FUEL, SYSTEM AND METHOD

Technical Field

The present disclosure relates to fuels, for example to hydrocarbon fuels which are useable as a replacement for conventional Diesel fuel and petrol fuels. Moreover, the present disclosure also relates to combustion systems for utilising aforesaid fuels, for example to combustion systems including internal combustion engines. Moreover, the present disclosure is also concerned with methods of combusting fuels in aforementioned systems.

Background

Combustion systems such as internal combustion engines are well known. In such combustion systems, combustible hydrocarbon fuels, typically petrol fuel (gasoline) or diesel fuel, are oxidized by air to generate hot gases that are used to generate mechanical power, for example for vehicles powered by spark-ignition engines or compression-ignition engines. However, such combustion in air generates as by-products carbonaceous soot particles and Nitrogen oxides (NO_x). Several innovations have been devised in recent years to reduce and/or filter such soot particles and Nitrogen oxides (NO_x) in exhaust gases generated in operation from combustion systems.

Contemporary combustion fuels are derived, namely manufactured, from geological fossil reserves. Such contemporary fuels include heavy oils, Diesel fuel, kerosene and petrol. Moreover, such fossil reserves are of finite capacity and are being gradually exhausted, as the present World consumption of oil and gas is in an order of 100 millions barrels of oil equivalent per annum. More recently, there is a growing interest in biofuels derived from contemporary biota, and therefore potentially more sustainable. The use of biofuel as a motor fuel has been already studied in detail since the 20th Century. Biofuels, in contradistinction to conventional fossil-reserve-derived fuels, are used as a motor fuel, or an addition to basic fossil-reserve-derived fuel, in many countries, such as Brazil, Germany, Sweden and USA [1]. Technologies have been developed for producing motor fuels including plain ethanol, as well as its blends with regular gasoline and diesel fuel to be used in internal combustion engines. Significant innovations relating to alternative fuels are described in published patent documents W02009/106647, US5, 628, 805 and DE10339355.

In a European patent document EP011619781 (proprietor: AECI Ltd.; inventor Stiff), there is described a fuel additive comprising a mixture of a first component A, and second component B, wherein the first component A is at least one alcohol with a molecular weight of less than 160, and wherein the second component B is at least one organic compound of the formula

NO_2-O-(CH_2CH_2-O-)$_x$-NO_2 Eq. 1

wherein x is an integer greater than 3, and wherein the average molecular weight of at least one compound of the formula described in Equation 1 (Eq. 1) is in a range of 260 to about 390, with a proviso that no other compounds of formula described in Equation 1 are present.

Optionally, the fuel additive is added to a fuel such as ethanol and/or methanol to provide a mixture which can be combusted in combustion engines, for example in cylinder-based internal combustion engines. The additive is capable of improving fuel ignition in cylinder-based internal combustion engines, for example at lower temperatures when such engines are started and their respective engine blocks are cold.

Over recent years, many different fuel additives have been developed. An example of a contemporary fuel additive is known as "Avocet", "Avocet' is a trademark.

In the mid-1980's, a South African chemicals group, AECI, introduced a *"green innovation"* in the area of fuels, namely "Encetal"; *"Encetal"* is a trademark. Encetal was developed for purposes of seeking to increase a local consumption of methanol produced from local coal feedstock, which could be used as an alternative to imported oil for fuels.

"Encetal, the name of the fuel mixture of Methanol and Avocet, burns cleanly, producing low amounts of pollutant gases (Nitrous Oxide and Carbon Monoxide) and particulates in a vehicle's exhaust. Moreover, Avocet is an ignition improver to allow methanol fuel to be used in diesel engines, requiring a minimum of engine modifications to accommodate its use.

Avocet has been employed in several tests using alcohols as biofuels, to substitute for fossil-reserve-derived diesel fuel in private and public transportation vehicles. In the mid-1990s, ethanol containing Avocet at a concentration in a range of 2% to 10% by volume as an ignition enhancer was tested in a small controlled group of public transport vehicles

[1]. Theory predicts a significantly higher volume consumption of ethanol, in comparison to diesel fuel, but the exact higher volume has to be calculated for each case, since it depends on the specific characteristics of the vehicle (e.g. operating temperature) and the detailed composition of the fuel itself. It was found from the tests that the use of ethanol-Avocet fuel consumed 84% more per volume, which both negatively compensated for an initial economic argument as well as presented a new significant logistic challenge of transporting 84% more fuel by volume.

Moreover, the use of alcohols in existing diesel engines also requires some modifications to be made to engine components to prevent chemical degradation due to exposure to alcohols. Further improvements in engine operation, temperature and catalysts are needed in preparation for the use of ethanol and other alcohols as a replacement for diesel fuel. As far as economic arguments are concerned, a reduction in the use of Avocet, which represents a significant proportion of the costs, potentially makes combustion systems cheaper, namely potentially sufficiently cheaper to compensate for the comparative ratio Alcohol/diesel; as above, ethanol is taken as the reference, ethanol/diesel = 1.84.

An initial economic argument for using the Avocet-enhanced methanol fuel as a diesel replacement was based on an average 25% cost savings when comparing the same volume of methanol to diesel fuel. Meanwhile, environmental arguments pointed out less particulate emissions and less smokiness of such Avocet-enhanced methanol fuel. However, in the early 1990's, the use of Avocet as an ignition improver or as a fuel enhancer was been deemed impracticable and/or too expensive for regular automobiles and other road vehicles by the parent company ICI-UK (Imperial Chemical Industries UK was the holding company of the group that owned AECI). This conclusion was reached, in part, due to the lack of commercial drive for environmentally friendly fuels, when the additive has been introduced in the early 1980s. Since then, there has been little activity in this area of work.

Although the composition of Avocet is proprietary, and may have varied over time, the composition of the original Avocet additive includes following components as provided in Table 1:

Table 1: Original Avocet composition

Component part	Percentage composition
PEG (PolyEthyleneGiycol) dinitrate	Circa 75% to 90%
Methanol	Circa 10% to 25%
Lubricity additive	1.5%
Antioxidant	0.1%

However, as aforementioned, Avocet is prohibitively expensive for use in many contemporary combustion systems, which has unfortunately limited its general use.

Additives are also employed in exhaust systems of vehicles, for example for reducing emissions of NOx components in exhaust gases emitted from exhaust systems associated with internal combustion engines. A well-known contemporary additive for this purpose of reducing NO_x emissions is *"AdBlue"*, which is the registered trademark for AUS32, or Aqueous Urea Solution 32.5% that is used with the Selective Catalytic Reduction system (SCR) to reduce emissions of oxides of Nitrogen from the exhaust of UK diesel vehicles. AdBlue is a 32.5% solution of high-purity urea in de-mineralized water that is clear, non-toxic and safe to handle. It is non-explosive, non-flammable, nor harmful to the environment. AdBlue is classified under a minimum risk category of transportable fluids. However, AdBlue is not a fuel, nor a fuel additive, and needs to be supplied from a dedicated tank in heavy-duty vehicles, for example trucks and buses. The dedicated tank is replenished with AdBlue in a similar manner to refuelling diesel into heavy-duty vehicles. In an event that AdBlue is accidently spilt on human skin, it can be simply washed off with water, and presents no great hazard.

However, as aforementioned, Avocet is a fuel additive and is prohibitively expensive for use in many contemporary combustion systems, which has unfortunately limited its general use. There is therefore a need for alternative additives which, when added to fuel, are able to enhance combustion properties of the fuel.

In a patent document W0201202164A1, there is disclosed using various additives to diesel fuel. The document mentions Ammonium Nitrate (AN) as an example of compounds to be potentially used as an additive to diesel. In this case, AN is described as being emulsified

in diesel. There is no mention of its use as a cetane enhancement of employed AN in methanol.

Currently the accepted knowledge is that an additive based in PEG dinitrate is the only proven ignition improver for alcohols.

Summary

The present disclosure seeks to provide an alcohol-based fuel for use in combustion engines.

Moreover, the present disclosure seeks to provide an improved method of manufacturing the aforementioned alcohol-based fuel.

According to a first aspect, there is provided an alcohol-based fuel for use in internal combustion engines, wherein the alcohol-based fuel includes a mixture of:

- at least one alcohol,
- at least one ignition-improver additive comprising dimethylether (DME),
-at least one lubricity agent comprising polyethylene glycol, synthetic esters, hydroxyesters and/or fatty acids,
- at least one anti-corrosion agent comprising at least one of the additives based on zinc dithiophosphates and/or calcium nitrates or organic amines,
- a cetane enhancer comprising Ammonium Nitrate (AN), wherein the AN is included in a concentration in a range of 0.5% to 20% by weight with respect to the at least one alcohol, and
-water, wherein, the water is included in a quantity which renders the AN dissolved in the at least one alcohol,

wherein the AN and water solution is mixed in the at least one alcohol to allow a ratio of the AN relative to at least one alcohol to be in a range of 0.5% to 20% by weight with respect to the at least one alcohol.

Optionally, the dimethylether (DME) is preferably added in a concentration in a range of 0.1% to 5% by weight with respect to the alcohol. More optionally, the DME is included in a concentration in a range of 0.1% to 3% by weight with respect to the alcohol. Dimethylether (DME) is produced by dehydration of methanol over a preferred catalyst, and is an additive independent of petroleum. For example, DME is soluble in methanol and water, and thus preferably mixed directly into the fuel without the need of

emulsification. The chemical formula of DME does not contain Carbon-Carbon bonds, which significantly reduces the possibility of formation of particulate impurities when compared to other commonly used additives, for example Avocet. Further advantages include the possibility of using DME in any engine tuned to be run with methanol as a fuel, wherein no extra modifications in this type of engine are needed.

The present invention is of advantage in that the fuel is economical to manufacture and results in a clean burn reaction within combustion engines. All fuel components are inexpensive and widely available and in large scale production allowing for easy adaptation in the market and efficient distribution.

The fuel is capable of being employed as a substitute fuel in various types of engine systems, although ratios of its constituent components are optionally varied depending upon intended uses.

Optionally, in the alcohol-based fuel, the AN is included in a concentration having a range of 1% to 10% by weight with respect to the alcohol.

Optionally, in the alcohol-based fuel, at least one alcohol includes methanol. Optionally, the methanol is manufactured from biological waste material, biota material, ~~algea~~ algae culture and similar.

According to a second aspect, there is provided a method of producing an alcohol-based fuel for use in internal combustion engines, wherein the method includes producing a mixture of:

- at least one alcohol,
- at least one ignition-improver additive comprising dimethylether (DME),
- at least one lubricity agent comprising polyethylene glycol, synthetic esters, hydroxyesters and/or fatty acids,
- at least one anti-corrosion agent comprising at least one of the additives based on zinc dithiophosphates and/or calcium nitrates or organic amines,
- a cetane enhancer comprising Ammonium Nitrate(AN),

wherein the AN is included in a concentration in a range of 0.5% to 20% by weight with respect to the at least one alcohol, and

- water, wherein the water is included in a quantity which renders the AN dissolved in the at least one alcohol,

wherein the AN and water solution is mixed in the at least one alcohol to allow a ratio of the AN relative to the at least one alcohol to be in a range of 0.5% to 20% by weight with respect to the at least one alcohol.

Optionally, in the method, at least one alcohol includes methanol.

Optionally, the method includes mixing the AN and water solution in methanol to allow the AN/methanol ratio in a range of 5% to 20% by weight with respect to the alcohol.

It will be appreciated that features of the invention are susceptible to being combined in various combinations without departing from the scope of the invention as defined by the appended claims.

Description of the diagrams

Embodiments of the present disclosure will now be described, by way of example only, with reference to the following diagrams wherein:
FIG. 1 is an illustration of components of a fuel pursuant to the present disclosure applied to spark-ignited engines; and
FIG. 2 is an illustration of components of a fuel pursuant to the present disclosure applied to combustion engines.

Description of embodiments of the disclosure

In overview, the present disclosure is concerned with a fuel for a combustion system, for example a cylinder combustion engine or a combustion turbine engine, wherein a mixture of air, a fuel and an additive are burned, wherein a quantity of the additive employed is optionally controlled, as a function of one or more operating parameters of the combustion system, for example engine block temperature. Moreover, the present disclosure is also concerned with the combustion system.

The environmental benefits of using an alcohol, as a replacement for diesel fuel, have been well established in prior-art, since a combustion system employing such alcohol as a fuel produces lower amounts of pollutant gases and particulates in a vehicle's exhaust in comparison to fuels such as petrol and diesel fuel. Moreover, in recent years, governments and society in general have been increasingly applying pressure on companies to adopt more environmentally friendly alternatives. Therefore, as the intrinsic

environmental benefits of using alcohols as a running fuel of contemporary vehicles are well-accepted and understood, it is clear from the foregoing that improving the economic efficiency of the use of alcohols as alternative fuels is a key problem to be resolved.

In overview, the present disclosure is concerned with an improved fuel which is based upon an alcohol, for example ethanol and/or methanol, which is economical in use, and which can be used as a substitute for conventional fossil-reserve-derived fuels. When aforementioned fuel additives such as Avocet are employed, for example mixed with methanol to provide a substitute for diesel fuel, a problem arising is that the Avocet is prohibitively expensive, rendering such substitutes for engine fuel to be potentially uneconomical.

In the present disclosure, there is proposed an alcohol-based fuel which is used to fuel vehicles powered by compression-ignition (diesel family), spark-ignition engines, or other suitable hybrid engines. The fuel includes adding an ignition-improver additive, preferably, dimethylether (DME), at least one lubricity agent and at least one anti-corrosion agent. The present disclosure proposes the addition of an optional cetane enhancer additive, preferably ammonium nitrate (AN) which is an alternative additive as a substitute for PEG-based and/or Avocet additives that allows alcohols to be used as an improved fuel in existing compression-ignition engines.

Dimethylether (DME) and other compounds with relatively high vapour pressures, including low-boiling point ethers, namely diethyl ether or methyl ethyl ether are suitable compounds to be employed as ignition-improver additive, particularly to enhance the cold-start of spark-ignited engines.

Dimethylether (DME) additive is inexpensive and readily available in large-scale. It provides several benefits to the engine operation, which includes enhancing the cold-start of spark-ignited engines. The DME additive is to be utilised range of 0.1-3% by weight. For its utilisation as an additive to a methanol-based fuel, Dimethylether has the following favourable characteristics:

a) It is inexpensive, widely available and in large scale production

b) It is miscible with methanol

c) It is derived efficiently from methanol by dehydration over an alumina catalyst, and, as such, is independent of petroleum.

d) It is a chemical with no C-C bonds, thus significantly decreasing the chance of formation of particulate impurities

e) Engines tuned to be run with methanol-based fuels are also capable of running with DME as an additive without extra modifications.

f) It has a high vapour pressure at ambient temperatures, so enabling facile starting of alcohol fuelled SI engines.

Methanol modified in the way proposed in the present disclosure enables the full benefits of dedicated methanol SI engines to be realised. These benefits include low emissions coupled with the high fuel efficiency and high-power output resulting from increased compression ratios made possible by methanol's high octane value.

The optional cetane enhancer additive ammonium nitrate (AN) is known to be an explosive material. Moreover, Ammonium Nitrate has been hitherto perceived to be unsuitable for use as an additive, because it is not soluble in alcohols, for example in methanol. However, pursuant to embodiments of the present disclosure, Ammonium nitrate (AN) has a significant potential as a cetane enhancer for alcohols, such as aforesaid methanol. The cetane enhancement capability effectively allows AN to be used as an ignition improver for such alcohol fuels. Ammonium Nitrate is, for example, manufactured in large quantities, for example for use in agriculture to replenish soil after crops have been grown which have a high fixed nitrogen requirement, for example grain crops, beans and so forth.

There is therefore disclosed an embodiment of the present disclosure, wherein DEM and/or AN are/is employed as ignition improver for methanol and/or another alcohol. AN is not directly soluble in methanol, for example, but both methanol and AN are soluble in water. Therefore, there is disclosed a fuel including a mixture of an alcohol, for example ethanol and/or methanol, water, at least one lubricity agent and at least one anti-corrosion agent. Optionally, DME and a cetane enhancer based on AN are also added. Such a fuel is beneficially optionally manufactured using a method including:

(i) Mixing methanol, DME and AN to a desired concentration, for example in a range of 1% to 5% AN relative to methanol; and 0.1 to 3% DME relative to methanol;

(ii) During mixing in (i), adding enough water so that AN becomes dissolvable in the methanol-water-DME mix.

In step (i) of the method, the range in which AN needs to be added is defined by a ratio N/C (namely, Nitrogen to Carbon), wherein Nitrogen atoms come from the AN additive and Carbon atoms, mostly, comes from the fuel, for example methanol. In contradistinction, in a case of PEG dinitrate, there is a Nitrogen to Carbon N:C = 20:1 is a typically required ratio. However, the values may vary depending on requirements of engine design and operating temperature.

In step (ii) of the method, water needs to be added to an extent that renders the required amount of AN soluble in the mixture, namely:

Enhanced fuel = Methanol + water + DME + AN Eq.2

Such a mixture of water, AN and methanol is of advantage in that it can be easily stored over a long-term period without separating out into individual component parts, and does not form an emulsion and does not need to be emulsified. Beneficially, as aforementioned, the fuel in Equation 2 (Eq. 2) includes at least one lubricity agent, to provide a versatile fuel for use in for compression-ignition engines.

The enhanced fuel pursuant to Equation 2 is considerably cheaper than known fuel substitutes based upon methanol, for example employing Avocet, and also is very clean when burnt in an internal combustion engine, for example results in very low soot production and low NO_x production. Moreover, the enhanced fuel pursuant to Equation 2 potentially avoids a need to employ AdBlue in exhaust systems of vehicles.

Methanol can be generated from a wide variety of sources, for example from fermenting biological waste, from processing wood by-products, from fossil fuel reserves, from coal, from coal liquefaction, from hydrates and so forth; *mutatis mutandis* ethanol is similarly derivable.

In recent years, current environmental laws and society pressure have placed less emphasis on economics of fuels, and more on environmental gains. Nevertheless, an additive that costs less, and makes an overall combustion process in internal combustion engines more efficient will increase economic benefits, which associated to intrinsic environmental gains, makes alcohol once more an attractive alternative to diesel fuel from a commercial perspective.

Embodiments of the present disclosure are concerned with an introduction of a new additive which increases the efficiency of a given fuel, for example a methanol-based fuel, by acting as a cetane enhancer. The new additive provides at least one of following benefits:

(a) the new additive allows methanol to act a direct replacement for many types of conventional fossil-reserve-derived fuel;

(b) the new additive is non-explosive, and this less hazardous in use; and

(c) the new additive has a potential for application in a wide range of combustion engines.

“Cetane" is a measure of an ignition quality of a given combustion hydrocarbon fuel for example a diesel fuel. The higher the cetane measure of a given diesel fuel, the easier it is to start a standard (direct injection) diesel engine using the given diesel fuel. The cetane measure is defined by a percentage, by volume, of cetane, with a chemical name *"hexadecane"*, in a combustion mixture, containing cetane and 1- methylnapthalene, whose ignition characteristics match those of a given diesel fuel being tested. Comparisons with other additives and fuels can be made by way of "equivalent cetane measure", for example as employed when describing embodiments of the present disclosure.

Further benefits of the enhanced fuel in Equation 2 include:

(a) The method allows Ammonium Nitrate to be used as cetane enhancer for methanol or similar alcohols, in turn allowing the fuel to be used in existing compression-ignition engines with minimal modifications;

(b) The addition of water keeps an engine burning the fuel of Equation 2 cool (due to a high latent heat of evaporation of water), thereby decreasing a need for cooling systems, thus making the vehicle more energy efficient;

(c) Lower particulate emission from engines burning the enhanced fuel of Equation 2, namely lower particulate emission than achievable by employing other methods, for example using exhaust filters, using AdBlue spraying in exhaust systems and so forth;

(d) Environmentally friendly, since the N-groups in AN are released as N_2 gas at the end of a burn cycle in a combustion engine;

(e) The enhanced fuel of Equation 2 results in a significant reduction in cost in comparison to PEG-dinitrate-based additives, namely AN cost approximately 1/10th of PEG-based additives.

Embodiments of the present disclosure provide benefits in direct injection combustion engines, and are also capable of providing cost reduction. Such cost reduction here is based on two factors:

(i) cost reduction due to the direct injection; and

(ii) cost reduction due to the use of AN instead of PEG-dinitrate or Octyl nitrate based additives.

In respect of the use of ammonium nitrate (AN) as additive for methanol, Ammonium nitrate (AN) has a significant potential as a cetane enhancer for alcohols such as methanol, as aforementioned. The cetane enhancement capability effectively allows AN to be used as an ignition improver for such alcohol fuels, which allows these fuels to be used as direct replacement for known convention combustible fuels.

The addition of water keeps the engine cool, on account of the high latent heat of evaporation of water, thereby decreasing the need for cooling systems, thus making a vehicle operating from aforementioned fuel pursuant to the present disclosure more energy efficient. Moreover, the fuel pursuant to the present disclosure is capable of lowering the particulate emission in comparison to traditional fuel additives. Furthermore, the fuel pursuant to the present disclosure is also capable of resulting in operating cost reduction aspect, for example compared to PEG-dinitrate based additives; AN cost approximately 1/10th of PEG-based additives.

Current European diesel trucks are fitted with a small urea tank, which is beneficially optionally used as the reservoir for the Ammonium Nitrate (AN), while petrol engines do not need such an addition.

Ammonium Nitrate (AN) has a great potential to be used as an ignition improver - cetane enhancement for methanol (or another alcohol). This present disclosure relates to the use of an aqueous solution of ammonium nitrate as an ignition improver directly injected into the engine cylinder.

With respect to diesel engines, the present disclosure provides a direct competitor to Octyl Nitrate, which is a currently favoured substance for improving the cetane number of lower grade diesel fuels. The addition of enough water to Ammonium Nitrate (AN) is capable of making this compound soluble in alcohol-based fuels, such as methanol. In turn, this potentially allows for the use of methanol, or another alcohol, in place of diesel fuel in current modern diesel engines. Moreover, modern diesel engines are required to be fitted with tanks containing an aqueous solution of urea, which in turn, are optionally used as a reservoir for the AN solution prior to injection.

In the case of modern diesel engine, the AN solution is beneficially injected in concentrations which vary in a range of 5% to 20% by weight with respect to the alcohol. The composition of an alcohol-based fuel, preferably methanol, with the additions of the AN solution in the range specified and a lubricity agent could be potentially used without adjustment in combustion engines, leading to the concept of a versatile fuel.

If the AN is injected as described above, then the fuel can be any substance suitable for use, for example, as a diesel fuel. The fuel can be used directly in spark-ignited petrol engines. For economic, safety, transport and environmental reasons, methanol has a unique capacity to provide this capability.

A fuel is disclosed for use in internal combustion engines, wherein the fuel includes a mixture of at least one alcohol, water, at least one lubricity agent and at least one anticorrosion agent; optionally, Ammonium Nitrate (AN) is added as a cetane-enhancer. Optionally, the water is included in a quantity which renders the AN dissolved in the at least one alcohol. Optionally, the AN is included in a concentration having a range of 0.5% to 10% by weight with respect to the alcohol; more optionally, the AN is included in a concentration having a range of 1% to 5% by weight with respect to the alcohol. Optionally, the at least one alcohol includes methanol.

The fuel is capable of being employed via a direct injection of the fuel, in a form of an aqueous solution, into engine cylinders. The aqueous solution includes AN and water, which acts as an ignition improver via cetane enhancement of the fuel used. Beneficially, the fuel includes an alcohol, preferably methanol, with an added lubricity agent and, optionally, an anti-corrosion agent, and is to be regarded as a versatile fuel to be used in a wide range of combustion engines.

Optionally, the AN and water solution is beneficially mixed in methanol to allow the AN/methanol ratio in be in a range of 5% to 20% by weight with respect to the alcohol. A cost reduction with respect to the use of PEG-dinitrate or Octyl Nitrate based additives is achievable. Optionally, water-soluble compounds such as hydrazine and hydroxylamine nitrates are used and potentially provide similar technical benefits, although their cost is greater than that of AN.

Optionally, the fuel is used by way of direct injection of additive into a given cylinder of a combustion engine. Modern diesel engines are required to be fitted with tanks containing an aqueous solution of urea; this same tank is beneficially made available to contain the AN solution prior to injection, provided that the injection line is modified to inject the additive solution directly into the engine cylinder. Modern engines with computer-based fuel injection management systems, under software control, are capable of using fuels pursuant to the present disclosure.

Ammonium nitrate (AN) is beneficially employed in embodiments of the present disclosure, for example with reference to FIG. 1 and FIG. 2, as a directly-injected cetane improver. An aqueous solution of AN is beneficially directly injected into a cylinder of a combustion engine to function as a cetane enhancer. Optionally, in such an engine, two injectors are employed for each cylinder of the combustion engine, namely a fuel injection and an AN solution injection. Thus, use of aqueous AN injection as a cetane enhancer enables fuel neutral operation to be achieved, namely applicable for both diesel fuel and alcohol-based fuels.

Embodiments of the present disclosure provide a versatile fuel, for example a mixture of methanol, a lubricity additive and at least one antioxidant. Such a versatile fuel is susceptible to being employed in spark-ignition engines. Injection of AN enables the versatile fuel to be employed in compression-ignition engines.

Modifications to embodiments of the invention described in the foregoing are possible without departing from the scope of the invention as defined by the accompanying claims. Expressions such as "including", "comprising", "incorporating", "consisting of", "have", "is" used to describe and claim the present invention are intended to be construed in a non-exclusive manner, namely allowing for items, components or elements not explicitly described also to be present. Reference to the singular is also to be construed to relate to

the plural. Numerals included within parentheses in the accompanying claims are intended to assist understanding of the claims and should not be construed in any way to limit subject matter claimed by these claims.

Reference literature

[1] Gaouyer, J. P.: "*What has happened in Europe in the Biofuels Domain over the last two years?"* Proceedings 2nd European Motor Biofuels Forum, Graz, p. 37 - 41, 1996.

CLAIMS

We claim:

1. An alcohol-based fuel for use in internal combustion engines, wherein the alcohol-based fuel includes a mixture of:

- at least one alcohol,
- at least one ignition-improver additive comprising dimethylether (DME),
- at least one lubricity agent comprising polyethylene glycol, synthetic esters, hydroxyesters and /or fatty acids,
- at least one anti-corrosion agent comprising at least one of the additives based on zinc dithiophosphates and/or calcium nitrates or organic amines,
- a cetane enhancer comprising Ammonium Nitrate (AN), wherein the AN is included in a concentration in a range of 0.5% to 20% by weight with respect to the at least one alcohol, and
- water, wherein, the water is included in a quantity which renders the AN dissolved in the at least one alcohol,

wherein the AN and water solution is mixed in the at least one alcohol to allow a ratio of the AN relative to at least one alcohol to be in a range of 0.5% to 20% by weight with respect to the at least one alcohol.

2. The alcohol-based fuel as claimed in claim 1, wherein the DME is included in a concentration in a range of 0.1% to 5% by weight with respect to the alcohol.

3. The alcohol-based fuel as claimed in claim 2, wherein the DME is included in a concentration in a range of 0.1% to 3% by weight with respect to the alcohol.

4. The alcohol-based fuel as claimed in claim 1, wherein the AN is included in a concentration having a range of 1% to 10% by weight with respect to the alcohol.~~5.~~

<u>5.</u> The alcohol-based fuel as claimed in claim 1, wherein the at least one alcohol includes methanol.

6. A method of producing an alcohol-based fuel for use in internal combustion engines, wherein the method includes producing a mixture of:

- at least one alcohol,
- at least one ignition-improver additive comprising dimethylether (DME),
- at least one lubricity agent comprising polyethylene glycol, synthetic esters, hydroxyesters and/or fatty acids,
- at least one anti-corrosion agent comprising at least one of the additives based on zinc dithiophosphates and/or calcium nitrates or organic amines,
- a cetane enhancer comprising Ammonium Nitrate(AN),

wherein the AN is included in a concentration in a range of 0.5% to 20% by weight with respect to the at least one alcohol, and

- water, wherein the water is included in a quantity which renders the AN dissolved in the at least one alcohol,

wherein the AN and water solution is mixed in the at least one alcohol to allow a ratio of the AN relative to the at least one alcohol to be in a range of 0.5% to 20% by weight with respect to the at least one alcohol.

7. The method as claimed in claim 6, wherein the at least one alcohol includes methanol.

8. The method as claimed in claim 6, wherein the method includes mixing the AN and water solution in methanol to allow the AN/methanol ratio in be in a range of 0.5% to 20% by weight.

ABSTRACT

A fuel is disclosed for use in internal combustion engines, wherein the fuel includes a mixture of at least one alcohol, water, an ignition-improver additive, preferably, dimethylether (DME), at least one lubricity agent and at least one anti-corrosion agent. Optionally, the fuel further includes a cetane enhancer, for example implemented using Ammonium Nitrate (AN). Optionally, the water is included in a quantity which renders the AN dissolved in the at least one alcohol. Optionally, the DME is included in the range of 0.5-3% by weight. More optionally, the AN is included in a concentration having a range of 0.5% to 10% by weight; more optionally, the AN is included in a concentration having a range of 1% to 5% by weight. Optionally, the at least one alcohol includes methanol.

The fuel is optionally capable of being employed via a direct injection of the fuel, in a form of an aqueous solution, into engine cylinders. The aqueous solution includes AN and water, which acts as an ignition improver via cetane enhancement of the fuel used. Optionally, the AN and water solution is beneficially mixed in methanol to allow the AN/methanol ratio in be in a range of 5% to 20% by weight. A cost reduction with respect to the use of PEG-dinitrate or Octyl Nitrate based additives is achievable.

FIG. 1 for the Abstract.