engine. Those formed in the combustion chamber area are commonly referred to as carbon deposits, although they consist of many complex compounds, often containing lead, oxygen, sulfur, bromine, and chlorine, as well as gums and carbonaceous material. In addition, there may be present mineral matter from road dust drawn into the carburetor, and metallic elements of additives used in the lubricating oil. One of the effects of these deposits in the combustion zone area is to increase the tendency of the engine to knock on the fuel charge, i.e. they increase the octane requirement of the engine. Furthermore, these deposits reduce the engine power output as, for example, by thermal and physical restriction of the air flow to the engine. Somewhat similar deposits are also formed on the faces and stems of intake and exhaust valves. Faulty operation leading to failure of these parts is often the result. Fuel and oil partial decomposition products along with lead compounds are found in the ring zone area, and excessive quantities of these can give rise to improper operation of the compression and oil rings with a resultant large increase in oil consumption. Generally the deposits in this area are more carbonaceous than gum-like in nature.

Deposits in internal combustion engines have long been a problem, and many attempts have been made to solve it. Most prior investigators have worked from the viewpoint of removing deposits to make the engine clean, but few have been concerned with the problem of the higher octane fuel required for an engine when it becomes dirty due to deposits in the combustion chamber. It is well known that an engine with clean combustion chambers will operate satisfactorily without knocking on a fuel of lower octane number than an engine in which deposits have accumulated in the combustion chamber. In general, formation of appreciable deposit causes the octane requirement of the engine to increase by 10 to 15 numbers and curtails the development of power. This frequently occurs to a significant extent after a few hundred miles of operation. This defect can be cured by taking the engine apart and cleaning the parts, but this is expensive, troublesome and impractical. It can also be remedied by

retarding the spark but at the expense of economy, power, and general performance.

An object of our invention is to provide a composition capable of removing substantial portions of deposits formed when operating an automotive engine and in particular when operating such an engine on a fuel containing a lead antiknock compound. It is a further object of our invention to provide a multicomponent composition of specific formulation to remove substantial portions of the deposit by introduction into the engine of a small quantity of the composition, thereby returning the engine to substantially clean condition and to its original octane requirement and power.

We have found an effective composition for this purpose containing specific ingredients, each serving a definite function as follows:

(1) A solvent of the aromatic type to remove the oily residue,

(2) A material to remove gum,

(3) A material to penetrate and remove the lead compounds in the deposits, and

(4) A low volatility material to stabilize the volatility of the mixture in order that the mixture will not evaporate too rapidly, thereby giving the mixture sufficient time to act on the deposits.

As to point 3, substantially all the gasoline today contains tetraethyllead, and certain portions of the deposits in the engine are due to it. Certain engine cleansing agents of the prior art are somewhat effective in removing deposits formed in the absence of leaded fuels. However, the effect of lead in the fuel upon the character of such deposits has not been fully appreciated heretofore, and it is particularly in combating such deposits that our compositions are useful and are an improvement in the art. For the efficient operation of an engine it is not sufficient that the so-called carbonaceous deposits be eliminated, but a substantial portion of all the various types of deposits must be removed. We have found that each of the above factors is essential in order to alleviate the increase in octane requirement of the engine due to such deposits.

The ingredients of the compositions of this invention are listed as follows in the same order as above:

(1) Any of the well known aromatic type solvents can be used to remove the oily residue. Very satisfactory results are obtained from benzene hydrocarbons having from 6 to about 18 carbon atoms in the molecule. Such benzene hydrocarbons are exemplified by benzene, toluene, o-, m-, and p-xylenes, ethylbenzene, propylbenzene, isoamylbenzene, tert-octylbenzene, m-di-n-butylbenzene, trimethylbenzene, sym-triisobutylbenzene, and the like. Mixtures of such benzene hydrocarbons likewise can be successfully used, as, for example, a high aromatic cut or fraction from petroleum containing a substantial proportion of benzene hydrocarbons containing from about 6 to about 18 carbon atoms per molecule. We particularly prefer xylol, toluene, benzene, ethylbenzene, and trimethylbenzene for this purpose, as these materials possess excellent solvency characteristics. We have found that our mixtures should contain by volume about 20 to 50 percent of this material, and we prefer to use from 30 to 50 percent.

(2) For the removal of gum-like material we can use the various monoalkyl ethers of ethylene glycol or diethyl-

ene glycol. We prefer the monomethyl ether of glycol, although the monoethyl, monopropyl, monobutyl ethers of glycol as well as the corresponding diethylene glycol derivatives can be used. We can successfully employ from 20 to 40 percent by volume of these materials, although we prefer to use from 25 to 35 percent.

(3) Monoamines, particularly alkyl monoamines, having less than 12 and preferably less than 9 carbon atoms are used to attack and penetrate the lead compounds in the deposits formed during the combustion of leaded gasoline. Among the amines that can be successfully employed are butyl amine, amyl amine, hexyl amine, octyl amine, dodecyl amine, diethylamine, trimethylamine, and the like. Inferior results are obtained when using polyamines. We can use from about 10 to 25 percent by volume of an alkyl monoamine, although we prefer to use from about 10 to 15 percent.

(4) We achieve enhanced deposit removal effectiveness by the use of another ingredient as an evaporation deterrent. For such purpose we use a low volatility chlorinated aromatic material. Among preferred materials for this purpose are the various chlorinated benzenes containing from 2 to 6 chlorine atoms in the molecule or mixtures of such chlorinated benzenes. Typical compounds of this type include o-, m-, and p-dichlorobenzene; 1,2,3-trichlorobenzene; 1,2,4-trichlorobenzene; 1,2,5-trichlorobenzene; 1,3,5-trichlorobenzene; 1,2,4,5-tetrachlorobenzene; pentachlorobenzene; and hexachlorobenzene. Any individual isomeric form of trichlorobenzene or a mixture of the several isomers thereof is a particularly useful material for this purpose, and it therefore constitutes a preferred embodiment of our invention. We have successfully used from about 15 to 35 percent by volume of these chlorinated benzenes, although we prefer to use from about 20 to 25 percent.

The above description shows what we believe to be the purpose of each of the materials employed, but it is to be understood that we do not want to be bound by any theory. We do know that the above materials in the proportions given are necessary to have a satisfactory deposit removal formulation from the viewpoint of minimizing the deposit effect on the octane requirement of engines.

A feature of the deposit removing formulations we have provided is that the addition of certain other ingredients detracts from their effectiveness. One such ingredient is water. We have found that the presence of more than trace amounts of water in our compositions minimizes the degree of effectiveness to a considerable extent. Similarly, the presence of detergents adversely effects the efficacy of our formulations. This we attribute to the fact that detergents promote the formation of a thin film of carbon remover solvent on the engine deposits. Since it is desirable to apply our formulation to heated engine deposits, such a thin film evaporates before it has an opportunity to exert its deposit removing function.

We have investigated several methods of introducing our compositions into the engine. We prefer to subject the deposits to frequent wetting, thereby reducing the amount of fluid required and total treatment time by approximately 50 percent, compared with a single wetting of the deposit, and still obtain the same high degree of effectiveness. We prefer to use the following method.

Operate the engine until it has been thoroughly warmed up; then turn off the ignition and plug the end of the exhaust pipe. Inject the material by one of the following procedures:

(*a*) Pour 40 to 100 milliliters (preferably 60 milliliters) through each spark plug hole. After all cylinders have received the carbon remover, crank the engine with the starter motor for a period of approximately 5 seconds with throttle closed.

(*b*) Inject or pour a supply of carbon remover at some point in the induction system, where it will be approximately equally distributed to all cylinders, while the engine is being cranked by the starter motor for a period of about 5 seconds.

Following the injection, crank the engine for 2 or 3 seconds at 10-minute intervals for a total elapsed time of 30 minutes. Then remove the plug from the end of the exhaust pipe and start the engine. Run the engine for 10 to 20 minutes with frequent accelerations to high engine speeds. This operation will tend to blow out all loose deposits. After the treatment has been completed, the crankcase oil is drained and new oil supplied.

The above method of application not only makes effective use of liquid left in the combustion chamber at the 10-minute intervals but forces generous amounts of liquid past the valves, the rings, and the piston and cylinder walls so as to dissolve, loosen, and flush deposits found thereon into the crankcase, and they are then removed along with the oil drained. Regular use of the mixtures of our invention keeps piston rings and valves free so as to maintain low oil consumption and high engine performance.

Other methods of introducing our carbon remover fluids may be used. For example, there are various devices on the market suitable for injection of our material into the engine, whether continuously or at regular intervals to remove the deposits. Examples of such methods of introduction are found in U.S. Patents 1,386,385 and 2,366,073.

Our superior mixes were tested in a stock V–8 L-head engine mounted on a test block and connected to a dynamometer. Combustion chamber deposits were accumulated in this engine by operating it under cycling conditions on a commercial gasoline containing 3.0 milliliters of tetraethyllead per gallon, and with a mixed-base type commercial lubricating oil in the crankcase. The test cycle consisted of 2 minutes of operation at 800 r.p.m. at no load followed by 6 minutes of running at 75 percent load at 2500 r.p.m. This cycle was repeated until 80 engine test hours had been accumulated. At the of that time the cycle head were removed and visual ratings were made of each combustion chamber on the basis of area covered by deposits. The cylinder heads were then reinstalled and the engine thoroughly warmed up. Each bank of cylinders was then treated with a test carbon remover mix in the manner described above. Good results were obtained in all cases when any of our compositions were used.

To properly evaluate our materials and to compare them with known materials, a laboratory procedure was developed. This procedure is as follows: Pistons having deposits thereon were divided into a number of pieces and placed in individual containers in a bath heated to about 80° C. To the respective containers were added equal amounts of the different compositions to be compared. After two minutes immersion of the piston parts in the test mixture, the parts were lifted from the liquid and held in the vapors immediately above the liquid for 30 minutes. At the end of the 32 minutes of test at about 80° C. the test pieces were removed and percent of deposit removal calculated based on visual ratings made of the area covered by deposits before and after treatment. This test procedure was found to correspond with engine data obtained by the procedure outlined above.

The following examples are typical of the results obtained by using our composition.

Example I

A mixture comprising 32 percent by volume of xylol, 32 percent of glycol monomethyl ether, 24 percent of trichlorobenzene, and 12 percent of butyl amine was compared with a mixture comprising 60 percent of xylol and 40 percent of glycol monomethyl ether using the laboratory bench test procedure as outlined above. Based on

this comparison it was found that our mixture removed over three times as much deposits as that removed by the binary component mixtures of the prior art, namely, glycol monomethyl ether and benzene. Our mixture removed over 85 percent of the deposit by the laboratory tests, and in the above engine test our mixture removed over 80 percent. Various other materials in which the proportions were varied within the ranges set forth above gave equally good results.

Example II

A mixture containing 40 percent by volume of xylol, 30 percent of glycol monomethyl ether, 20 percent of trichlorobenzene, and 10 percent of butyl amine removed about 75 percent of the deposit, which was about three times better than the removal obtained when using a two-component mixture of the prior art, namely, xylol and glycol monomethyl ether.

In other tests, when using about the same proportions as given in the above examples but in which benzene or toluene were substituted for xylol, substantially the same results were obtained. Likewise, excellent results were obtained both in the laboratory bench test and in the engine when either the methyl ether of diethylene glycol or glycol monoethyl ether was substituted for glycol monomethyl ether. The same was true when a mixture of chlorinated benzene-containing compounds having from 2 to 6 chlorine atoms were substituted for the compound trichlorobenzene. In like manner monoamines other than butyl amines within the scope of our invention, such as octyl amine, have been successfully employed. In general any of our mixtures remove several times the amount of deposit than can be removed by prior art mixtures such as a binary mixture of glycol monomethyl ether and benzene.

However, if any one of the above components are omitted from our formulations, inferior results are obtained. For example, when a mixture comprising 60 percent xylol, 20 percent glycol monomethyl ether, and 20 percent butyl amine was used, only about 35 percent of the deposit was removed compared with 25 percent for the binary mixture of the prior art, whereas, as mentioned previously, over 80 percent deposit removal was obtained when one of our mixtures was used.

The removal of deposit from the engine exhibits its greatest beneficial effect upon the octane requirement of the engine. This important fact has been established as follows: A standard 1951 eight cylinder automotive engine was operated on a fuel which contributed heavily toward engine deposit. The engine was operated for a total of 80 hours under a cycling schedule wherein the engine was operated for 6 minutes at three-quarter load at a speed of 2500 r.p.m. followed by a 2-minute operating period at zero load at a speed of 800 r.p.m. The octane requirements of this engine were measured at full throttle at a speed of 1000 r.p.m. This engine was a V–8 engine, and each bank of four cylinders was designed to permit individual control of the spark advance. After the 80-hour deposit build-up period, one bank of four cylinders was treated by the above described method with a composition comprising 60 percent xylol and 40 percent glycol monomethyl ether. The octane requirement of this bank of cylinders was decreased 3 octane numbers by this treatment. The remaining bank of four cylinders was treated as in the above example with one of our preferred compositions corresponding to Example I above, with the result that the octane requirement of this bank of cylinders was reduced by over 6 octane numbers, which was a two-fold improvement over the binary mixture and which resulted in this bank of cylinders having substantially the same octane requirement as the new engine.

Removal of combustion chamber deposits by our preferred mixes not only lowers the octane requirement of the engine but also greatly increases the power output. For example, several engines which had accumulated considerable amounts of deposits in the combustion chambers showed on the average a 6 percent gain in power output after treatment with one of our preferred compositions corresponding to Example I. Equally good results are obtained with other compositions within the scope of this invention.

Our compositions also tend to remove varnish deposits from piston skirts, piston ring grooves, and oil ring holes, as shown by engine test data in the table below. These tests were run on a Lauson LF single-cylinder engine operated under CRC FL–2 type test conditions with a "dirty" gasoline.

Engine part	Engine cleanliness ratings [1]	
	Before treatment	After treatment
Piston skirt	5	9.5
Piston ring grooves	7	8
Oil ring holes	8.5	10

[1] 10=clean.

Other embodiments of our invention may be made within the scope of the following claims.

We claim:

1. A cleaning composition particularly adapted for removing deposits from internal combustion engines consisting essentially, by volume, of about 20 to 50 percent of a hydrocarbon selected from the group consisting of xylol, toluene, benzene, ethylbenzene and trimethylbenzene, about 20 to 40 percent of a glycol monoalkyl ether whose glycol portion is derived from a compound selected from the group consisting of ethylene glycol and diethylene glycol and whose alkyl portion contains from 1 to 4 carbon atoms, about 15 to 35 percent of chlorinated benzene containing 2 to 6 chlorine atoms per molecule, and about 10 to 25 percent of an alkyl monoamine selected from the group consisting of butyl amine, amyl amine, hexyl amine, octyl amine, dodecyl amine, diethyl amine and trimethyl amine.

2. The composition of claim 1 wherein said hydrocarbon is xylol, said ether is ethylene glycol monomethyl ether, said chlorinated benzene is trichlorobenzene and said monoamine is butyl amine.

3. A cleaning composition particularly adapted for removing deposits from internal combution engines consisting essentially, by volume, of about 32 percent of xylol, about 32 percent of ethylene glycol monomethyl ether, about 24 percent of trichlorobenzene and about 12 percent of butyl amine.

4. A cleaning composition particularly adapted for removing deposits from internal combustion engines consisting essentially, by volume, of about 32 to 40 percent of xylol, about 30 to 32 percent of glycol monomethyl ether, about 20 to 24 percent of trichlorobenzene and about 10 to 12 percent of butyl amine.

5. The method of removing deposits from internal combustion engines comprising the steps of running the engine until it has been thoroughly warmed up, turning off the ignition switch, plugging the exhaust outlet, closing the throttle valve, introducing into the cylinders of said engine a cleaning composition consisting essentially, by volume, of about 20 to 50 percent of a hydrocarbon selected from the group consisting of xylol, toluene, benzene, ethyl benzene and trimethylbenzene, about 20 to 40 percent of a glycol monoalkyl ether whose glycol portion is derived from a compound selected from the group consisting of ethylene glycol and diethylene glycol and whose alkyl portion contains from 1 to 4 carbon atoms, about 15 to 35 percent of chlorinated benzene containing 2 to 6 chlorine atoms per molecule, and about 10 to 25 percent of an alkyl monoamine selected from the group consisting of butyl amine, amyl amine, hexyl

amine, octyl amine, dodecyl amine, diethyl amine and trimethyl amine, cranking the engine at frequent intervals, removing said plug from the exhaust valve and opening said throttle valve, and operating the engine under its own power for a time sufficient to remove the loose deposit from the combustion chamber.

6. The method as recited in claim 5 wherein the composition introduced into the cylinders of said engine consists essentially by volume of about 32 percent of xylol, about 32 percent of ethylene glycol monomethyl ether, about 24 percent of trichlorobenzene and about 12 percent of butyl amine.

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