US 3 925 031 teaches that an additive which contains camphor and naphthalene among others can be added to a gasifier fuel, a diesel fuel or a lubricating oil.

In the art, camphor has been used in fuel to provide a reduction in either fuel consumption or hazardous emissions. However, camphor is not known to reduce soot. Rather, as discussed in US 5 116 390, a disadvantage of using camphor is that additional soot formation is noted on burning fuel that contains camphor as an additive. Similarly, US 3 925 031 teaches that use of camphor in gasoline in sufficient quantities to increase the effective octane rating of the gasoline also results in a reduction of *combustion efficiency and a corresponding increase in the quantity of unburned carbon*, leading to sooty exhaust particles.

It is also known that combustion catalysts can lead to the production of ash, see for example US 6 948 926. Thus, additives which reduce soot formation may lead to an increase in the formation of ash. H. Jungbluth, B. Richter, "Neue Ergebnisse zur Regeneration von Dieselpartikelfiltern mit Additiven", Mineralöltechnik, July 1998; Regeneration von Partikelfiltern mit Additiven, FUELS 1999, 2nd International Colloquium, 20-21.01.1999, page 489-495, shows how using such additives in the fuel of heavy duty diesel engines provides an increased peak in the emissions caused by the ash derived from combustion of the additive.

CN 1597873 discloses a fuel which includes methanol, hydrogen peroxide, ferrocene and camphor that reduces the harmful emissions.

The present invention alleviates the problems of the prior art.

In one embodiment~~aspect~~ the present disclosure~~invention~~ provides an additive composition for a fuel comprising:

(i) a metal compound selected from an iron compound, a manganese compound, a calcium compound, a cerium compound and mixtures thereof; and

(ii) an organic compound selected from a bicyclic monoterpene, substituted bicyclic monoterpene, adamantane, propylene carbonate and mixtures thereof;

*wherein the additive composition comprises at least 100 ppm of the organic compound* (ii).

In one aspect, there is provided a fuel composition comprising:
(i) at least 0.1 ppm of a metal compound selected from an iron compound, a manganese compound, a calcium compound, a cerium compound and mixtures thereof;
(ii) at least 1 ppm of an organic compound selected from a bicyclic monoterpene, substituted bicyclic monoterpene, adamantane, propylene carbonate and mixtures thereof; and
(iii) a fuel selected from biofuel, diesel, marine fuel, heating oil, middle distillate oil and heavy fuel oil and including such fuels containing renewable or bio-derived components and commonly termed biofuel; wherein the fuel composition comprises 9 ppm or less of metal compound (i).

In another aspect, there is provided a method for combustion of a fuel composition in a combustion system with an exhaust, comprising providing the fuel composition comprising:
(i) at least 0.1 ppm of a metal compound selected from an iron compound, a manganese compound, a calcium compound, a cerium compound and mixtures thereof;
(ii) at least 1 ppm of an organic compound selected from a bicyclic monoterpene, substituted bicyclic monoterpene, adamantane, propylene carbonate and mixtures thereof; and
(iii) a fuel; and
combusting the same such that soot content and ash content of the exhaust is reduced; wherein the fuel composition comprises 9 ppm or less of metal compound (i).

In another aspect, there is provided the use of:
(i) at least 0.1 ppm of a metal compound selected from an iron compound, a manganese compound, a calcium compound, a cerium compound and mixtures thereof; and
(ii) at least 1 ppm of an organic compound selected from a bicyclic monoterpene, substituted bicyclic monoterpene, adamantane, propylene carbonate and mixtures thereof;
in a fuel composition comprising 9 ppm or less of metal compound (i) for reducing the soot content and the ash content of an exhaust of a combustion system for fuel.

In a further embodimentaspect the present disclosureinvention provides a fuel composition comprising an additive composition as disclosed hereinof the present invention and a fuel.

In a further embodimentaspect the present disclosureinvention provides a fuel composition comprising:

(i) a metal compound selected from an iron compound, a manganese compound, a calcium compound, a cerium compound, and mixtures thereof;

(ii) an organic compound selected from a bicyclic monoterpene, substituted bicyclic monoterpene, adamantane, propylene carbonate and mixtures thereof; and

(iii) a fuel selected from biofuel, diesel, marine fuel, heating oil, middle distillate oil and heavy fuel oil.

In a further embodimentaspect the present disclosureinvention provides a method for combustion of a fuel composition in a combustion system with an exhaust, comprising providing the fuel composition comprising:

(i) a metal compound selected from an iron compound, a manganese compound, a calcium compound, a cerium compound, and mixtures thereof;

(ii) an organic compound selected from a bicyclic monoterpene, substituted bicyclic monoterpene, adamantane, propylene carbonate and mixtures thereof; and

(iii) a fuel; and

combusting the same such that soot content and ash content of the exhaust is reduced.

In one embodimentaspect, the task of the invention is to provide a hydrocarbon mixture which contains an organic iron compound in combination with a further component which leads to a considerable reduction in soot. That is the combination of the iron compound and the further component produces a greater reduction in the amount of soot compared to that observed if the same quantity of iron compound is used alone, or to that observed if the same quantity of the further component is used alone. Thus, the quantity of the iron compound used in the mixture may be reduced to a level where, if the iron compound were used on its own, its catalytic effect in respect of soot reduction would be minimal. This task is fulfilled by means of a hydrocarbon mixture which produces little soot on combustion with at least 0.1 ppm ferrocene and at least 1 ppm camphor added.

Thus, it is known in the art that metal compounds, such as ferrocene, can improve combustion in a combustion system and reduce carbon deposits leading to a reduction in the amount of soot observed in the exhaust of the combustion system. However, the

quantity of iron compound required to produce an adequate reduction in soot also leads to an increased amount of ash being formed. In contrast, organic compounds, such as camphor, do not produce ash, but are known to increase the amount of soot observed. The present disclosure~~invention~~ surprisingly shows that compositions comprising a metal compound in small quantities, such as ferrocene, and an organic compound, such as camphor, can provide good reductions in soot whilst only producing low amounts of ash. Surprisingly, such a composition provides significantly better soot reduction than is observed if the same amount of metal compound is used in the absence of the organic compound.

Various embodiments~~Aspects~~ of the invention are defined in the appended claims.

Metal compound (i)

The metal compound (i) is selected from an iron compound, a manganese compound, a calcium compound, a cerium compound, and mixtures thereof.

Preferably, the metal compound (i) is selected from an iron compound, methylcyclopentadienyl manganese tricarbonyl, manganese(II) 2-ethylhexanoate, manganese naphthenate, calcium 2-ethylhexanoate, calcium napthenate, calcium sulfonate, cerium(III) 2-ethylhexanoate, cerium sulfonate, and mixture thereof.

It is important that the metal compound (i) for use in the invention are fuel soluble or dispersible and preferably fuel stable. The precise nature of the metal containing compounds is less important.

Manganese compound

Preferably the manganese compound is selected from a manganese carbonyl compound, manganese(II) 2-ethylhexanoate, manganese naphthenate, and mixtures thereof.

The most desirable general type of manganese carbonyl compounds utilised in accordance with this invention comprise organomanganese polycarbonyl compounds. For best results, use should be made of a cyclopentadienyl manganese tricarbonyl