clean. Run 4 showed that a small amount of the reaction product of Example 3, used as top treat to the fuel of Run 3, was sufficient to clean up the dirty fuel injectors from Run No. 3.

**Table 4**

| **Run No.** | **Additives and treat rate (ppm by weight)** | **Normalized LTFT %** |
|---|---|---|
| 3 | Gasoline with typical Mannich detergent[2] (81 ppmw) | 9.3 |
| 5 | Fuel and additive of Run 3 plus 8 ppm of Inventive Example 3 | 0.0 |

[2]Mannich detergent as described in Table 1.

**[00040]** Table 5 showed that the Mannich detergent of Run 3 was not effective to keep the injectors clean. However, when the Mannich was combined with 8 ppm of the Inventive Example 3, the fuel was effective to keep the injectors clean.

**[00041]** It is noted that, as used in this specification and the appended claims, the singular forms "a," "an," and "the," include plural referents unless expressly and unequivocally limited to one referent. Thus, for example, reference to "an antioxidant" includes two or more different antioxidants. As used herein, the term "include" and its grammatical variants are intended to be non-limiting, such that recitation of items in a list is not to the exclusion of other like items that can be substituted or added to the listed items

**[00042]** For the purposes of this specification and appended claims, unless otherwise indicated, all numbers expressing quantities, percentages or proportions, and other numerical values used in the specification and claims, are to be understood as being modified in all instances by the term "about." Accordingly, unless indicated to the contrary, the numerical parameters set forth in the following specification and attached claims are approximations that can vary depending upon the desired properties sought to be obtained by the present disclosure. At the very least, and not as an attempt to limit the application of the doctrine of equivalents to the scope of the claims, each numerical parameter should at least be construed in light of the number of reported significant digits and by applying ordinary rounding techniques.

~~**[00043]** While particular embodiments have been described, alternatives, modifications, variations, improvements, and substantial equivalents that are or can be presently unforeseen can arise to applicants or others skilled in the art. Accordingly, the appended claims as filed and as~~

they can be amended are intended to embrace all such alternatives, modifications variations, improvements, and substantial equivalents.

**WHAT IS CLAIMED IS:**

1. A method of improving the injector performance of a fuel injected gasoline engine comprising operating the engine on a fuel composition comprising a major amount of fuel and from about 1 to about 200 ppm by weight based on a total weight of the fuel of a reaction product of (i) a hydrocarbyl substituted compound containing at least one tertiary amino group and (ii) a halogen substituted $C_2$-$C_8$ carboxylic acid, ester, amide, or salt thereof, wherein the reaction product as made ~~is substantially devoid of free anion species~~does not contain detectible amounts of anions that are not covalently bound to the reaction product.

2. The method of claim 1, wherein the engine comprises a direct injected gasoline (DIG) engine.

3. The method of claim 1, wherein the fuel injected gasoline engine comprises a port fuel injected (PFI) gasoline engine having an average fuel flow loss of less than 20 percent in a port fuel injection test.

4. The method of claim 1, wherein the halogen substituted carboxylic acid or salt thereof comprises an alkali metal chloroacetate.

5. The method of claim 1, wherein the hydrocarbyl group of the hydrocarbyl substituted compound is selected from the group consisting of linear, branched, substituted, cyclic, saturated, unsaturated compounds and compounds containing one or more hetero atoms.

6. The method of claim 1, wherein the hydrocarbyl groups of the hydrocarbyl substituted compound (i) are selected from alkyl, alkenyl, and alkanol groups.

7. The method of claim 1, wherein the hydrocarbyl substituted compound (i) comprises a hydrocarbyl-substituted, carbonyl-containing compound selected from the group consisting of acylated polyamines, fatty amide tertiary amines, fatty acid substituted tertiary amines, and fatty ester tertiary amines.

8. The method of claim 7, wherein the amines comprises $C_{10}$-$C_{30}$-alkyl or alkenyl-substituted amidopropyldimethylamines.

9. The method of claim 7, wherein the amines are selected from the group consisting of polyalkenyl succinic carbonyl amine, oleylamidopropyl dimethylamine, and cocoamidopropyl dimethylamine.

10. The method of claim 1, wherein the amine comprises a dimethyl-$C_8$-$C_{24}$ fatty amine.

11. The method of claim 1, wherein from about 0.1 to about 1.0 moles of (i) are reacted with from about 1.0 to about 0.1 moles of (ii).

12. The method of claim 1, wherein the amount of ~~additive~~reaction product in the fuel ranges from about 10 to about 150 ppm by weight based on a total weight of the fuel.

13. The method of claim 1, wherein the amount of ~~additive~~reaction product in the fuel ranges from about 30 to about 100 ppm by weight based on a total weight of the fuel.

14. The method of claim 1, wherein said improved fuel injected gasoline engine performance comprises providing an average fuel flow loss of less than 10 percent in a port fuel injection test.

15. A method of operating a fuel injected gasoline engine comprising combusting in the engine a fuel composition comprising a major amount of fuel and from about 1 to about 200 ppm by weight based on a total weight of the fuel of a reaction product of (i) a hydrocarbyl substituted compound containing at least one tertiary amino group and (ii) a halogen substituted C2-C8 carboxylic acid, ester, amide, or salt thereof, wherein the reaction product as made ~~is substantially devoid of free anion species~~does not contain detectible amounts of anions that are not covalently bound to the reaction product.

16. The method of claim 15, wherein the hydrocarbyl substituted compound is selected from the group consisting of C10-C30-alkyl or alkenyl-substituted amidopropyldimethylamines, and C12-$C_{200}$-alkyl or alkenyl-substituted succinic-carbonyldimethylamines.

17. The method of claim 15, wherein the hydrocarbyl group of the hydrocarbyl substituted compound is selected from the group consisting of linear, branched, substituted, cyclic, saturated, unsaturated compounds and compounds containing one or more hetero atoms.

18. The method of claim 15, wherein the halogen substituted acetic acid or salt thereof comprises alkali metal chloroacetate.

19. The method of claim 15, wherein the engine comprises a direct injected gasoline (DIG) engine.

20. The method of claim 15, wherein the engine comprises a port fuel injected (PFI) engine.

# GASOLINE FUEL COMPOSITION FOR IMPROVED PERFORMANCE IN FUEL INJECTED ENGINES


## ABSTRACT

A method for improving performance of fuel injectors, and a method for cleaning fuel injectors for an internal combustion engine. The methods include operating the engine on a fuel composition comprising a major amount of fuel and from about 1 to about 200 ppm by weight based on a total weight of the fuel of a reaction product of (i) a hydrocarbyl substituted compound containing at least one tertiary amino group and (ii) a halogen substituted C2-C8 carboxylic acid, ester, amide, or salt thereof, wherein the reaction product as made is substantially devoid of free anion species.


No Suitable Figure.