FUEL ADDITIVES

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NOYES DATA CORPORATION
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FOREWORD

The detailed, descriptive information in this book is based on U.S. patents since 1971 relating to the composition and use of fuel additives.

This book serves a double purpose in that it supplies detailed technical information and can be used as a guide to the U.S. patent literature in this field. By indicating all the information that is significant, and eliminating legal jargon and juristic phraseology, this book presents an advanced, technically oriented review of modern fuel additives.

The U.S. patent literature is the largest and most comprehensive collection of technical information in the world. There is more practical, commercial, timely process information assembled here than is available from any other source. The technical information obtained from a patent is extremely reliable and comprehensive; sufficient information must be included to avoid rejection for "insufficient disclosure."

The patent literature covers a substantial amount of information not available in the journal literature. The patent literature is a prime source of basic commercially useful information. This information is overlooked by those who rely primarily on the periodical journal literature. It is realized that there is a lag between a patent application on a new process development and the granting of a patent, but it is felt that this may roughly parallel or even anticipate the lag in putting that development into commercial practice.

Many of these patents are being utilized commercially. Whether used or not, they offer opportunities for technological transfer. Also, a major purpose of this book is to describe the number of technical possibilities available, which may open up profitable areas of research and development. The information contained in this book will allow you to establish a sound background before launching into research in this field.

Advanced composition and production methods developed by Noyes Data are employed to bring our new durably bound books to you in a minimum of time. Special techniques are used to close the gap between "manuscript" and "completed book." Industrial technology is progressing so rapidly that time-honored, conventional typesetting, binding and shipping methods are no longer suitable. We have bypassed the delays in the conventional book publishing cycle and provide the user with an effective and convenient means of reviewing up-to-date information in depth.

The Table of Contents is organized in such a way as to serve as a subject index. Other indexes by company, inventor and patent number help in providing easy access to the information contained in this book.

15 Reasons Why the U.S. Patent Office Literature Is Important to You —

1. The U.S. patent literature is the largest and most comprehensive collection of technical information in the world. There is more practical commercial process information assembled here than is available from any other source.

2. The technical information obtained from the patent literature is extremely comprehensive; sufficient information must be included to avoid rejection for "insufficient disclosure."

3. The patent literature is a prime source of basic commercially utilizable information. This information is overlooked by those who rely primarily on the periodical journal literature.

4. An important feature of the patent literature is that it can serve to avoid duplication of research and development.

5. Patents, unlike periodical literature, are bound by definition to contain new information, data and ideas.

6. It can serve as a source of new ideas in a different but related field, and may be outside the patent protection offered the original invention.

7. Since claims are narrowly defined, much valuable information is included that may be outside the legal protection afforded by the claims.

8. Patents discuss the difficulties associated with previous research, development or production techniques, and offer a specific method of overcoming problems. This gives clues to current process information that has not been published in periodicals or books.

9. Can aid in process design by providing a selection of alternate techniques. A powerful research and engineering tool.

10. Obtain licenses — many U.S. chemical patents have not been developed commercially.

11. Patents provide an excellent starting point for the next investigator.

12. Frequently, innovations derived from research are first disclosed in the patent literature, prior to coverage in the periodical literature.

13. Patents offer a most valuable method of keeping abreast of latest technologies, serving an individual's own "current awareness" program.

14. Copies of U.S. patents are easily obtained from the U.S. Patent Office at 50¢ a copy.

15. It is a creative source of ideas for those with imagination.

CONTENTS AND SUBJECT INDEX

INTRODUCTION

The search for improved fuel additives, while the subject of continuing research effort for many years, has taken on new and significantly added dimensions with the pending worldwide fuel shortage. The recognition in the late sixties of our need to clean up the environment has resulted in extremely stringent specifications for fuel oils and gasoline. The current implementation of automotive emissions standards throughout the world will mean drastic reductions in mileage per gallon for the average consumer. With these standards, considerable progress has already been made in air pollution control.

The mid-seventies are expected to be a time of increasingly short fuel supplies. This could drastically curtail our production capability, our personal travel patterns and in the long run, our gross national product and our very way of life, while at the same time reversing the ecological progress made to date.

The challenge to and the opportunity for the technical community is thus greatly intensified and the need for more effective fuel additives to increase efficiency, while at the same time decreasing the emission of pollutants, will provide many new business opportunities in the seventies. Fuel additive production can be expected to show well above normal growth in the next decade.

The research activity in this field is nowhere more evident than in the recent United States patent literature. This book describes over 200 processes, including more than 1,000 fuel additive formulations, which appeared in the patent literature during the past three years. Major developments have centered on multipurpose carburetor detergents, anti-icing and emission control additives, antiknock compounds and improved oxidation and corrosion inhibitors for today's high performance internal combustion engine fuels. The problems associated with middle distillate fuels for diesel engines, such as smoke generation and flow and pour point control have also been the subject of considerable investigation and product development.

The arrangement of this book is designed to emphasize the major contribution of a given type of fuel additive, although it must be recognized that many such products provide a variety of improvements. Additionally, many fuel additives, particularly dispersants, detergents, stabilizers and flow control agents are also widely used in modern lubricant technology.

The reader's attention is directed to another publication by Noyes Data Corporation which provides considerable background information:

M.W. Ranney, *Lubricant Additives* 1973

DETERGENTS AND ANTI-ICING ADDITIVES

Spark ignition engines are operated at speeds varying from slow to fast at atmospheric conditions varying from dry to humid at low to high temperatures. When a spark ignition engine is operated at cool, humid atmospheric conditions, using a gasoline fuel having a relatively low 50% ASTM distillation point, i.e., below about 235°F., excessive engine stalling is apt to be encountered at idling speeds during the warmup period, especially where engine idling occurs following a period of light load operation. Engine stalling under such conditions has been attributed to the partial or complete blocking of the narrow air passage that exists between the carburetor throat and the carburetor throttle valve during engine idling, by ice particles that deposit upon and adhere to the metal surfaces of the carburetor parts.

Such icing of carburetor parts occurs as a result of the condensation of moisture from the air drawn into the carburetor and as a result of the solidification of such condensed moisture. The condensation and solidification of moisture are caused by the refrigerating effect of rapidly evaporating gasoline. Accordingly, excessive engine stalling due to carburetor icing occurs as a practical matter only in the instance of gasolines containing a large proportion of relatively high volatile components. In practice, the problem of engine stalling due to carburetor icing has been found to be serious, under cool, humid atmospheric conditions, in connection with gasolines having a 50% ASTM distillation point below about 235°F.

Engine stalling can be caused not only by ice which is deposited in the carburetor but also by other deposits which may form in the carburetor, particularly in the throttle body area of the carburetor. While such other deposits may form under any driving conditions, these deposits are more likely to be formed in the carburetor of an engine operating at idling speeds during a considerable period of the operating time. Such driving conditions are normally encountered in engines of automobiles used to a great extent in driving in heavy traffic of the type encountered in city driving.

As deposits begin to build up in the throttle area of the carburetor, the clearance between the throttle plate and the body wall of the carburetor becomes progressively less. As the clearance is reduced the amount of air passing the throttle plate for a given amount of fuel is also reduced. As a result of a reduced amount of air, the air-fuel mixture introduced into the combustion chamber is richer than it should be for satisfactory engine operation. As deposits continue to build up in the carburetor, rough engine idling is encountered and eventually the engine will stall under idling conditions. The deposits which are formed in the carburetor may be due in part to the makeup of the motor fuel which is used, but it is believed that the deposits are due, to a greater extent at least, to foreign matter introduced into the carburetor through the air intake system. Air cleaners employed in automotive engines do not appear to effectively remove these contaminants. Major contributors to air contamination are crankcase vapors, exhaust vapors, dust and smoke. The problem with respect to carburetor deposits resulting from air contamination is further aggravated by positive crankcase ventilating systems which are employed in many of the current automotive engines. In engines equipped with a positive crankcase ventilating system, fumes and/or vapors from the crankcase are passed through a metering valve to the air intake system of the engine. While this system helps to cut down on fumes escaping to the atmosphere the system adds to the problem of deposits formed in the carburetor.

Excessive engine stalling whether resulting from the formation of ice or from other deposits in the carburetor is, of course, a source of annoyance due to the resulting increased fuel consumption, battery wear and inconvenience of frequent restarting. It is, therefore, important that any inherent engine stalling characteristics of gasoline fuels due to carburetor icing be reduced substantially and that the formation of other deposits also be reduced. While ice deposits will melt eventually, other deposits which accumulate in the carburetor must either be removed or the carburetor must be replaced before satisfactory engine performance can be obtained.

This chapter describes several hundred formulations and synthetic procedures related to carburetor detergents and anti-icing additives. While these have been developed primarily for gasoline motor fuels, many such additives can also be employed in other types of fuel.

MULTIPURPOSE CARBURETOR DETERGENTS

Polyoxypropylene Ester and Tallow Trimethylenediamine Naphthenate

G.E. Gaston; U.S. Patent 3,573,011; March 30, 1971; assigned to Gulf Research & Development Company describes a gasoline motor fuel having improved anti-icing, detergency, antirust and ignition control characteristics is obtained by incorporating in the fuel a small amount of a combination of a polyoxypropylene ester and a monocarboxylic acid salt of an N-aliphatic substituted polymethylenediamine. The polyoxypropylene ester has the general formula

$$RCOOC_3H_6O(C_3H_6O)_nC_3H_6OH$$

where R is an aliphatic hydrocarbon radical containing 7 to 29 carbon atoms and n is an integer of 20 to 100. The monocarboxylic acid salt is the salt of a monocarboxylic acid which contains at least 8 carbon atoms in the molecule and an N-aliphatic substituted polymethylenediamine which has the general formula $RNH(CH_2)_xNH_2$ where R is an aliphatic hydrocarbon radical containing 8 to 30 carbon atoms and x is an integer of 2 to 10.

To illustrate the nature of the improvement obtained, there are presented in Table 1 the results obtained with engine tests made upon a base gasoline motor fuel and the same base gasoline motor fuel containing a combination of polyoxypropylene monooleate and N-tallow trimethylenediamine naphthenate.

TABLE 1

	Fuel composition	
	A	B
Base gasoline, volume percent	100	100
Added:		
Polyoxypropylene monooleate: lb./1,000 bbl		6.0
N-tallow-trimethylene diamine naphthenate: lb./1,000 bbl		6.0
Engine Tests, Carburetor Throat Rating [1]	21	6

[1] Rating of 0 denotes a clean condition; rating of 22 denotes very heavy deposits.

Typical properties of the polyoxypropylene monooleate and N-tallow trimethylenediamine naphthenate used in the illustrative examples are as follows.

Properties	Polyoxypropylene monooleate	N-tallow trimethylene diamine naphthenate[1]
Gravity: ° API	9.7	21.6
Specific gravity, 60°/60° F	1.002	0.924
Viscosity, SUV: Sec.:		
At 100° F	906	1,692
At 130° F	815	600
At 150° F	157.8	355
Flash point, P-M: ° F	220	142
Pour point, ° F	−10	−10
Color, ASTM D1500	<1.0	8.0
Neutralization No. ASTM D664, Total Acid No.	1.0	64
Sulfated Ash, ASTM D874, percent	0.002	0.02
Insolubles, ASTM D893, percent:		
n-Pentane	0.01	0.01
Benzene	0.01	0.01
Molecular weight	1,850	

[1] Determinations made in kerosene: (75% by weight N-tallow trimethylene diamine naphthenate; 25% by weight kerosene).

Typical properties of the base gasoline used in the carburetor throat rating test described below are as follows.

Gravity, °API	55.6
Specific gravity, 60°/60°F.	0.7563
Doctor, Fed. 520.3.2	Negative (sweet)
Sulfur, ASTM D1266, weight percent	0.034
Copper strip test, 122°F., 3 hrs.	1.0
Copper dish gum, mg./100 ml.	11.0
Oxidation stability, min.	1,440
Bromine No.	28
Knock rating:	
Motor method	90.6
Research method	99.6
TEL, ml./gal.	3.00
Vapor pressure, Reid, lb.	6
Distillation, gasoline:	
Over point, °F.	105
End point, °F.	387
10% evap. at °F.	150
50% evap. at °F.	234
90% evap. at °F.	324
Recovery	98.0
Residue	1.1

The base gasoline contained 25 lbs. (0.01% by weight) of 2,6-ditertiary-butyl-4-methylphenol as an antioxidant and 1.0 lb. (0.0004% by weight) of N,N'-disalicylidene-1,2-diaminopropane as a metal deactivator per 1,000 barrels of gasoline.

According to the test procedure followed, the fuel compositions to be tested are burned in a 371 cubic inch, eight cylinder, Oldsmobile engine equipped with an AC Positive Crankcase Ventilating system and a 2 barrel carburetor. In this test, the engine is operated for 100 cycles, each cycle consisting of 36 minutes operation at idle (650 ± 50 rpm) with no load and 12 minutes operation at 1,800 ± 50 rpm with a load of 15 brake horsepower.

Prior to each test, the crankcase of the engine is flushed with new lubricating oil for a period of 10 minutes, a new oil filter is installed and a clean carburetor and a clean positive crankcase ventilation metering valve are installed. The test starts under the idling portion of the cycle. The jacket temperature is maintained at 175 ± 5°F. during the test period. The air to fuel ratio is set, during idle condition, at 10.5 (± 0.3) to 1 at the beginning of each test. The duration of the test is 80 hours. The crankcase of the engine contains a 20/20W, nondetergent oil. At the conclusion of each 80 hour test, the carburetor is removed and examined. The carburetor throat is visually rated, using 0 to denote a clean rating and 22 to signify a maximum deposit rating. The makeup of the fuels tested and the results of the engine tests are shown in Table 1. The data in Table 1 clearly demonstrate the marked superiority of a gasoline motor fuel composition of the process Composition B over the base gasoline Composition A.

In order to further illustrate the detergency characteristics of a composition, a base gasoline was compared with the same gasoline containing 0.0023% by weight (6 lbs./1,000 bbl.) of each of polyoxypropylene monooleate and N-tallow trimethylenediamine naphthenate. The comparison was made in accordance with the Laboratory Induction System Deposit (ISD) Detergency Test. This test comprises forming a gum deposit in the test apparatus by evaporating the test fuel in the apparatus by flowing a stream of heated air countercurrent to the flow of the fuel. At the completion of the test, the weight of the adhering gum is determined and compared to the reference gasoline (without additives) for an appraisal of the additives' detergency action.

In conducting the test, a gum deposit is formed on the walls of a steam-jacketed glass U-tube by evaporating 2 liters of fuel admitted to the system countercurrent to a stream of preheated air. The U-tube is then washed with a number of portions of naphtha until a *final wash shows no discoloration. The amount of gum adhering to the apparatus is then* determined by extracting it with chemically pure acetone, evaporating the acetone extract with filtered, heated air to obtain a gum residue which is then heated in an oven (½ hour at 100° to 105°C.), cooled and weighed. Results of the determinations using the same gasoline with and without additives are compared in order to evaluate detergency action. Table 2 summarizes the results obtained in the Laboratory ISD Detergency Test.

TABLE 2

Composition	Laboratory ISD test, weight of adhering deposits, mg.	Deposit reduction, percent
Base gasoline	149	0
Base gasoline plus (1) and (2)	74	50

NOTE:
(1) 6 pounds of polyoxypropylene monooleate per 1,000 barrels of gasoline.
(2) 6 pounds of N-tallow trimethylene diamine naphthenate per 1,000 barrels of gasoline.

It is evident from the data in Table 2 that a composition of the process has improved detergency characteristics over the base gasoline in that the amount of deposits with the gasoline composition of the process was reduced by 75 mg. This corresponds to a 50% reduction in deposits. Gasoline compositions of the process can be used as fuels for internal combustion engines over an extended period of time without accumulating undesirable deposits in either the carburetor or crankcase ventilating system. Even deposits which have formed from using unimproved gasoline may be effectively removed by using the gasoline motor fuel composition. The composition of the process also has valuable car*buretor anti-icing properties.*

Alkyl Aryl Phosphate Esters and N-Oleyl-1,3-Propylenediamine Salts

W.G. Annable; U.S. Patent 3,707,361; December 26, 1972; assigned to Union Oil Co. of California describes a gasoline composition containing a tetraalkyl lead compound, an alkyl aryl phosphate ester and about 0.0004 to 0.02% of the N-oleyl-1,3-propylenediamine salt of tall oil fatty acids. The process is based on the discovery that alkyl phosphates, aryl phosphates or mixed alkyl aryl phosphates, a necessary ingredient in leaded gasolines to modify the deposits on spark plugs and combustion chamber walls so that they do not accumulate during or interfere with the operation of the engine, have the undesirable property of inducing wear of the rings and cylinders, along with the lead alkyl, and that this detrimental property can be offset or mitigated by the use of the N-oleyl-1,3-propylenediamine salt of tall oil fatty acids, essentially free of rosin acids, in combination with the phosphates. In order to demonstrate the process series of laboratory engine anti-icing, detergency and abrasive wear tests were conducted using a number of different additive combinations. The laboratory engine abrasive wear tests were conducted on a single cylinder COT engine employing a radioactive piston ring.

The wear rate is determined by measuring the relative radioactivity of the iron particles worn from the ring which are carried away in the oil lubricating the engine. This oil is continuously withdrawn into a counting chamber and the radioactivity is determined in counts per minute by means of a rate meter and a scintillation counter. Wear rate is proportional to the change in counts per minute per hour, and wear reduction is determined by comparing the wear rate when using the base fuel with the wear rate when using the fuel with additives present.

TABLE 1: ANTI-ICING, DETERGENCY AND ANTIWEAR TESTS

Composition No.	1	2	3	4	5	6	7	8	9	10
Ingredients:										
Base gasoline	100%	1 gal	1,000 bbl	1,000 bbl	1,000 bbl	1,000 bbl	1,000 bbl	1,000 bbl	1,000 bbl	1,000 bbl.
TEL (ml. per gal.)		3 ml	3 ml	3 ml	3 ml	3 ml	3 ml	3 ml	3 ml	3 ml.
N-oleyl-1,3-propylene diamine salt of iso-octanoic acid.			20 lb	20 lb	20 lb					
N-oleyl-1,3-propylene diamine salt of iso-decanoic acid.						20 lb				
N-oleyl-1,3-propylene diamine salt of tall oil fatty acids.							20 lb	10 lb	20 lb	20 lb.
Mixed phenylphosphates						20 lb				
Trimethyl phosphate				40 lb			40 lbs. 0.3 TH.	40 lb	40 lb	40 lb.
Oleic acid									40 lb	
Methanol				20 lb	20 lb			20 lb		
Isopropanol										45 lb.
Test results:										
Anti-icing										
Detergency										
Anti-wear (percent wear reduction).			0 to negative.	25	21	Negative [1]	0 [1]	23	18	

Composition No.	11	12	13	14	15	16	17	18
Ingredients:								
Base gasoline	1,000 bbl	1,000 bbl	1,000 bbl	1,000 bbl	1,000 bbl	1,000 bbl	1,000 bbl	1,000 bbl.
TEL (ml. per gal.)	3 ml	3 ml	3 ml	3 ml	3 ml	3 ml	3 ml	3 ml.
N-oleyl-1,3-propylene diamine salt of iso-octanoic acid.								
N-oleyl-1,3-propylene diamine salt of iso-decanoic acid.								
N-oleyl-1,3-propylene diamine salt of tall oil fatty acids.	20 lb	25 lb	10	6	15	20	15	20.
Mixed phenylphosphates							.3 TH	.3 TH.
Trimethyl phosphate								
Oleic acid								
Methanol								
Isopropanol								
Test results:								
Anti-icing			.5-.75		.75-1.0	1.0		
Detergency			10	8.5-10	(10)	(10)		
Anti-wear	56-33 [1]	18			R 25.8 C 23.1	R 45.0 C 40.1	R 19 C 11	R 46.2 C 14.6

[1] Duplicate results.

In each of the compositions reported in Table 1, the gasoline was a composition containing 80% by volume of FCC stock and 20% by volume of alkylate showing the following analysis.

TABLE 2

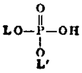
	Percent of Volume
Paraffins and naphthenes	61
Olefins	16
Aromatics	23

This fuel qualified as a premium fuel exhibiting RON of 99.5 and MON of 90.8. The anti-icing properties are given in terms of equivalent percent alcohol (90% isopropanol to 10% methanol). The detergency properties are presented on a deposit rating scale of 1 to 10, wherein 10 represents clean. Antiwear properties are presented as percent reduction in wear rate; the ring wear is presented under (R) and cylinder wear under (C) for runs 15 through 18. Antiwear properties as reported for runs 1 through 14 are based on ring wear only. As seen from these results the N-oleyl-1,3-propylenediamine salt of tall oil acids when used in low concentrations ranging from 1 lb:/1,000 bbl. (0.0004% by weight) to 50 lbs./1,000 bbl. (0.02% by weight) in combination with a lead alkyl produces a surprising and substantial reduction in the wear rate of the engine which is not shared by other similar salts.

In addition, the combination of N-oleyl-1,3-propylenediamine salt of tall oil acids at these low concentrations in combination with the mixed phenylphosphates at concentrations of about 0.005 to 0.06 weight percent or 0.1 to 0.5 theories gives good wear reduction, even though the mixed phenyl phosphates alone or in combination with other salts are ineffective to prevent wear of the moving parts of the engine. The results also show that the anti-icing, detergency and anticorrosion properties of the N-oleyl-1,3-propylenediamine salt of tall oil acids are not affected by the use with mixed phenylphosphates.

Amine-Phosphoric Acid Salt and Olefin Hydrocarbon

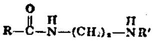
W.L. Perilstein; U.S. Patent 3,703,360; November 21, 1972; assigned to Ethyl Corporation has found that a combination of an amine/phosphoric acid salt and an olefin hydrocarbon when added to gasoline effectively reduces deposit formation and/or buildup in the intake system and the carburetor of an internal combustion engine. Preferred phosphoric acid salts are those prepared from an alkyl phosphoric acid having the formula:



$$\mathrm{LO{-}\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle L'}{\displaystyle O}}{\underset{|}{P}}}{-}OH}$$

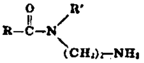
where L and L' are independently selected from hydrogen and alkyl groups having from 1 to 20 carbon atoms such that at least one of L and L' is an alkyl group, and the organic amines are selected from the compounds having the formulas:

(1)

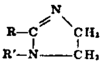


$$\mathrm{R{-}\overset{\overset{\displaystyle O}{\|}}{C}{-}\overset{H}{N}{-}(CH_2)_x{-}\overset{H}{N}R'}$$

(2)



(3)



(4) Mixtures of (1) and (2)

(5) Mixtures of (1), (2) and (3)

where R is an acyclic hydrocarbon radical having 11 to 19 carbon atoms, R' is selected from the group consisting of hydrogen, C_2 to C_4 alkyl, 2-hydroxyethyl, and 2-aminoethyl and x is an integer selected from 2 and 3. Preferred olefin hydrocarbons are those obtained by polymerizing a mixture of monoolefins in the C_{12} and higher carbon number range using a Friedel-Crafts catalyst. The following examples illustrate the process.

Example 1: A 100 gal. glass lined kettle is charged with about 500 lbs. of a C_{12+} monoolefin mixture. The olefin mixture is cooled to about 20°C. with agitation. About 25 lbs. of aluminum chloride are then added to the agitated olefin mixture. The temperature of the mixture rises to about 95°C. after the $AlCl_3$ addition. The mixture is cooled to about 50°C. A solution containing about 6.3 lbs. 37% HCl and about 60.75 lbs. of water is then added to the mixture and it is then heated to about 80°C. with agitation. When this temperature is reached, the agitation is discontinued and the mixture is allowed to stand for about 15 minutes.

Two layers form and the lower aqueous layer is separated and discarded. The remaining material constitutes the polymerized olefin hydrocarbon reaction product. This product is washed twice with about 20 gal. of water allowing about 15 minute settling period for adequate phase separation after each wash. The water layer, after each wash, is separated and discarded. Finally, the washed reaction product is subjected to distillation under reduced pressure (about 40 mm. Hg).

The distillate is a mixture of water and light hydrocarbons. This distillate is separated and the light hydrocarbon portion (which is part of the reaction product) is dried and is returned to the distilled product. The final product containing the light hydrocarbon is then cooled to room temperature and filtered. The yield of polymerized hydrocarbon olefin product is about 99.4% based on the C_{12+} olefin charged. The product is an amber colored clear fluid having an average molecular weight of less than about 500.

Using substantially the procedure as above, a series of polymerized olefin hydrocarbons was prepared. Properties of the polymerized olefin products thus obtained ranged as follows: physical appearance, amber fluid; average molecular weight (by osmometry) is 418 to 464; flash point (Cleveland open cup) is 211° to 264°F.; viscosity at 20°C. is 38 to 49 centistokes; and density at 20°C. is 0.818 to 0.820 g./ml.

The salts of phosphoric acids and organic amines are prepared by simply mixing the two components in proper proportions. Ordinarily, the base number of the amine and the acid number of the acid are obtained to determine what proportions should be used. By adjusting the ratio of amine to acid, salts can be prepared where acid is in excess, amine is in excess, or where the salt is substantially neutral. The substantially neutral salt is ordinarily preferred. By substantially neutral is meant that about one equivalent of acid is provided for each equivalent of amine. Commercial additives having such a composition are available. Following is an example illustrating the preparation of a suitable salt.

Example 2: A mixture of organic amines having formulas of the type (1) and (2) is prepared from N-(2-hydroxyethyl)-1,2-ethylenediamine and tall oil acids (mixture of unsaturated C_{18} acids). A salt is then prepared by adding to this mixture of amines about 0.9 equivalent of a mixture of mono- and ditridecylorthophosphoric acids. An inert hydrocarbon diluent is generally added to facilitate handling. The salt thus obtained is useful as an additive in gasoline.

Any internal combustion engine gasoline base fuels may be used in preparing gasoline compositions of the process. Gasoline is generally a blend of hydrocarbons boiling from about 25° to 225°C. which occurs naturally in petroleum and suitable hydrocarbons made from petroleum by processes such as thermal or catalytic cracking, reforming and the like. Hydrocarbon compositions of typical base gasolines are tabulated below, percentages are by volume.

Base Gasolines

	A	B	C	D	E	F	G	H	J	K
Percent:										
Aromatics	29.0	30.0	16.0	24.0	....	....	5	45	80	38
Olefins	3.0	4.0	12.0	12.5	....	10	....	30	20	7
Saturates	68.0	66.0	72.0	63.5	100	90	95	25	....	55