Aqueous emulsifier package with anionic surfactant for fuel emulsion

Description

The present invention relates to a method for powering a diesel engine with a fuel emulsion comprising the step of preparing the fuel emulsion by emulsifying a fuel and water in the presence of an emulsifier package which comprises an anionic surfactant selected from sulfates and sulfonates. It also relates to the emulsifier package for emulsifying a fuel and water; and to the fuel emulsion for powering a diesel engine.

Aqueous fuel emulsions are known for powering diesel engines.

Object of the present ~~invention~~disclosure was to find an emulsifier package for fuel emulsions, which is cheap, easy to prepare, storage stable, based on commercial available emulsifiers, based only on carbon, hydrogen, nitrogen and oxygen, and allow for fast and easy emulsification even with low shear forces. The emulsifier package should result in a low foaming fuel emulsion, it should have a low cloud point, provide corrosion protection, have low foaming, improve filterability of the emulsion, and reduce precipitate when mixing the fuel with water. The emulsifier package should stabilize the fuel emulsion at high water concentrations, at various temperatures and pressures, with various types of water.

The object was achieved by a method for powering a diesel engine with a fuel emulsion comprising the step of preparing the fuel emulsion by emulsifying a fuel and water in the presence of an emulsifier package which comprises an anionic surfactant selected from sulfates and sulfonates.

The object was also achieved by the emulsifier package for emulsifying a fuel and water comprising

- an anionic surfactant selected from sulfates and sulfonates, where the sulfate is selected from C_{6-22} alkyl sulfates and alkyl ether sulfates of the general formula R-O—$(CH_2CH_2O)_mSO_3$, in which R is a linear or branched alkyl and/or alkenyl radical having 6 to 22 carbon atoms and m is numbers from 1 to 10**,** and where the sulfonate is selected from di-(C_{8-10}) alkyl sulfosuccinates,
- at least two nonionic surfactants which are alkoxylates, where the alkoxylates are selected from alkoxylated alkanols, and
- water.

In an aspect, there is provided amethod for powering a diesel engine with a fuel emulsion comprising the step of preparing the fuel emulsion by emulsifying a fuel and water in the presence of an emulsifier package which comprises

- an anionic surfactant selected from sulfates and sulfonates and further comprises
- a nonionic surfactant which is an alkoxylated alkanol of the formula (I),

R^e-O-$(AO)_m$-R^f (I)

in which

R^e is straight-chain or branched alkyl or alkylene with from 1 to 32, preferably 4 to 32, more preferably from 10 to 22, carbon atoms,

AO is an ethylene oxide radical, propylene oxide radical, butylene oxide radical, pentylene oxide radical, styrene oxide radical or mixtures of the abovementioned radicals, e.g. in random or block sequence (wherein a diblock sequence is preferred),

m is numbers from 1 to 100, preferably 1 to 30, and

R^f is hydrogen or alkyl with from 1 to 4 carbon atoms, preferably hydrogen,

where the emulsifier package comprises a mixture of anionic surfactants, comprising

- at least one sulfate selected from C_{6-22} alkyl sulfates and
- at least one alkyl ether sulfate of the general formula R-O-$(CH_2CH_2O)_mSO_3$, in which R is a linear or branched alkyl and/or alkenyl radical having 6 to 22 carbon atoms and m is numbers from 1 to 10.

In another ~~embodiment~~ example, the object was achieved by an emulsifier package for emulsifying a fuel and water comprising

- a mixture of anionic surfactants, comprising at least one sulfate selected from C_{6-22} alkyl sulfates and at least one alkyl ether sulfate of the general formula R-O-$(CH_2CH_2O)_mSO_3$, in which R is a linear or branched alkyl and/or alkenyl radical having 6 to 22 carbon atoms and m is numbers from 1 to 10,
- at least one nonionic surfactant which is an alkoxylated alkanol, and
- water.

In another aspect, there is provided an emulsifier package for emulsifying a fuel and water comprising

- an anionic surfactant selected from sulfates and sulfonates, comprising
  - at least one sulfate selected from C_{6-22} alkyl sulfates and
  - at least one alkyl ether sulfate of the general formula R-O—$(CH_2CH_2O)_mSO_3$, in which R is a linear or branched alkyl and/or alkenyl radical having 6 to 22 carbon atoms and

m is numbers from 1 to 10, and where the sulfonate is selected from di-(C_{8-10}) alkyl sulfosuccinates,

- at least two nonionic surfactants which are alkoxylates, where the alkoxylates are selected from alkoxylated alkanols of the formula (I),

R^e-O-$(AO)_m$-R^f (I)

in which

R^e is straight-chain or branched alkyl or alkylene with from 1 to 32, preferably 4 to 32, more preferably from 10 to 22, carbon atoms,

AO is an ethylene oxide radical, propylene oxide radical, butylene oxide radical, pentylene oxide radical, styrene oxide radical or mixtures of the abovementioned radicals, e.g. in random or block sequence (wherein a diblock sequence is preferred),

m is numbers from 1 to 100, preferably 1 to 30, and

R^f is hydrogen or alkyl with from 1 to 4 carbon atoms, preferably hydrogen, and

- water.

In another aspect, there is provided an emulsifier package for emulsifying a fuel and water comprising

a mixture of anionic surfactants, comprising at least one sulfate selected from C_{6-22} alkyl sulfates and at least one alkyl ether sulfate of the general formula R-O-$(CH_2CH_2O)_mSO_3$, in which R is a linear or branched alkyl and/or alkenyl radical having 6 to 22 carbon atoms and m is numbers from 1 to 10,

at least one nonionic surfactant which is an alkoxylated alkanol, and

water.

In another aspect, ~~T~~the object was also achieved by the fuel emulsion for powering a diesel engine as defined above.

The **fuel** usually comprises hydrocarbons, such as alkanes, cycloalkanes and aromatics. The fuel may be obtained from petroleum distillation as distillate or residue. The fuels is usually a liquid fuel. Examples of fuels are gasoline, diesel or biodiesel or mixtures thereof, wherein gasoline or diesel are preferred. In particular the fuel is diesel. The gasoline may contain mainly C4 to C12 hydrocarbons of alkanes, alkenes and cycloalkanes. The diesel may contain saturated hydrocarbons and aromatic hydrocarbons. The biodiesel typically includes lower alkyl fatty acid esters, prepared, for example, by transesterifying trigycerides with lower alcohols, e.g. methanol or ethanol.

The viscosity of the fuel can vary in a broad range, such as in the range from 1 to 10,000 mm^2/s at 40 °C (ISO 3104) or 1 to 1000 mm^2/s at 50°C (ISO 3104).

The fuel may be a **marine fuel**, such as MGO (Marine gas oil), MDO (Marine diesel oil), IFO (Intermediate fuel oil), MFO (Marine fuel oil), or HFO (Heavy fuel oil). Further examples for marine fuel are IFO 380 (an Intermediate fuel oil with a maximum viscosity of 380 centistokes (<3.5% sulphur)), IFO 180 (an Intermediate fuel oil with a maximum viscosity of 180 centistokes (<3.5% sulphur)), LS 380 (a Low-sulphur (<1.0%) intermediate fuel oil with a maximum viscosity of 380 centistokes), LS 180 (a Low-sulphur (<1.0%) intermediate fuel oil with a maximum viscosity of 180 centistokes), LSMGO (a Low-sulphur (<0.1%) Marine Gas Oil, which is often be used in European Ports and Anchorages according to EU Sulphur directive 2005/33/EC), or ULSMGO (a Ultra-Low-Sulphur Marine Gas Oil, also referred to as Ultra-Low-Sulfur Diesel (sulphur 0.0015% max). Further suitable marine fuels are according to DIN ISO 8217 of the category ISO-F- DMX, DMA, DFA, DMZ, DFZ, or DFB, or ISO-F RMA, RMB, RMD, RME, RMG, or RMK. Further suitable marine fuel is distillate marine diesel or residual marine diesel.