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(54) **SYNERGISTIC DEPOSIT CONTROL
ADDITIVE COMPOSITION FOR DIESEL
FUEL AND PROCESS THEREOF**

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(76) Inventors: **Suresh K. Puri**, Faridabad (IN);
Anurag A. Gupta, Faridabad (IN);
Haren C. Dekka, Faridabad (IN);
Mahalingam Vanmamalai, Faridabad
(IN); **Ajit K. Jha**, Faridabad (IN);
Ravinder K. Malhotra, Faridabad (IN);
Niranjan R. Raje, Faridabad (IN)

(57) **ABSTRACT**

The present application relates to deposit control additive composition comprising of Mannich base and Polyisobutylene succinimide (PIBSI) having average molecular weight of about 800 as a synergistic component for hydrocarbon fuel, particularly diesel fuel along with other conventional additives such as fluidizer oil, dehazer, corrosion inhibitor, solvents, and optionally lubricity improver, antistatic agent and ignition accelerator to obtain diesel fuel composition. The application also relates to a process for the preparation of fuel composition by blending at an ambient temperature diesel fuel and deposit control additive formulation obtained by blending Mannich base, Polyisobutylene succinimide (PIBSI) fluidizer oil, dehazer, corrosion inhibitor, optionally lubricity improver, antistatic agent, ignition accelerator at a temperature ranging between 50° C. to 60° C. for a time period of up to 2 hours.

Correspondence Address:
PERKINS COIE LLP
PATENT-SEA
P.O. BOX 1247
SEATTLE, WA 98111-1247 (US)

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**SYNERGISTIC DEPOSIT CONTROL ADDITIVE
COMPOSITION FOR DIESEL FUEL AND
PROCESS THEREOF**

CROSS REFERENCE TO RELATED
APPLICATION(S)

[0001] This application claims priority to Indian Patent Application No. 1521/DEL/2005, filed on Jun. 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 a Mannich base and Polyisobutylene succinimide as synergistic components of the deposit control additive composition. The present application also relates to a process for the preparation of a fuel composition including blending a diesel fuel and the deposit control additive composition at an ambient temperature.

BACKGROUND

[0003] Mannich condensation products have often been employed as stabilizers, antioxidants, dispersants, or detergents in heavy hydrocarbon stocks.

[0004] 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 amine groups to form imines or hydroxymethylamines.

[0005] Accordingly, such polymeric compositions have principally been utilized in heavier fuels such as heating and furnace oils (as described in U.S. Pat. No. 2,962,442) and in 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.

[0006] Use of Mannich base in lighter hydrocarbon stocks, such as gasoline, has been disclosed in U.S. Pat. Nos. 3,269,810 and 3,649,229. In addition, 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 inhibiting the accumulation of carbonaceous deposits in refinery cracking units. The primary inhibitors disclosed include mixtures of amides, imides and amine salts formed by reacting an ethylene polyamine with hydrocarbon substituted succinic acids or anhydride, whose hydrocarbon substituent has at least 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.

[0007] 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.

[0008] The high molecular weight Mannich condensation products referred to in U.S. Pat. Nos. 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 diesel engines. 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 un-dissolved or borderline (sparingly) soluble by-products that are not substantially incapable of being removed by filtration. When used in diesel engine crankcase, lubricant oils are subject to high temperature during service. Piston ring groove carbonaceous deposits and skirt varnish tend to build up sufficiently rapidly to prevent desirable long in-service use of such lubricant oils.

[0009] 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.

[0010] 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.

[0011] The disclosures of all the referenced patents and patent applications referred to herein are also incorporated herein in their entirety by reference.

DETAILED DESCRIPTION

[0012] 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 improve deposit control characteristics of a diesel engine.

[0013] A deposit control additive composition comprising a Mannich base and Polyisobutylene succinimide as synergistic components of the deposit control additive formulation can be incorporated into a fuel, more particularly a diesel fuel. A process is also provided for the preparation of the fuel composition by blending at an ambient temperature a diesel fuel and a deposit control additive formulation which is obtained by blending a Mannich base, Polyisobutylene succinimide, fluidizer oil, a dehazer, a corrosion inhibitor, a solvent and optionally a lubricity improver, an antistatic agent, an ignition accelerator at a temperature ranging from about 40° C. to about 50° C.

[0014] This deposit control additive formulation is highly miscible with diesel fuel at room temperature and can be mixed with fuel in storage tanks, road tanks, railway tanks, and etc.

[0015] In various embodiments, a deposit control additive composition ("the composition") is provided for a diesel fuel to control and reduce deposits on carburetor surfaces and to keep port fuel injectors and intake valves clean in diesel fueled spark ignition internal combustion engines.

[0016] In various embodiments, the composition comprises a Mannich base and Polyisobutylene succinimide (PIBSI) having an average molecular weight of about 800.

[0017] In various embodiments, a deposit control additive formulation is provided. The formulation comprises a deposit control additive composition, fluidizer oil, a dehazer, a corrosion inhibitor, a solvent and optionally a lubricity improver, an antistatic agent and an ignition accelerator.

[0018] In various embodiments, a fuel composition is provided comprising a diesel fuel and a deposit control additive formulation.

[0019] In various embodiments, an easy and economical process for the preparation of a fuel composition comprising blending the deposit control additive formulation and diesel at an ambient temperature is provided.

[0020] The present application provides a deposit control additive formulation including:

[0021] a) a Mannich base; and

[0022] b) Polyisobutylene succinimide (PIBSA) having an average molecular weight ranging from about 700 to about 1000.

[0023] The deposit control additive formulation can further include fluidizer oil, a dehazer, a corrosion inhibitor, a solvent and optionally a lubricity improver, an antistatic agent and an ignition accelerator.

[0024] One embodiment provides a fuel composition includes:

[0025] a) a diesel fuel ranging from about 99.99 to 99.90% weight, and

[0026] b) a deposit control additive formulation ranging from about 0.01 to 0.1% weight.

[0027] In accordance with another embodiment, the additive composition comprises PIBSI and a Mannich base in the ratio of about 1:0.2 by weight.

[0028] The Mannich base used can be derived from a 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. 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.

[0029] Still another embodiment provides a fuel composition comprising a diesel fuel such as cetane 45, cetane 46, cetane 47, cetane 48, cetane 49, cetane 50, and cetane 51.

[0030] Yet another embodiment provides a fuel composition whose concentration of deposit control additive formulation ranges from about 100 to about 1000 mg/liter. The fuel composition shows excellent performance in a Peugeot XUD9A Engine test. The fuel composition passes the corrosion test as per ASTM D 665A carried out at room temperature and the ASTM D 1094 test of water reaction and meets the IS 1460:2000 specification of Indian diesel fuel.

[0031] Further embodiment provides a process for the preparation of a fuel composition including the following steps:

[0032] a) obtaining a deposit control additive formulation by mixing a Mannich base, Polyisobutylene succinimide, fluidizer oil, a dehazer, a corrosion inhibitor, a solvent, optionally a lubricity improver, an antistatic agent, an ignition accelerator in a suitable container at

a temperature ranging from 50° C. to 60° C. for a time period of up to 2 hours; and

[0033] b) mixing the deposit control additive formulation prepared in step (a) with a diesel fuel at an ambient temperature.

[0034] The addition of Mannich bases derived from reacting hydrogenated and distilled Cashew Nut Shell Liquid (CNSL) or para-alkyl-phenols with aldehyde and an amine to fuels for use in diesel engines can significantly improve the deposit control characteristics of the fuel. The fuel can also include a detergent such as Polyisobutylene succinimide (PIBSI), fluidizers, a dehazer, a corrosion inhibitor and optionally a lubricity improver, an antistatic agent and an ignition accelerator, such as an organic nitrate.

[0035] For example, if Polyisobutylene succinimide (PIBSI) was used alone in diesel fuel at 500 mg/liter, the fuel flow restriction was reduced from a base value of 94% to around 35% as per Peugeot XUD9A test method. At the same or higher dosages levels of Mannich Base alone, the fuel flow restriction level could not be reduced to the desired level of 80% or below. However, if a combination of a Mannich base and Polyisobutylene succinimide (PIBSI) is used, the flow rate restriction of treated diesel fuel was reduced to about 22% with a 200 mg/liter treat rate as compared to a 35% with 500 mg/liter treat rate in the base diesel fuel.

[0036] A successful attempt has been made to develop a deposit control diesel fuel additive containing a Mannich base as a synergistic component. Mannich bases can be derived from hydrogenated and distilled Cashew Nut Shell Liquid (CNSL) or from commercially available p-substituted phenols.

[0037] 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).

[0038] 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.

[0039] Suitable Polyisobutylene succinimide (PIBSI) can have an average molecular weight of about 750 to about 1000. In one embodiment, PIBSI has an average molecular weight of about 800. Normally, suitable PIBSI has the following characteristics:

Characteristics	Limits
Density @ 20° C.	0.92 min.
Flash point (PMCC)	>55° C.
Boiling Point	>160° C.
Solvents % weight	50 max.
Solubility in Water	Insoluble

[0040] The fluidizer oil can be an aromatic solvent, such as toluene, xylenes and aromatic streams of refineries.

[0041] The dehazer can be a de-emulsifier without ash having a mixture of polymers and copolymers designed to reduce the interaction of diesel fuels with water and to improve the water tolerance characteristics of treated diesel fuels. The typical properties are as follows:

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

[0042] 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 @ 20° C.	0.970–1.00
Total acid number (TAN)	160–185
K.V @ 100° C.	26–40

[0043] Optionally, the fuel composition can contain an ignition accelerator. The ignition accelerator can be an organic nitrate. In one embodiment, organic nitrates can be substituted or unsubstituted alkyl or cycloalkyl nitrates having up to about 10 carbon atoms. The alkyl group may be either linear or branched. Specific examples of nitrate compounds include, methyl nitrate, ethyl nitrate, n-propyl nitrate, isopropyl nitrate, allyl nitrate, n-butyl-nitrate, isobutyl nitrate, sec-butyl nitrate, tert-butyl nitrate, n-amyl nitrate, isoamyl nitrate, 2-amyl nitrate, 3-amyl nitrate, tert-amyl nitrate, n-hexyl nitrate, 2ethylhexyl nitrate, n-heptyl nitrate, sec-heptyl nitrate, n-octyl nitrate, sec-octyl nitrate, n-nonyl nitrate, n-decyl nitrate, n-dodecyl nitrate, cyclopentylnitrate, cyclohexylnitrate, methylcyclohexyl nitrate, isopropylcyclohexyl nitrate and the esters of alkoxy substituted aliphatic alcohols, such as 1-methoxypropyl-2-nitrate, 1-ethoxypropyl-2 nitrate, 1-isopropoxy-butyl nitrate, 1-ethoxybutyl nitrate and the like. In one embodiment, alkyl nitrates can be ethyl nitrate, propyl nitrate, amyl nitrates and hexyl nitrates. Other alkyl nitrates can be mixtures of primary amyl nitrates or primary hexyl nitrates. Primary here means that the nitrate functional group is attached to a carbon atom attached to two hydrogen atoms. Examples of primary hexyl nitrates include

n-hexyl nitrate, 2-ethylhexyl nitrate, 4-methyl-n-pentyl nitrate and the like. Preparation of the nitrate esters may be accomplished by any of the commonly used methods, for example, esterification of the appropriate alcohol, or reaction of a suitable alkyl halide with silver nitrate.

[0044] Other conventional ignition accelerators may also be used, such as hydrogen peroxide, benzoyl peroxide, and etc. Further, certain inorganic and organic chlorides and bromides, for example, aluminum chloride, ethyl chloride or bromide may be used as primers in combination with the alkyl nitrates accelerators.

[0045] Other additives may also be used in formulating the compression ignition fuel compositions including lubricity improvers and anti-static agents (ASA), and the like, provided these additives do not adversely affect the deposit control effectiveness of the Mannich base.

[0046] The amount of the Mannich base in the compression ignition fuel composition should be enough to provide the desired deposit control. This concentration can be conveniently expressed in terms of percent by weight of the Mannich base based on the total weight of the compression ignition fuel composition. In one embodiment, the concentration is from about 10 to about 50 percent by weight. In another embodiment, the concentration is from about 10 to about 20 percent by weight.

[0047] The concentration of Polyisobutylene succinimide (PIBSI) in the diesel MFA package should also be enough to get the desired flow of diesel in the injectors. This concentration can be conveniently expressed in terms of percent by weight of PIBSI based on the total weight of the compression ignition fuel composition. In one embodiment, the concentration is from about 30 to about 70 percent by weight. In another embodiment, the concentration is from about 45 to about 60 percent by weight.

[0048] A dehazer can be added in the composition of diesel MFA package 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.

[0049] 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.

[0050] 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.

[0051] Optionally, an ignition accelerator should be in an amount that will achieve a level of auto-ignition sufficient to allow the operation of diesel engines. In one embodiment, the range can be from about 0.01 percent by weight to about 0.05 percent by weight based on the total weight of the

compression ignition fuel composition. In another embodiment, the range can be from 0.01 percent by weight to 0.03 percent by weight.

[0052] 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 component with the PIBSI, fluidizer oil, corrosion inhibitor, anti static agent and, if desired, ignition accelerator in a determined proportion. This operation can normally be carried out at ambient temperature. The fuel composition may contain other additives well known to those skilled in the art in addition to the deposit control additive formulation.

[0053] 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:

[0054] Various deposit control additive formulations for a diesel fuel were prepared by using different combinations of various ingredients by mixing the ingredients in a blending vessel at 50-60° C. with continuous stirring for 2 hours. Details are as follows:

[0055] The following commercially available material has been used in formulations: PIBSI—commercial name: KEROCOM PIBSI [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.

[0056] Formulation-1: a combination of PIBSI, fluidizer oil, a dehazer and a corrosion inhibitor in the ratio 50:48:1:1 was prepared without the addition of a Mannich base.

[0057] Formulation-2: a combination of a Mannich base, fluidizer oil, a dehazer and a corrosion inhibitor in the ratio 50:48:1:1 was prepared without the addition of PIBSI.

[0058] Formulation-3: a combination of PIBSI, a CSNL based Mannich Base, fluidizer oil, a dehazer and a corrosion inhibitor in the ratio 50:15:33:1:1 was prepared. The Mannich base was added to establish the synergistic effect of the Mannich base with PIBSI in the engine cleanliness test.

[0059] Formulation-4: a combination of PIBSI, nonyl phenol based Mannich Base, fluidizer oil, a dehazer and a corrosion inhibitor in the ratio 50:15:33:1:1 was prepared. The Mannich base was added to establish the synergistic effect of the Mannich base with PIBSI in the engine cleanliness test.

[0060] Formulation-5: a combination of PIBSI, dodecyl phenol based Mannich Base, fluidizer oil, dehazer and

corrosion inhibitor in the ratio 50:15:33:1:1 was prepared. The Mannich base was added to establish the synergistic effect of the Mannich base with PIBSI in the engine cleanliness test.

[0061] Formulation-6: a cetane improver, a lubricity additive and an antistatic agent were added in the ratio 50:37:12.5:0.5 to Formulation-4, in order to make a fully loaded package to provide improved ignition quality, better lubricity and ability to dissipate the static current of ultra low sulfur diesel.

Example 2

Evaluation Methodology

[0062] The complete evaluation of deposit control additive formulations was carried out in the diesel fuel by assessing the performance with the following parameters:

[0063] (a) Testing of deposit control additive formulation treated diesel fuel as per National Standard IS 1460:2000: The regular diesel fuel meeting Indian standard IS 1460:2000 was used for the evaluation of the deposit control additive formulations and a desired concentration of deposit control additive formulations was added thereto. After the addition of the deposit control additive formulations, the product was again tested as per IS 1460: 2000 to confirm that the addition of the deposit control additive formulations in the desired concentration does not adversely affect the properties of the diesel fuel.

[0064] (b) The short listed compositions were additionally tested for following characteristics:

[0065] i) WATER REACTION OF FUELS: This test is designed to measure water tolerance characteristics of diesel fuels. 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 80ml of a diesel 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.

[0066] ii) DYNAMIC CORROSION TEST: This test is carried out to evaluate the ability of a diesel 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 diesel 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.

[0067] (c) Diesel Nozzle coking test as per CEC F-23-A-01 on PSA XUD 9A engine:

[0068] Diesel Nozzle coking test CEC-F-23-A-01 on a PSA XUD engine is the internationally accepted standard test for assessing the performance of a diesel fuel containing deposit control additive formulations for injector nozzle coking propensity. The deposits can be formed between the injector needle, the injector body and the needle seat to potentially cause unacceptable variations in engine performance. The results are expressed in terms of the percentage of injector airflow reduction at needle lift of 0.1, 0.2, and 0.3 mm for all

nozzles. The performance criterion is a single value of the average percentage airflow reduction at 0.1 mm needle lift for all 4 nozzles.

Example 3

[0069] The above formulations were added in the diesel fuel meeting IS 1460:2000 specification at 200 mg/liter treat rate and the treated samples were tested as per national specifications IS 1460:2000 to establish that the addition of these formulations does not have any deteriorating effect on the properties of diesel fuel. The results are given in Table 1 to 3.

TABLE 1

S. No	Properties	Sample Details		
	Requirement as per IS 1460:2000	HSD without Deposit Control Additive	HSD with 200 mg/liter Formulation-1	HSD with 200 mg/liter Formulation-2
1.	Acidity, Inorganic	Nil	Nil	Nil
2.	Acidity, total, mg of KOH/gm, Max	0.20	0.02	0.02
3.	Ash, % wt., Max	0.01	0.003	0.003
4.	Carbon residue (Ramsbottom) on 10% residue % wt., Max	0.30	0.10	0.10
5.	Cetane No. Min	48	48.2	48.4
6.	Pour point ° C., Max			
	Winter	3° C.	-6	-6
	Summer	15° C.		
7.	Copper strip corrosion for 3 hours at 100° C.	Not worse than No. 1	No. 1	No. 1
8.	Distillation, % v/v recovered			
	at 350° C., Min.	85	94.0	93.5
	at 370° C., Min.	95	97.0	96.5
9.	Flash point, ° C., (Able), Min.	35	46	47
10.	K. V., cSt at 40° C.	2.0 to 5.0	3.083	3.092
11.	Sediment, % wt., Max	0.05	<0.01	<0.01
12.	Density at 15° C., Kg/m ³	820 to 860	849.5	849.8
13.	Total sulfur % wt., Max	0.25/0.05	0.024	0.024
14.	Water, % vol., Max	0.05	Nil	Nil
15.	Cold filter plugging (CFPP)	6° C. for winter 18° for summer	-3	-3

[0070]

TABLE 2

S. No	Properties	Sample Details		
	Requirement as per IS 1460:2000	HSD without Deposit Control Additive	HSD with 200 mg/liter Formulation-3	HSD with 200 mg/liter Formulation-4
1.	Acidity, Inorganic	Nil	Nil	Nil
2.	Acidity, total, mg of KOH/gm, Max	0.20	0.02	0.02
3.	Ash,% wt., Max	0.01	0.003	0.003
4.	Carbon residue (Ramsbottom) on 10% residue % wt., Max	0.30	0.10	0.10
5.	Cetane No. Min	48	48.2	48.4
6.	Pour point ° C., Max			
	Winter	3° C.	-6	-6
	Summer	15° C.		

TABLE 2-continued

S. No	Properties	Sample Details		
	Requirement as per IS 1460:2000	HSD without Deposit Control Additive	HSD with 200 mg/liter Formulation-3	HSD with 200 mg/liter Formulation-4
7.	Copper strip corrosion for 3 hours at 100° C.	Not worse than No. 1	No. 1	No. 1
8.	Distillation, % v/v recovered			
	at 350° C., Min.	85	94.0	93.5
	at 370° C., Min.	95	97.0	96.5
9.	Flash point, ° C., (Able), Min.	35	46	47
10.	K. V., cSt at 40° C.	2.0 to 5.0	3.083	3.092
11.	Sediment, % wt., Max	0.05	<0.01	<0.01
12.	Density at 15° C., Kg/m ³	820 to 860	849.5	849.8
13.	Total sulfur % wt., Max	0.25/0.05	0.024	0.024
14.	Water, % vol., Max	0.05	Nil	Nil
15.	Cold filter plugging (CFPP)	6° C. for winter 18° for summer	-3	-3

[0071]

TABLE 3

S. No	Properties	Sample Details		
	Requirement as per IS 1460:2000	HSD without Deposit Control Additive	HSD with 200 mg/ liter Formulation-5	HSD with 200 mg/ liter Formulation-6
1.	Acidity, Inorganic	Nil	Nil	Nil
2.	Acidity, total, mg of KOH/gm, Max	0.20	0.02	0.02
3.	Ash, % wt., Max	0.01	0.003	0.003
4.	Carbon residue (Ramsbottom) on 10% residue % wt., Max	0.30	0.10	0.10
5.	Cetane No. Min	48	48.2	48.4
6.	Pour point ° C., Max			
	Winter	3° C.	-6	-6
	Summer	15° C.		
7.	Copper strip corrosion for 3 hours at 100° C.	Not worse than No. 1	No. 1	No. 1
8.	Distillation, % v/v recovered			
	at 350° C., Min.	85	94.0	93.5
	at 370° C., Min.	95	97.0	96.5
9.	Flash point, ° C., (Able), Min.	35	46	47
10.	K. V., cSt at 40° C.	2.0 to 5.0	3.083	3.092
11.	Sediment, % wt., Max	0.05	<0.01	<0.01
12.	Density at 15° C., Kg/m ³	820 to 860	849.5	849.8
13.	Total sulfur % wt., Max	0.25/0.05	0.024	0.024
14.	Water, % vol., Max	0.05	Nil	Nil
15.	Cold filter plugging (CFPP)	6° C. for winter 18° for summer	-3	-3

Example 4

[0072] Diesel fuels doped with the deposit control additive formulations as prepared in Example-1 were tested per ASTM D1094 to measure the ability of the doped diesel fuels to separate from water. The results are given in Table-4.

TABLE 4

Sr. No.	Product	Additive Concentration (mg/liter)	Test results
1	Base Diesel	—	Pass
2	Base Diesel + Formulation-1	200	Pass
3	Base Diesel + Formulation-2	200	Pass
4	Base Diesel + Formulation-3	200	Pass
5	Base Diesel + Formulation-4	200	Pass
6	Base Diesel + Formulation-5	200	Pass
7	Base Diesel + Formulation-6	200	Pass

Example 5

Dynamic Corrosion Test:

[0073] Diesel 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 diesel to prevent corrosion. The results are given in Table-5.

TABLE 5

Sr. No.	Product	Additive Concentration (mg/liter)	Test results
1	Base Diesel	—	Pass
2	Base Diesel + Formulation-1	200	Pass
3	Base Diesel + Formulation-2	200	Pass
4	Base Diesel + Formulation-3	200	Pass
5	Base Diesel + Formulation-4	200	Pass
6	Base Diesel + Formulation-5	200	Pass
7	Base Diesel + Formulation-6	200	Pass

Example 6

[0074] The above formulations were evaluated for diesel nozzle coking per CEC F-23-A-01 in PSA XUD 9A engine. The test results are given in Table-6.

TABLE 6

Sr No.	Formulation	Treat Rate, mg/liter	% Nozzle Fouling
1	Reference Fuel	—	94
2	Reference Fuel + Formulation-1	100	80
3	Reference Fuel + Formulation-1	200	72
4	Reference Fuel + Formulation-1	500	35
5	Reference Fuel + Formulation-2	100	84
6	Reference Fuel + Formulation-2	150	80
7	Reference Fuel + Formulation-2	200	78
8	Reference Fuel + Formulation-3	100	60
9	Reference Fuel + Formulation-3	150	40
10	Reference Fuel + Formulation-3	200	22
11	Reference Fuel + Formulation-4	100	62
12	Reference Fuel + Formulation-4	150	39
13	Reference Fuel + Formulation-4	200	25
14	Reference Fuel + Formulation-5	100	64
15	Reference Fuel + Formulation-5	150	45

TABLE 6-continued

Sr No.	Formulation	Treat Rate, mg/liter	% Nozzle Fouling
16	Reference Fuel + Formulation-5	200	30
17	Reference Fuel + Formulation-6	100	80
18	Reference Fuel + Formulation-6	150	75
19	Reference Fuel + Formulation-6	200	70

I/we claim:

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

- a) a Mannich base; and
- b) Polyisobutylene succinimide (PIBSA) having an average molecular weight ranging generally between about 700 and about 1000.

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

3. The additive composition of claim 1, wherein the ratio of PIBSA 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:
 - a) a diesel fuel ranging from 99.90 to 99.99 percent by weight; and
 - b) the deposit control additive formulation of claim 2 ranging from generally 0.01 to 0.10 percent by weight.

7. A fuel composition of claim 6, wherein the diesel fuel is selected from a group consisting of cetane 45, cetane 46, cetane 47, cetane 48, cetane 49, cetane 50, and cetane 51.

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

9. A process for the preparation of fuel composition, comprising:

- i) obtaining the deposit control additive formulation of claim 2 by mixing a Mannich base, Polyisobutylene succinimide, fluidizer oil, a dehazer, a corrosion inhibitor, and a solvent at a temperature ranging generally between 50° C. to 60° C. for a time period of up to 2 hours; and
- ii) mixing the obtained deposit control additive formulation of step (i) with diesel fuel at an ambient temperature.

10. The process of claim 9, wherein obtaining the deposit control additive formulation of claim 2 further comprises mixing a lubricity improver, an antistatic agent and an ignition accelerator.

11. The deposit control additive formulation of claim 2, further comprising a lubricity improver, an antistatic agent and an ignition accelerator.