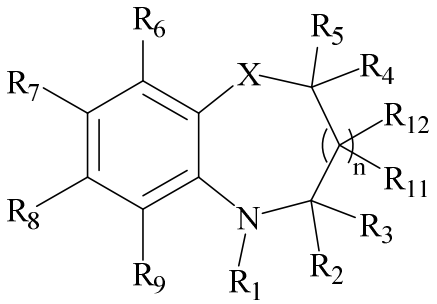
boosting additive and a base fuel, wherein the non-metallic octane-boosting additive, when used at a treat rate of 0.67 % weight additive / weight base fuel, increases the research octane number of a fuel by at least 1.8 without:

increasing the T_{90} by more than 2.0 %; or

increasing the vapour pressure by more than 2.0 %.

In one aspect, the present disclosure provides a fuel composition for a spark-ignition internal combustion engine, the fuel composition comprising a non-metallic octane-boosting additive and a base fuel, wherein the non-metallic octane-boosting additive has the formula:



where: R_1 is hydrogen;

R_2, R_3, R_4, R_5, R_{11} and R_{12} are each independently selected from hydrogen, alkyl, alkoxy, alkoxy-alkyl, secondary amine and tertiary amine groups;

R_6, R_7, R_8 and R_9 are each independently selected from hydrogen, alkyl, alkoxy, alkoxy-alkyl, secondary amine and tertiary amine groups;

X is selected from -O- or -NR_{10}-, where R_{10} is selected from hydrogen and alkyl groups; and

n is 0 or 1,

wherein the non-metallic octane-boosting additive, when used at a treat rate of 0.67 % weight additive / weight base fuel, increases the research octane number of a fuel by at least 1.8 without increasing:

the T_{90} by more than 2.5 %; or

the vapour pressure by more than 2.0 %.

The present disclosure also provides the use of a non-metallic octane-boosting additive for increasing the octane number, whilst maintaining the T_{90} or the vapour pressure, of a fuel for a spark-ignition internal combustion engine. In another aspect, the present disclosure provides use of a non-metallic octane-boosting

additive for increasing the octane number, whilst maintaining the T_{90} or the vapour pressure, of a fuel for a spark-ignition internal combustion engine, wherein the non-metallic octane-boosting additive, when used at a treat rate of 0.67 % weight additive / weight base fuel, increases the research octane number of a fuel by at least 1.8 without increasing: the T_{90} by more than 2.5 %; or the vapour pressure by more than 2.0 %. The present disclosure also provides a method for increasing the octane number, whilst maintaining the T_{90} or the vapour pressure, of a fuel for a spark-ignition internal combustion engine, wherein the method comprises blending a non-metallic octane-boosting additive with the fuel. In another aspect, the present disclosure provides a method for increasing the octane number, whilst maintaining the T_{90} or the vapour pressure, of a fuel for a spark-ignition internal combustion engine, wherein the method comprises blending a non-metallic octane-boosting additive with the fuel, and wherein the non-metallic octane-boosting additive, when used at a treat rate of 0.67 % weight additive / weight base fuel, increases the research octane number of a fuel by at least 1.8 without increasing: the T_{90} by more than 2.5 %; or the vapour pressure by more than 2.0 %.

Brief Description of the Figures

Figures 1a-c are graphs of the change in octane number (both RON and MON) of fuels when treated with varying amounts of a non-metallic octane-boosting additive. Specifically, Figure 1a shows a graph of the change in octane number of an E0 fuel having a RON of 90; Figure 1b shows a graph of the change in octane number of an E0 fuel having a RON of 95; and Figure 1c shows a graph of the change in octane number of an E10 fuel having a RON of 95.

Figures 2a-c show graphs comparing the change in octane number (both RON and MON) of fuels when treated with a non-metallic octane-boosting additive and N-methyl aniline. Specifically, Figure 2a shows a graph of the change in octane number of an E0 and an E10 fuel against treat rate; Figure 2b shows a graph of the change in octane number of an E0 fuel at a treat rate of 0.67 % w/w; and Figure 2c shows a graph of the change in octane number of an E10 fuel at a treat rate of 0.67 % w/w.

Figure 3 shows a graphs comparing the T_{90} of base fuels and the blends of base fuel and 0.67 % w/w non-metallic octane-boosting additive.

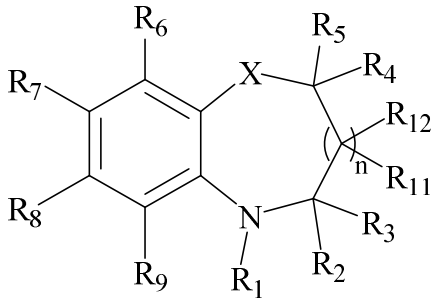
Detailed Description of the Invention

Octane-boosting additive

The non-metallic octane-boosting additive that is used in the present invention, when used at a treat rate of 0.67 % weight additive / weight base fuel, increases the research octane number of a fuel by at least 1.8 (preferably by at least 2.5, and more preferably by at least 3.0) without increasing: the T_{90} by more than 2.5 % (preferably 2.0

Claims:

1. A fuel composition for a spark-ignition internal combustion engine, the fuel composition comprising a non-metallic octane-boosting additive and a base fuel, wherein the non-metallic octane-boosting additive has the formula:



where: R_1 is hydrogen;

R_2, R_3, R_4, R_5, R_{11} and R_{12} are each independently selected from hydrogen, alkyl, alkoxy, alkoxy-alkyl, secondary amine and tertiary amine groups;

R_6, R_7, R_8 and R_9 are each independently selected from hydrogen, alkyl, alkoxy, alkoxy-alkyl, secondary amine and tertiary amine groups;

X is selected from -O- or -NR_{10}-, where R_{10} is selected from hydrogen and alkyl groups; and

n is 0 or 1,

wherein the non-metallic octane-boosting additive, when used at a treat rate of 0.67 % weight additive / weight base fuel, increases the research octane number of a fuel by at least 1.8 without increasing:

the T_{90} by more than 2.5 %; or

the vapour pressure by more than 2.0 %.

2. A fuel composition according to claim 1, wherein the non-metallic octane-boosting additive, when used at a treat rate of 0.67 % weight additive / weight base fuel, increases the research octane number of a fuel by at least 1.8 without increasing:

the T_{90} by more than 2.5 %; and

the vapour pressure by more than 2.0 %.

3. A fuel composition according to any preceding claim, wherein the non-metallic octane-boosting additive, when used at a treat rate of 0.67 % by weight, increases the research octane number of a fuel by at least 2.5, and preferably 3.0.

4. A fuel composition according to any preceding claim, wherein the non-metallic octane-boosting additive, when used at a treat rate of 0.67 % by weight, does not increase the T_{90} of a fuel by more than 2.0 %, and preferably 1.5 %.

5. A fuel composition according to any preceding claim, wherein the non-metallic octane-boosting additive, when used at a treat rate of 0.67 % by weight, does not increase the vapour pressure of a fuel by more than 1.0 %, and preferably 0.5 %.

6. A fuel composition according to any preceding claim, wherein the fuel composition has a research octane number of at least 80, preferably at least 90, and more preferably at least 95.

7. A fuel composition according to any preceding claim, wherein the non-metallic octane-boosting additive has a blending research octane number of greater than 290, preferably greater than 300, and more preferably greater than 310.

8. A fuel composition according to any preceding claim,wherein R_2, R_3, R_4, R_5, R_{11} and R_{12} are each independently selected from hydrogen and alkyl groups, preferably from hydrogen, methyl, ethyl, propyl and butyl groups, more preferably from hydrogen, methyl and ethyl, and even more preferably from hydrogen and methyl.

9. A fuel composition according to any preceding claim, wherein R_6, R_7, R_8 and R_9 are each independently selected from hydrogen, alkyl and alkoxy groups, preferably from hydrogen, methyl, ethyl, propyl, butyl, methoxy, ethoxy and propoxy groups, more preferably from hydrogen, methyl, ethyl and methoxy, and even more preferably from hydrogen, methyl and methoxy.

10. A fuel composition according to any preceding claim, wherein at least one of R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, R_{11} and R_{12}, and preferably at least one of R_6, R_7, R_8 and R_9, is selected from a group other than hydrogen.

11. A fuel composition according to any preceding claim, wherein no more than five, preferably no more than three, and more preferably no more than two, of R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, R_{11} and R_{12} are selected from a group other than hydrogen.

12. A fuel composition according to any preceding claim, wherein at least one of R_2 and R_3 is hydrogen, and preferably wherein R_2 and R_3 are hydrogen.

13. A fuel composition according to any preceding claim, wherein at least one of R_4, R_5, R_7 and R_8 is selected from methyl, ethyl, propyl and butyl groups and the remainder of R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, R_{11} and R_{12} are hydrogen, and preferably wherein at least one of R_7

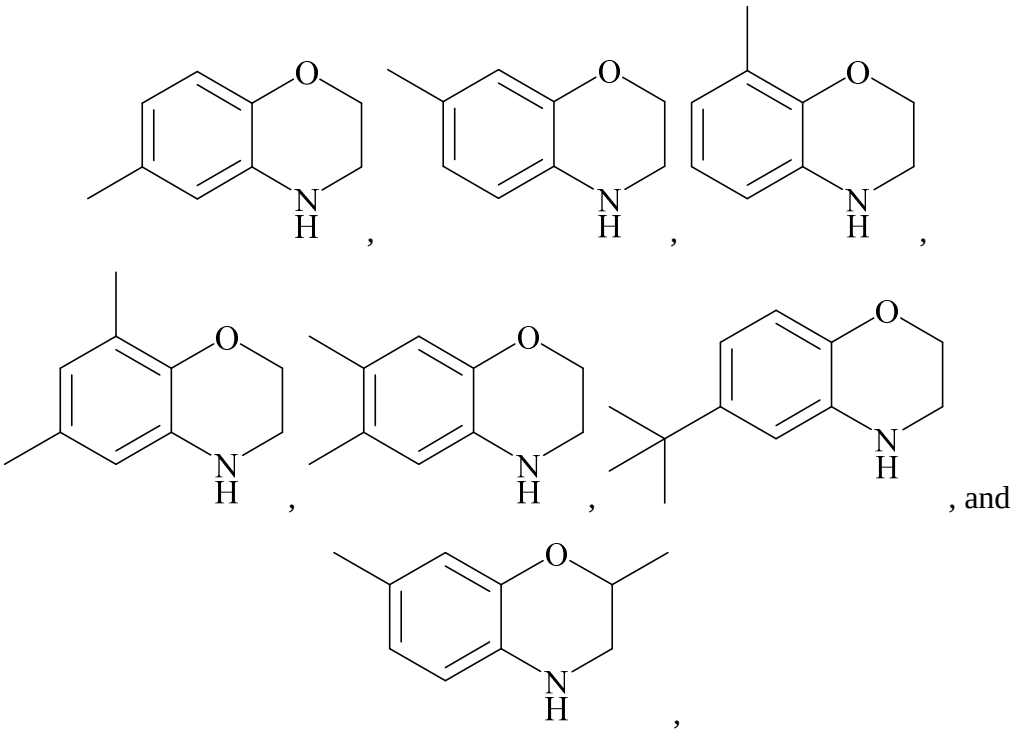
and R_8 are selected from methyl, ethyl, propyl and butyl groups and the remainder of R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, R_{11} and R_{12} are hydrogen.

14. A fuel composition according to any preceding claim, wherein at least one of R_4, R_5, R_7 and R_8 is a methyl group and the remainder of R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, R_{11} and R_{12} are hydrogen, and preferably wherein at least one of R_7 and R_8 is a methyl group and the remainder of R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, R_{11} and R_{12} are hydrogen.

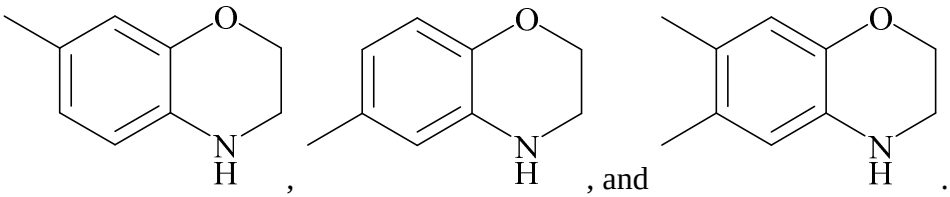
15. A fuel composition according to any preceding claim, wherein X is -O- or -NR_{10}-, where R_{10} is selected from hydrogen, methyl, ethyl, propyl and butyl groups, preferably from hydrogen, methyl and ethyl groups, and even more preferably is hydrogen, and preferably wherein X is -O-.

16. A fuel composition according to any preceding claim, wherein n is 0.

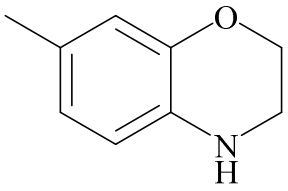
17. A fuel composition according to any preceding claim, wherein the additive is selected from:

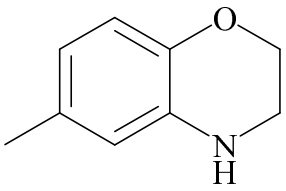


18. A fuel composition according to claim 1, wherein the additive is selected from:



19. A fuel composition according to claim 1, wherein the additive is a mixture of:



and


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20. A fuel composition according to any preceding claim, wherein the additive is present in the fuel composition an amount of up to 20 %, preferably from 0.1 % to 10 %, more preferably from 0.2 % to 5 %, even more preferably from 0.25 % to 2 %, and even more preferably still from 0.3 % to 1 %, weight additive / weight base fuel.

21. A fuel composition according to any preceding claim, further comprising ethanol present in the fuel composition in an amount of up to 85 %, preferably from 1 % to 30 %, more preferably from 3 % to 20 %, and even more preferably from 5 % to 15 %, by volume.

22. Use of a non-metallic octane-boosting additive for increasing the octane number, whilst maintaining the T_{90} or the vapour pressure, of a fuel for a spark-ignition internal combustion engine, wherein the non-metallic octane-boosting additive, when used at a treat rate of 0.67 % weight additive / weight base fuel, increases the research octane number of a fuel by at least 1.8 without increasing:

the T_{90} by more than 2.5 %; or

the vapour pressure by more than 2.0 %.

23. A method for increasing the octane number, whilst maintaining the T_{90} or the vapour pressure, of a fuel for a spark-ignition internal combustion engine, wherein the method comprises blending a non-metallic octane-boosting additive with the fuel, and wherein the non-metallic octane-boosting additive, when used at a treat rate of 0.67 % weight additive / weight base fuel, increases the research octane number of a fuel by at least 1.8 without increasing:

the T_{90} by more than 2.5 %; or

the vapour pressure by more than 2.0 %.