However, the derivatives provide a significantly smaller increase in the RON of a fuel than is provided by NMA at similar treat rates.

Accordingly, there remains a need for additives for a fuel for a spark-ignition internal combustion engine that are able to achieve anti-knock effects, *e.g.* at least comparable anti-knock effects to NMA, while mitigating at least some of the problems highlighted above.

Summary of the Invention

Surprisingly, it has now been found that an additive having a chemical structure comprising a 6-membered aromatic ring sharing two adjacent aromatic carbon atoms with a 6- or 7-membered saturated heterocyclic ring, the 6- or 7-membered saturated heterocyclic ring comprising a nitrogen atom directly bonded to one of the shared carbon atoms to form a secondary amine and an atom selected from oxygen or nitrogen directly bonded to the other shared carbon atom, the remaining atoms in the 6- or 7-membered heterocyclic ring being carbon, provides a substantial increase to the octane number, particularly the RON, of a fuel for a spark-ignition internal combustion engine. Such octane-boosting additives are also predicted to exhibit lower toxicity that NMA. Reduced toxicity would enable additive compositions, containers and kits comprising the octane-boosting additives to provide octane-boosting benefits, whilst being easily stored, transported, used and disposed of.

Accordingly, in one aspect, the present disclosure provides an additive composition for use in a fuel for a spark-ignition internal combustion engine, the additive composition comprising an octane-boosting additive having a chemical structure comprising a 6-membered aromatic ring sharing two adjacent aromatic carbon atoms with a 6- or 7-membered saturated heterocyclic ring, the 6- or 7-membered saturated heterocyclic ring comprising a nitrogen atom directly bonded to one of the shared carbon atoms to form a secondary amine and an atom selected from oxygen or nitrogen directly bonded to the other shared carbon atom, the remaining atoms in the 6- or 7-membered heterocyclic ring being carbon, and one or more further fuel additives.

In another aspect, the present disclosure provides a container comprising:

(i) an octane-boosting additive described herein; and

(ii) means configured to introduce the octane-boosting additive into a fuel system.

In another aspect, the present disclosure further provides a container comprising an octane-boosting

additive in an amount which is:

(a) suitable for treating a fuel in a fuel tank or a fuel tanker at a rate of 0.1 % to 10 %, more preferably from 0.2 % to 5 %, still more preferably from 0.25 % to 2 %, and even more preferably still from 0.3 % to 1 % weight additive / weight base fuel;

(b) suitable for increasing the octane number of a fuel in a fuel tank or a fuel tanker by at least 0.5, preferably at least 1, more preferably at least 2, and still more preferably at least 2.5; or

(c) greater than 100 ml, preferably greater than 150 ml, and more preferably greater than 200 ml;

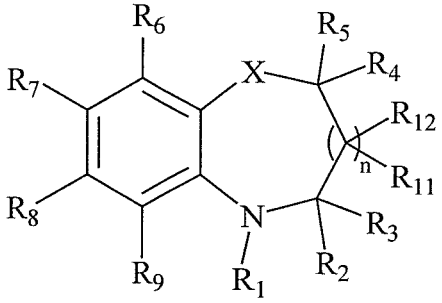
wherein the octane-boosting additive is as described herein.

In a further aspect, the present disclosure provides a kit comprising:

an octane-boosting additive described herein; and

instructions for using the octane-boosting additive in a fuel for a spark-ignition internal-combustion engine.

The octane-boosting additive described herein preferably 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.

The present disclosure also provides the use of an additive composition described herein in a fuel for a spark-ignition internal-combustion engine, and the use of an additive composition described herein for increasing the octane number of a fuel for a