Fuel compositions comprising primarily diethyl succinate as an oxygenation additive are described. The fuels can be diesel fuels which generate carbon based particulates in diesel engines. The result is reduced emissions of particulates from the diesel engines.
FIGURE 1

FIGURE 2
FUEL COMPOSITIONS WITH DIETHYL SUCCINATE AND METHOD OF USE THEREOF

BACKGROUND OF THE INVENTION

[0001] (1) Field of the Invention

[0002] The present invention relates to fuel compositions containing diethyl succinate as a primary additive to oxygenate the fuel and reduce particulate emissions. In particular, the present invention relates to diesel fuel compositions.

[0003] (2) Description of Related Art

[0004] Diesel fuels are a significant contribution to pollution. This is shown by U.S. News & World Report for Nov. 4, 2002, page 63. The problem then is to reduce the particulates from diesel fuels.

[0005] In a number of studies the correlation between properties of diesel fuels and emission has been investigated. Most of current additive candidates are ethers, esters or alcohols, but even glycols, carbonates and acetates have been considered. In 1995 Kazushi Tsurutani et al (SAE Paper 952349) examined 11 different oxygenates demonstrated that oxygenates considerably reduce the amount of particles (PM), measured in g/kWh, but that the effect on NOx was nonexistent or very small. The observed effect was more related to the total oxygen content in the fuel after the additive was combined with the fuel, rather than the structure of the molecule. Noboru Miyamoto et al (SAE Paper 962115 (1996)) showed that the reduction of smoke and particle emissions were proportional (linear) to the oxygen concentration in the fuel despite the additive. A general conclusion would be that all oxygenates reduce smoke and particle emission without influencing NOx, a certain reduction of total carbon (THC) and CO was also seen.

[0006] Matthew Stoner and Thomas Litzinger (SAE Paper 1999-01-1475 (1999)) conducted a test to see how structure and boiling point of maleated glycol ethers affects the emissions. They suspected a connection between molecular structure and the amount of the reduced particle amount. They found that both kinds of oxygenate reduce emission of NOx and soot, but the maleates seems more effective. The maleates also reduced emissions of NOx because a delay of SOC (Start of Combustion). No connection between boiling point and effects on the emission could be detected. In a later study it was shown again that the molecule structure has an influence on the reduction of soot emissions. It was also confirmed that the ignition delay increased slightly and hence the NOx emission was reduced.

[0007] Methanol and ethanol are excellent gasoline additives, but are not miscible with diesel fuel and emulsifiers and ignition improvers need to be added which increase the cost. Methanol is also both more toxic and corrosive than ethanol. Rapeseed methyl esters (biodiesel) are of significant interest because they are non-toxic and with small engine modifications they can be used in existing diesels motors.

[0008] A number of alternative fuels that are advocated today have disadvantages because they are expensive. DME (dimethyl ether) has for example good emission properties, works well in a converted diesel motor and is easy to ignite and is a gas non-miscible with diesel fuel.

[0009] Natural gas can on a long-term perspective be a cost effective alternative to diesel, but natural gas is a fossil fuel and therefore not a renewable resource based alternative.

[0010] Relevant patents are U.S. Pat. Nos. 5,268,008 to Kanne; 5,752,989 to Henly et al; 6,488,173 B1 to Lin and U.S. Pat. No. 6,468,319 B1 to Yeh et al. The trend of the patent art is towards high molecular weight additives having a molecular weight greater than or equal to 200, presumably to obtain the necessary solubility and reduced volatility in diesel or other fuels. There is a need for a less expensive additive for internal combustion engines which is readily available and which in particular can be produced from "green" or natural source precursor compounds. To summarize, it can be concluded that there still is a need to find the optimal additive for internal combustion engine fuels.

OBJECTS

[0011] It is therefore an object of the present invention to provide novel internal combustion engine fuel compositions incorporating a low molecular weight additive which is miscible with the fuel. Further, it is an object of the present invention to provide compositions which are easily prepared, are economical and can be prepared from natural source precursor compounds. These and other objects will become increasingly apparent by reference to the following description and the drawings.

SUMMARY OF THE INVENTION

[0012] The present invention relates to a composition which comprises: a liquid hydrocarbon fuel; and between 0.1 and 30 percent by weight of diethyl succinate as a primary organic oxygenation source for the fuel. The fuel is preferably diesel fuel; however, it could be gasoline or other alternative hydrocarbon fuels. The diethyl succinate is preferably 5 to 10 percent by weight of the fuel. The fuel is preferably substantially free of contaminants which cause pollution. The composition preferably contains only the diethyl succinate as the additive.

[0013] The present invention also relates to a method for increasing combustion in an internal combustion engine of a fuel to water and carbon dioxide, and reducing particulates from the combustion, which comprises: providing a composition which comprises: a liquid hydrocarbon as the fuel and between 0.1 and 30 percent by weight of diethyl succinate as a primary organic oxygenation source to run the engine so as to increase the combustion and reduce the particulates from the combustion.

[0014] The term "primary" is intended to mean more than 50% and preferably more than 80% of the regeneration source for the fuel is diethyl succinate.

BRIEF DESCRIPTION OF DRAWINGS

[0015] FIG. 1 is a distribution graph showing concentration of particles versus diameter with diethyl succinate.

[0016] FIG. 2 is a distribution graph showing concentration of particles versus diameter with 5 percent by weight diethyl succinate.
DESCRIPTION OF PREFERRED EMBODIMENTS

[0017] U.S. Pat. No. 6,468,319 B1 which is incorporated by reference contains a detailed description of the various oxygenation secondary additives which can be used with diethyl succinate as well as a discussion of the art of testing oxygenates. The other patents discussed previously are also incorporated by reference showing secondary oxygenation additives.

EXAMPLE 1

[0018] Diethyl succinate (DES) was tested as an additive in diesel fuel. DES fulfills properties that are required for an additive: renewable, non-toxic, inexpensive and miscible with diesel fuel. The tests were performed and show a 20% reduction of the particle emission, using 5% DES in MK 1, as shown by comparison of FIG. 1 with FIG. 2. FIG. 2 also shows the displacement in the particle size distribution by addition of DES to MK 1, from accumulation (larger particle) mode to a significantly increased amount in nuclei (fine particles) mode. In FIG. 1, the total concentrates particles 85.1 (μg/m³) in MK 1 with 1100 rpm and 10% of maximum load. In FIG. 2, the total concentrate of particles was 72.2 (μg/m³) with blending of 5% diethyl succinate in MK 1 with 1100 rpm and 10% of maximum load.

[0019] There are numerous published sources of diesel fuel compositions. One is shown at Lubrizol.com/ReadyReference. The present invention can reduce particulates in any of the diesel fuels sold worldwide in the same manner as Example 1.

[0020] It is intended that the foregoing description be only illustrative of the present invention and that the present invention be limited only by the hereinafter appended claims.

1 claim:
1. A composition which comprises:
   (a) a liquid hydrocarbon fuel; and
   (b) between 0.1 and 30 percent by weight of diethyl succinate as a primary organic oxygenation source for the fuel.
2. The composition of claim 1 wherein the fuel is diesel fuel.
3. The composition of claim 1 wherein the diethyl succinate is 5 to 10 percent by weight of the fuel.
4. The composition of any one of claims 1, 2 or 3 wherein the fuel is substantially free of contaminants which cause pollution.
5. A method for increasing combustion of a fuel to water and carbon dioxide, and reducing particulates from the combustion, which comprises:
   providing a composition which comprises a liquid hydrocarbon as the fuel and between 0.1 and 30 percent by weight of diethyl succinate as a primary organic oxygenation source to run the engine so as to increase the combustion and reduce the particulates from the combustion.
6. The method of claim 5 wherein the fuel is diesel fuel.
7. The method of claim 5 wherein the diesel fuel is 5 to 10 percent by weight of the fuel.
8. The method of any one of claims 5, 6 or 7 wherein the fuel is substantially free of contaminants which cause pollution.
9. The composition of any one of claims 1, 2 or 3 wherein the diethyl succinate is the sole organic oxygenation source for the fuel.
10. The method of any one of claims 5, 6 or 7 wherein the diethyl succinate is the sole organic oxygenation source for the fuel.

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