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ADDITIVE COMPOSITION FOR GASOLINE  
FUEL AND PROCESS THEREOF****Publication Classification**(51) **Int. Cl.**  
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The present application relates to deposit control additive composition comprising of Mannich base and Polyisobutylene amine (PIBA) having average molecular weight of 800 as a synergistic component of deposit control additive formulation. The application also relates to deposit control additive composition comprising further components such as fluidizer oil, dehazer, corrosion inhibitor and solvent to obtain deposit control additive formulation and mixed with gasoline fuel to obtain fuel composition. The application further relates to a process for the preparation of fuel composition by blending at an ambient temperature gasoline fuel and deposit control additive composition obtained by blending in a suitable container Mannich base, Polyisobutylene amine (PIBA), fluidizer oil, dehazer, corrosion inhibitor and solvent at a temperature ranging between 50° C. to 60° C. for a time period of up to 2 hours.

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Jun. 13, 2005 (IN)..... 1522/DEL/2005

# SYNERGISTIC DEPOSIT CONTROL ADDITIVE COMPOSITION FOR GASOLINE FUEL AND PROCESS THEREOF

## CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims priority to Indian Patent Application No. 1522/DEL/2005 filed on June 13, 2005, the disclosure of which is incorporated herein by reference in its entirety.

## FIELD OF INVENTION

[0002] The present application relates to a deposit control additive composition comprising Polyisobutylene amine (PIBA) having an average molecular weight of from about 700 to 1000 and a Mannich Base as synergistic components of the deposit control additive formulation. The application further relates to a deposit control additive formulation comprising a deposit control additive composition, fluidizer oil, a dehazer, a corrosion inhibitor and a solvent, blended with a gasoline fuel to obtain the fuel composition and the process of preparation thereof.

## BACKGROUND

[0003] Deposits in the fuel delivery system and the combustion chambers of an internal combustion engine can adversely affect the combustion performance in terms of power output and emissions. As a result, development of effective fuel additives to prevent and/or reduce deposits is highly desirable.

[0004] Canadian Patent No. 2,089,833; U.S. Pat. Nos. 5,697,988; 5,873,917 and 5,876,468 involve Mannich detergents generally prepared by reaction of alkyl-phenols with aldehyde, amines, and polyether fluidizers for reduction of deposits in the combustion chambers and/or fuel delivery system of an engine.

[0005] U.S. Pat. No. 6,179,885 discloses a composition, comprising: (I) an aromatic Mannich compound derived from: (A) a hydroxy containing aromatic compound; (B) an aldehyde or ketone and (C) a mixture of water and an amine containing at least one primary or secondary amino group; and (II) an alcohol.

[0006] Mannich condensation reactions usually produce high molecular weight products by linear growth due to the use of mono-substituted phenols and amine groups. Excess aldehyde may also react with the amine groups to form imines or hydroxymethylamines. Accordingly, the properties of such polymeric compositions have principally been utilized in heavier fuels such as heating and furnace oils (as disclosed in U.S. Pat. No. 2,962,442) and lubricating oils (as disclosed in U.S. Pat. Nos. 3,036,003 and 3,539,633). None of these compositions have been used in a sensitive carburetion system such as a gasoline-powered spark-ignition internal combustion system.

[0007] Mannich condensation products often have been employed as stabilizers, antioxidants, dispersants, or detergents in heavy hydrocarbon stocks. Uses in lighter hydrocarbon stocks, such as gasoline, have been disclosed in U.S. Pat. Nos. 3,269,810 and 3,649,229.

[0008] U.S. Pat. No. 3,235,484 (Now U.S. Pat. No. Re. 26,330) discloses the addition of certain compositions to

refinery hydrocarbon fuel stocks for the purpose of inhibiting accumulation of carbonaceous deposits in refinery cracking units. The primary inhibitors disclosed are mixtures of amides, imides and amine salts formed by reacting an ethylene polyamine with hydrocarbon substituted succinic acids or anhydride where the hydrocarbon substituent has at least about 50 carbon atoms. As an adjunct for such primary carbonaceous deposit inhibitors, the patent also discloses that Mannich condensation products can be formed by reacting (1) alkyl-phenol, (2) an amine and (3) formaldehyde in the ratio of one mole alkyl-phenol and from 0.1-10 mole each of formaldehyde and amine reactant.

[0009] U.S. Pat. No. 3,368,972 discloses a process for preparing high molecular weight Mannich condensation products as dispersant-detergent additives for lubricating oil from (1) high molecular weight alkyl-substituted hydroxyl-aromatic compounds whose alkyl-substituent has a molecular weight in the range of 600-3000, (2) a compound containing at least one NH group and (3) an aldehyde in the respective molar ratio of 1.0:0.1-10:1.0-10.

[0010] The high molecular weight Mannich condensation products referred to in U.S. Pat. No. 3,235,484 and 3,368,972 have a drawback in large-scale preparation and in extended service use as lubricant addition agents under high temperature conditions encountered in gasoline engines.

[0011] In the large-scale or plant preparation of such high molecular weight condensation products in light mineral oil solvents, the resulting concentrated oil solution of the condensation products either has or develops haziness during storage. The haziness is believed to be caused by undissolved or borderline (sparingly) soluble by-products that are not substantially incapable of being removed by filtration.

[0012] When used in a gasoline engines, crankcase lubricant oils are subject to high temperature during service, piston ring groove carbonaceous deposits and skirt varnish tend to build up rapidly to prevent desirable long in-service use of such lubricant oils. U.S. Pat. No. 4,038,044 discloses a combination of diamine and higher polyamine Mannich condensation products as carburetor detergents to control intake valve deposits and quick-heat intake manifold deposits.

[0013] A process for preparation of novel Mannich Bases from hydrogenated and distilled Cashew Nut Shell Liquid (CNSL) for use as an additive in liquid hydrocarbon fuels for removing and protecting build up of deposits on carburetor surfaces and intake valve systems in a gasoline powered engine is reported by the Applicant in U.S. Pat. No. 6,797,021.

[0014] The disclosures of all referenced patents and patent applications referred to herein are also incorporated herein in their entirety by reference.

## DETAILED DESCRIPTION

[0015] Mannich bases have been used in isolation or in combination with diamine to reduce deposits on carburetor surfaces. As disclosed in the present application, a surprising result has been achieved by using a Mannich base and Polyisobutylene amine as synergistic components of a deposit control additive formulation to drastically reduce

deposits on carburetor surfaces and keep port fuel injectors and intake valves clean in gasoline fueled spark ignition internal combustion engines.

[0016] Specifically, the present application relates to a deposit control additive composition comprising Polyisobutylene amine (PIBA) having average molecular weight of about 800 and a Mannich base as synergistic components of the formulation. This application also relates to a fuel composition comprising a deposit control additive formulation and gasoline fuel. The application further relates to a process for the preparation of a fuel composition by blending at an ambient temperature a gasoline fuel and a deposit control additive formulation obtained by blending the Mannich base, Polyisobutylene amine (PIBA), fluidizer oil, a dehazer, a corrosion inhibitor and a solvent at a temperature ranging between 50° C. to 60° C. for a time period of up to 2 hours.

[0017] This deposit control additive formulation is highly miscible with gasoline fuel at room temperature and can be mixed with fuel in storage tanks, road tanks, railway tanks, and etc.

[0018] In various combinations, a deposit control additive composition ("the composition") is provided for a gasoline fuel to control and reduce deposits on carburetor surfaces and keep port fuel injectors and intake valves clean in gasoline fueled spark ignition internal combustion engines.

[0019] In various embodiments, the composition comprises a Mannich base and Polyisobutylene amine (PIBA) having average molecular weight of about 800 as a synergistic component of the deposit control additive formulation.

[0020] In various embodiments, a deposit control additive formulation is provided comprising a deposit control additive composition, fluidizer oil, a dehazer, a corrosion inhibitor and a solvent.

[0021] In various embodiments, a fuel composition is provided comprising a gasoline fuel and a deposit control additive formulation.

[0022] In various embodiments, an easy and economical process for the preparation of fuel composition by blending deposit control additive formulation and gasoline fuel is provided.

[0023] The present application provides a deposit control additive formulation including:

[0024] a) a Mannich base; and

[0025] b) Polyisobutylene amine (PIBA) having average molecular weight ranging from about 700 to 1000.

[0026] The deposit control additive composition further comprises fluidizer oil, a dehazer, a corrosion inhibitor and a solvent to provide the deposit control additive formulation.

[0027] One embodiment provides a fuel composition includes:

[0028] a) a gasoline fuel ranging from about 99.99 to 99.90 % weight, and

[0029] b) a deposit control additive formulation ranging from about 0.01 to 0.1 % weight.

[0030] Another embodiment provides a fuel composition having gasoline fuels, such as octane 88, octane 91, octane 95, and octane 96 and like fuels.

[0031] A gasoline fuel used in the fuel composition may further include alcohol for up to 10% by weight of the fuel.

[0032] Yet another embodiment includes a deposit control additive composition containing PIBA and a Mannich base in the ratio of about 1:0.2 by weight.

[0033] The Mannich base can be derived from the reaction of a hydrogenated and distilled Cashew Nut Shell Liquid (CNSL) or para substituted alkyl-phenol with an aldehyde and an amine having at least one reactive hydrogen atom.

[0034] One suitable para substituted alkyl-phenol can be para-nonyl phenol; one suitable aldehyde can be para-formaldehyde; and one suitable amine can be dibutylamine.

[0035] Still another embodiment provides a fuel composition having a concentration of a deposit control additive formulation ranging from 100 to 1000 mg/liter. The fuel composition has excellent performance in an intake deposit testing, a PFI testing, a corrosion testing as per ASTM D 665A carried out at room temperature, an ASTM D 1094 Testing of water reaction. Also, the fuel composition meets the IS 2796:2000 specification of Indian gasoline fuel.

[0036] Further embodiment provides a process for the preparation of a fuel composition including the following steps:

[0037] a) obtaining a deposit control additive formulation by blending a Mannich base, Polyisobutylene amine, fluidizer oil, a dehazer and a corrosion inhibitor and a solvent in a suitable container at a temperature ranging between 50° C. to 60° C. for a time period of up to 2 hours, and

[0038] b) blending at an ambient temperature the deposit control additive formulation prepared in step (a) with a gasoline fuel to obtain the fuel composition.

[0039] The present application provides the addition of Mannich bases, which can be derived from reacting hydrogenated and distilled Cashew Nut Shell Liquid (CNSL) or para-alkyl-phenols with aldehyde and an amine, to gasoline fuels with other compositions including a detergent Polyisobutylene amine (PIBA), fluidizer Oil, a dehazer a corrosion inhibitor and a solvent.

[0040] The present application establishes that when a Mannich base (dispersant), combining with a detergent such as Polyisobutylene amine (PIBA), fluidizer Oil, a dehazer, a corrosion inhibitor and a solvent, is incorporated into a gasoline fuel, deposit control characteristics relating to port fuel injectors and intake valve cleanliness can be improved drastically.

[0041] If Polyisobutylene amine (PIBA) is used alone, the intake valve deposits ("IVD") are found to be about 40 mg per valve when a gasoline fuel having 250 mg/liter of PIBA is used in a Mercedes Benz M111 engine test carried out as per CECF20A98. At the same dosages level or at higher levels of Mannich Base alone, the IVD deposits are found to be more than 100 mg and cannot be reduced to the desired level of less than 50 mg. However, a combination of a Mannich base and Polyisobutylene amine (PIBA) doped in the reference gasoline at 250 mg/liter, IVD can be drastically reduced to about 7 mg per valve. The result clearly shows the synergistic effect of the deposit control additive composition used in the gasoline fuel.

[0042] A successful attempt has been made to develop a deposit control additive composition having a Mannich base and PIBA for a gasoline fuel. The Mannich base can be derived from hydrogenated and distilled Cashew Nut Shell Liquid (CNSL) or from commercially available para-substituted phenols.

[0043] The alkyl-phenol used in the preparation of the Mannich base can be para-nonyl phenol, para-dodecyl phenol, or hydrogenated and distilled Cashew Nut Shell Liquid (popularly known as CNSL). CNSL, on distillation, gives the pale and yellow phenolic derivatives, which can be mixtures of biodegradable unsaturated m-alkyl-phenols, including cardanol. Catalytic hydrogenation of these phenols gives a white waxy material predominantly rich in tetrahydroanacardol, which is also known as hydrogenated CNSL. Mannich condensation products can be prepared by the reaction of para-nonyl phenol, para-dodecyl phenol, or the hydrogenated CNSL (hydrogenation of cashew nut shell liquid can be carried out in an autoclave using conventional method of catalytic hydrogenation), an amine having at least one reactive hydrogen atom, and an aldehyde in the molar ratio of 1:0.1 to 10:0.1 to 10 at a temperature ranging from 70° C. -175° C. for 6 to 12 hours in the presence of a protic organic solvent. The process for the preparation of a Mannich base from hydrogenated and distilled Cashew Nut Shell Liquid (CNSL) is reported by the Applicant in U.S. Pat. No 6,797,021, the disclosure of which is incorporated herein by reference in its entirety.

[0044] Polyisobutylene amine (PIBA) can have an average molecular weight of about 700 to 1000. In one embodiment, the PIBA has an average molecular weight of 800.

Characteristics	Limits
Density at 20° C.	0.842 min.
Flash point (PMCC)	>60° C.
Boiling Point	>190° C.
Solvents % weight	35 max.
Solubility in Water	Insoluble

[0045] The fluidizer oil can be an aromatic solvent, such as toluene, xylenes and aromatic streams of refineries.

[0046] The dehazer can be a de-emulsifier without ash having a mixture of polymers and copolymers designed to reduce the interaction of gasoline with water and to improve the water tolerance characteristics of treated gasoline. The typical properties are as follows:

Characteristics	Limits
Density at 20° C.	0.96 min.
Flash point (PMCC)	>62° C.
Boiling Point	>160° C.
Solubility in Water	Dispersible

[0047] The corrosion inhibitors ("CI") can include esters of succinic acid, imidazolines and alkyl benzotriazoles. In one embodiment, corrosion inhibitors can be those derived from esterification of succinic acid. These partial esters of succinic acid can have the following characteristics:

Characteristics	Limits
Density at 20° C.	0.970-1.00
Total Acid Number (TAN)	160-185
Kinematic Viscosity at 100° C.	26-40

[0048] The amount of the Mannich base combined with PIBA should be enough to provide the desired reduction in deposits by establishing a synergistic effect with PIBA. This concentration can be conveniently expressed in terms of percent by weight of the Mannich base based on the total weight of the additive formulation. In one embodiment, the concentration of the Mannich base can be from about 10 to about 50 percent by weight. In another embodiment, the range can be from about 10 to about 20 percent by weight.

[0049] The concentration of Polyisobutylene amine (PIBA) in the deposit control additive formulations should also be enough to control the deposits on intake valves. This concentration can be conveniently expressed in terms of percent by weight of PIBA based on the total weight of the deposit control additive formulation. In one embodiment, the concentration can be from about 40 to about 90 percent by weight. In another embodiment, the range can be from about 60 to about 80 percent by weight.

[0050] A deposit control additive formulations for a gasoline fuel in the present application can be prepared by blending the deposit control additive composition with additional components such as fluidizer oil, a dehazer, a corrosion inhibitor and a solvent in a suitable container.

[0051] A dehazer can be added for fast separation of water from the fuel during transportation and storage. The dehazer helps to prevent premature blocking of fuel filters, corrosion, carburetor icing and possible fuel line freezing when excessive water is carried into the fuel delivery system.

[0052] The dehazer can be highly surface-active chemicals having limited solubility in water and/or fuel and tend to concentrate at the fuel-water interface. Therefore, the dehazer can be added at a very low concentration. In one embodiment, the concentration can be from about 1 to about 5 percent by weight. In another embodiment, the concentration can be from about 1 to about 3 percent by weight.

[0053] Corrosion can lead to severe problems in storage tanks, pipelines and automobile fuel tanks. To prevent corrosion, inhibitors can be added in relatively low concentrations. In one embodiment, the concentration can be from about 1 to about 5 percent by weight. In another embodiment, the concentration can be from about 1 to about 3 percent by weight.

[0054] Conventional blending equipment and techniques can be used in preparing the deposit control additive formulation. In general, a homogeneous blend of the foregoing active components can be achieved by merely blending the Mannich base with PIBA, fluidizer oil, a dehazer, a corrosion inhibitor and a solvent in a determined proportion at 40-50° C. for 2 hours.

[0055] The deposit control additive formulation can be mixed with the gasoline fuel in storage tanks, road tanks, or railway tanks in a concentration sufficient to reduce the deposit forming tendencies of the fuel. This can be normally carried out at an ambient temperature.

[0056] The following examples are illustrative and should not be construed to limit the scope of the claims. The

disclosure has been described in terms of the specific embodiments and certain modifications and equivalents will be apparent to those skilled in the art and are intended to be included within the scope of present application.

### EXAMPLES

#### Example 1:

##### Preparation of Deposit Control Additive Formulations:

[0057] The following commercially available materials have been used in the following formulations: PIBA-commercial name: PURAD 6847/2 [BASF, Germany]; corrosion inhibitors-commercial name: Lz 849 [Lubrizol USA]; dehazer-commercial name: PX-3109 [Dorf Ketel, India]; fluidizer oil-commercially available polyether based solvent.

[0058] Various different deposit control additive formulations for gasoline fuel can be prepared by blending different combinations of components such as detergent (PIBA), dispersant (Mannich BASE), fluidizer oil, dehazer, corrosion inhibitor and solvent in a suitable container at 50-60° C. with continuous stirring for 2 hours. Details are enumerated as follows:

[0059] Formulation-1: a combination of PIBA, fluidizer oil, a dehazer and a corrosion inhibitor in the ratio 70:28:1:1 was prepared without the addition of a Mannich base.

[0060] Formulation-2: a combination of a Mannich base, fluidizer oil, a dehazer and a corrosion inhibitor in the ratio 70:28:1:1 was prepared without the addition of PIBA.

[0061] Formulation-3: a combination of PIBA, CSNL based Mannich Base, fluidizer oil, a dehazer and a corrosion inhibitor in the ratio 70:15:13:1:1 was prepared. The Mannich base was added to establish the synergistic effect of the Mannich base with PIBA in the intake valve deposit engine test.

[0062] Formulation-4: a combination of PIBA, Nonyl phenol based Mannich Base, fluidizer oil, a dehazer and a corrosion inhibitor in the ratio 70:15:13:1:1 was prepared. The Mannich base was added to establish the synergistic effect of Mannich base with PIBA in the intake valve deposit engine test.

[0063] Formulation-5: A combination of PIBA, dodecyl phenol based Mannich Base, fluidizer oil, a dehazer and a corrosion inhibitor in the ratio 70:15:13:1:1 was prepared. The Mannich base was added to establish the synergistic effect of the Mannich base with PIBA in the intake valve deposit engine test.

#### Example 2

##### Evaluation Methodology

[0064] The complete evaluation of deposit control additive formulations was carried out in the gasoline fuel by assessing the performance with the following parameters:

[0065] a) Testing gasoline fuel treated with the deposit control additive formulation as per National Standard IS 2796:2000: The regular gasoline fuel meeting Indian standard IS 2796:2000 was used for the evaluation of deposit control additive formulations. A desired concentration of deposit control additive formulations was added to the fuel. After the addition of the deposit control additive formulations, the product was again tested as per IS 2796: 2000 specifications to confirm that addition of

the deposit control additive formulations in the desired concentration in gasoline fuel does not adversely affect the properties of the fuel.

[0066] b) The compositions meeting IS 2796: 2000 specifications were additionally tested for following characteristics:

[0067] i) WATER REACTION OF FUELS: This test is designed to measure water tolerance characteristics of gasoline fuel. The test is a quick way to measure the ability of a fuel to separate rapidly from water after mixing under low shear conditions. Briefly, the procedure involves hand shaking of 80 ml of gasoline fuel containing the deposit control additive formulations with 20 ml of phosphate buffer solution for 2 minutes. After a 5 minute settling period, the fuel-water interface and water layer are rated for emulsion, the fuel phase and clarity.

[0068] ii) DYNAMIC CORROSION TEST: This test is carried out to evaluate the ability of a gasoline fuel containing the deposit control additive formulations to prevent rusting of ferrous parts when fuel comes in contact with water. Corrosion can lead to severe problems in storage tanks, pipelines tankers and automobile fuel tanks. The particles of rust can also clog fuel lines, filters carburetor orifices or jets. This evaluation procedure is based upon the ASTM D-665-95 standard test method for mineral oils (with modification so that the test is run at ambient temperature for fuels). 300 ml of the gasoline fuel containing deposit control additive formulations is stirred at 1000±50 rpm with 30 ml of distilled water for 24 hours using polished steel spindle conforming to grade 1018 of ASTM A-108 specifications. After the test the spindle is assessed for the corrosion.

[0069] c) Intake Valve Deposit Test using Mercedes Benz M111 Engine as per CEC F-20-A-98 : Intake valve deposit test using Mercedes Benz M111 engine as per CEC-F-20-A-98 is the internationally accepted standard test for assessing the performance of a gasoline fuel containing deposit control additive formulations. The product giving lowest intake valve deposits is considered better in performance to control the intake valve deposits under field conditions.

[0070] d) Port Fuel Injector Fouling Bench Test: Port Fuel Injector bench test apparatus from SwRI is the internationally accepted standard test for assessing the additive effectiveness and fouling tendency of gasoline for the port fuel injectors. The deposits that formed on the tip of the pintle-type injectors of certain engines restricted flow and caused drivability and emission problems. This method carried out as per ASTM D 6421 and has excellent correlation with the ASTM D 5598 PFI vehicle test for the predictor of port fuel-injector fouling.

[0071] The following examples illustrate the preparation of some typical fuel compositions of the present application and performance evaluation thereof:

#### Example 3

[0072] The formulations prepared as per Example 1 were added in the gasoline fuel meeting IS 2796:2000 specification at 250 mg/liter treat rate, and the treated samples were tested as per national specifications IS 2796:2000 to establish that the addition of these formulations does not have any deteriorating effect on the properties of the gasoline fuel. The results are reported in Table 1 to 3.

TABLE 1

S. No	Properties	Limits IS:2796:2000	Sample details		
			Gasoline without additive	Gasoline with 250 mg/ liter formulation-1	Gasoline with 250 mg/liter formulation-2
1.	Color, visual	Colorless/ Orange/Red	Orange	Orange	Orange
2.	Copper strip corrosion for 3 hours at 50° C.	Not more than No. 1	No. 1	No. 1	No. 1
3.	Density, at 15° C.	710–770 Kg/m <sup>3</sup>	753.3	753.4	753.6
4.	Distillation	To be reported	40.0	41.0	43.0
	Initial boiling point ° C.	10–45	11.0	10.5	10.0
	Recovery up to 70° C. (E70), percent by vol.	40–70	40.5	40.5	40.0
	Recovery up to 100° C. (E100), percent by vol.	90	98.0	98.0	98.0
	Recovery up to 180° C. (E180), percent by vol., min	215	173.5	174.0	177.0
	Final boiling point ° C. max	2	1.5	1.0	1.5
	Residue, percent by volume, max	88	88.7	88.9	88.5
5.	Octane requirements: Research Octane Number, Min	88	88.7	88.9	88.5
6.	Potential gum, g/m <sup>3</sup> , Max	50	NA	NA	NA
7.	Existent gum, g/m <sup>3</sup> , Max	40	8	10	10
8.	Sulfur, total, percent by mass, Max	0.10/0.05	0.021	0.021	0.023
9.	Lead content (as Pb), g/l, Max	0.013	<0.001	<0.001	<0.001
10.	Reid vapor pressure, (RVP) at 38° C., KPa	35–60	43.2	42.9	42.0
11.	Vapor lock index (VLI) (VLI = 10 RVP + 7 E 70), Max	750	509	502	490
	Summer	950			
	Other months	5/1.0	0.9	0.9	0.9
12.	Benzene content % vol., Max	5/1.0	0.9	0.9	0.9

[0073]

TABLE 2

S. No	Properties	Limits IS:2796:2000	Sample details		
			Gasoline without additive	Gasoline with 250 mg/ liter formulation-3	Gasoline with 250 mg/ liter formulation-4
1.	Color, visual	Colorless/Orange/ Red	Orange	Orange	Orange
2.	Copper strip corrosion for 3 hours at 50° C.	Not more than No. 1	No. 1	No. 1	No. 1
3.	Density, at 15° C. Kg/m <sup>3</sup>	710–770	753.3	753.4	753.6
4.	Distillation	To be reported	40.0	41.0	43.0
	Initial boiling point ° C.	10–45	11.0	11.5	11.0
	Recovery up to 70° C. (E 70), percent by vol.	40–70	40.5	41.5	40.0
	Recovery up to 100° C. (E100), percent by vol.	90	98.0	98.0	98.0
	Recovery up to 180° C. (E180), percent by vol., min	215	173.5	174.0	177.0
	Final boiling point ° C., max	2	1.5	1.0	1.0
	Residue, percent by volume, max	88	88.7	88.9	88.5
5.	Octane requirements: Research Octane Number, Min	88	88.7	88.9	88.5

TABLE 2-continued

S. No	Properties	Limits IS:2796:2000	Sample details		
			Gasoline without additive	Gasoline with 250 mg/ liter formulation-3	Gasoline with 250 mg/ liter formulation-4
6.	Potential gum, g/m <sup>3</sup> , Max	50	NA	NA	NA
7.	Existent gum, g/m <sup>3</sup> , Max	40	8	10	10
8.	Sulfur, total, percent by mass, Max	0.10/0.05	0.021	0.021	0.023
9.	Lead content (as Pb), g/l, Max	0.013	<0.001	<0.001	<0.001
10.	Reid vapor pressure, (RVP) at 38° C., KPa	35–60	43.2	43.0	42.5
11.	Vapor lock index (VLI) (VLI = 10 RVP + 7 E 70), Max				
	Summer	750	509	510.5	502
	Other months	950			
12.	Benzene content % vol., Max	5/1.0	0.9	0.9	0.9

[0074]

TABLE 3

S. No	Properties	Limits IS:2796:2000	Sample details	
			Gasoline without additive	Gasoline with 250 mg/liter formulation-5
1.	Color, visual	Colorless/ Orange/Red	Orange	Orange
2.	Copper strip corrosion for 3 hours at 50° C.	Not more than No. 1	No. 1	No. 1
3.	Density, at 15° C., Kg/m <sup>3</sup>	710–770	753.3	753.4
4.	Distillation	To be reported	40.0	41.0
	Initial boiling point ° C.			
	Recovery up to 70° C. (E 70), percent by vol.	10–45	11.0	11.0
	Recovery up to 100° C. (E100), percent by vol.	40–70	40.5	41.5
	Recovery up to 180° C. (E180), percent by vol., min	90	98.0	98.0
	Final boiling point ° C., max	215	173.5	174.0
	Residue, percent by volume, max	2	1.5	1.0
5.	Octane requirements: Research Octane Number, Min	88	88.7	88.9
6.	Potential gum, g/m <sup>3</sup> , Max	50	NA	NA
7.	Existent gum, g/m <sup>3</sup> , Max	40	8	10
8.	Sulfur, total percent by mass, Max	0.10/0.05	0.021	0.021
9.	Lead content (as Pb), g/l, Max	0.013	<0.001	<0.001
10.	Reid vapor pressure, (RVP) at 38° C., KPa	35–60	43.2	43.5
11.	Vapor lock index (VLI) (VLI = 10 RVP + 7 E 70), Max			
	Summer	750	509	512
	Other months	950		
12.	Benzene content % vol., Max	5/1.0	0.9	0.9

## Example 4:

[0075] Gasoline fuel doped with the deposit control additive formulations as prepared in Example-1 were also tested as per ASTM D1094 to measure the ability of the doped gasoline to separate from water. The results are given in Table-4.

TABLE 4

Sr. No.	Product	Additive Concentration (mg/liter)	Test results
1	Base gasoline	—	Pass
2	Base Gasoline + Formulation-1	250	Pass
3	Base Gasoline + Formulation-2	250	Pass
4	Base Gasoline + Formulation-3	250	Pass
5	Base Gasoline + Formulation-4	250	Pass
6	Base Gasoline + Formulation-5	250	Pass

## Example5:

## Dynamic Corrosion Test:

[0076] Gasoline fuel doped with the deposit control additive formulations as prepared in Example-1 were also tested as per ASTM D 665 (modified) to measure the ability of the doped gasoline to prevent corrosion. The results are given in Table-5.

TABLE 5

Sr. No.	Product	Additive Concentration (mg/liter)	Test results
1	Base Gasoline	—	Pass
2	Base Gasoline + Formulation-1	250	Pass
3	Base Gasoline + Formulation-2	250	Pass
4	Base Gasoline + Formulation-3	250	Pass
5	Base Gasoline + Formulation-4	250	Pass
6	Base Gasoline + Formulation-5	250	Pass

## Example 6:

[0077] The above formulations were evaluated for intake valve deposit (IVD) test using Mercedes Benz M111 engine as per CEC F-20-A-98. The test results are given in Table-6.

TABLE 6

Sr No.	Formulation	Treat Rate, mg/liter	Intake valve deposits per valve
1	Reference Fuel	—	300
2	Reference Fuel + Formulation-1	250	40
3	Reference Fuel + Formulation-2	250	180
4	Reference Fuel + Formulation-3	250	10
5	Reference Fuel + Formulation-4	250	7
6	Reference Fuel + Formulation-4	375	3
7	Reference Fuel + Formulation-5	250	12

## Example-7

[0078] The above formulations were evaluated for port fuel injector fouling test using port fuel injector test apparatus from SwRI as per ASTM D 6421. The test results are given in table-7.

TABLE 7

Sr No.	Formulation	Treat Rate, mg/liter	% Flow loss
1	Reference Fuel + Formulation-1	250	8
2	Reference Fuel + Formulation-2	250	8
3	Reference Fuel + Formulation-3	250	5
4	Reference Fuel + Formulation-4	250	4
5	Reference Fuel + Formulation-4	375	3
6	Reference Fuel + Formulation-5	250	5

We claim:

1. A deposit control additive composition as a synergistic component for gasoline fuel comprising:

a. a Mannich base, and

b. Polyisobutylene amine (PIBA) having an average molecular weight generally ranging from about 700 to about 1000.

2. A deposit control additive formulation comprising the deposit control additive composition of claim 1, fluidizer oil, a dehazer, a corrosion inhibitor and a solvent.

3. The composition of claim 1, wherein the ratio of the PIBA to the Mannich base is about 1:0.2 percent by weight.

4. The composition of claim 1, wherein the Mannich base is derived either from a reaction of a hydrogenated and distilled Cashew Nut Shell Liquid (CNSL) or from a reaction of a para substituted alkyl-phenol with an aldehyde and an amine having at least one reactive hydrogen atom.

5. The composition of claim 4 wherein the para substituted alkyl-phenol is para-nonyl phenol, the aldehyde is paraformaldehyde, and the amine is dibutylamine.

6. A fuel composition, comprising of:

a. gasoline fuel ranging from 99.90 to 99.99 percent by weight, and

b. the deposit control additive formulation of claim 2 ranging from about 0.01 to about 0.1 percent by weight.

7. A composition of claim 6 wherein the gasoline fuel is selected from a group consisting of octane 88, octane 91, octane 95, and octane 96.

8. A composition of claim 6 wherein the gasoline fuel further comprises an alcohol at up to 10 percent by weight of the gasoline fuel.

9. A fuel composition of claim 6 wherein a concentration of the deposit control additive formulation ranges from about 100 to about 1000 milligram per liter.

10. A process for preparing of fuel composition as claimed in claim 6, comprising:

a. obtaining the deposit control additive formulation of claim 2 by mixing a Mannich base, a Polyisobutylene amine, fluidizer oil, a dehazer, a solvent, and a corrosion inhibitor at a temperature ranging between 50° C. and 60° C. for a time period of up to 2 hours, and

b. mixing the obtained deposit control additive formulation of step (a) with a gasoline fuel at an ambient temperature.

11. The deposit control additive composition of claim 1 wherein the Polyisobutylene amine has an average molecular weight of about 800.

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