Cold flow improver with broad applicability in mineral diesel, biodiesel and blends thereof

The present application relates to compositions comprising at least one polyalkyl(meth)acrylate polymer, a graft copolymer comprising a copolymer based on ethylene as graft base and one or more polyalkyl(meth)acrylate polymer(s) grafted thereon and at least one non-grafted ethylene-based copolymer, as well as the use of such compositions to improve the performance, especially the cold flow properties and injector nozzle coking tendency of middle distillates, especially diesel fuels, biodiesel and blends thereof.

Summary

Most fuels are nowadays typically obtained from fossil sources. However, these resources are limited, so that replacements are being sought. Therefore, interest is rising in renewable raw materials which can be used to produce fuels. A very prominent replacement is in particular biodiesel fuel.

At reduced temperatures mineral oils and biodiesel comprising waxes, such as middle distillates, diesel and heating oils, exhibit a significant deterioration in the flow properties. The cause of this lies in the crystallization of relatively long-chain n-paraffins or saturated fatty esters which occurs at and below the cloud point temperature, which forms large e.g. platelet-shaped wax crystals. These wax crystals like to build up card house structures or sponge-like structures and lead to incorporation of other fuel constituents in the crystal composite. The occurrence of these crystals leads rapidly to the clogging of fuel filters, both in tanks and in motor vehicles. At temperatures below the pour point (PP), flow of the fuel finally no longer takes place.

To alleviate these problems, fuel additives have already been added for some time to fuels in small concentrations, which frequently consist of combinations of nucleators for controlled formation of small crystals of the paraffins with the actual cold flow improvers (also known as CFIs or MDFIs). These in turn exhibit similar crystallization properties as the waxes of the fuel, but prevent their growth, such that passage through the filter is possible at significantly lower temperatures compared to the unadditized fuel. As a measure of this, the so-called cold filter plugging point (CFPP) is determined.

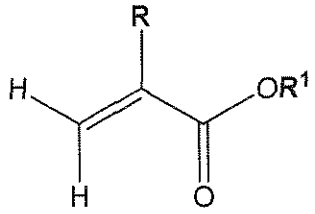
and robust performance window with regard to fuel blend composition and additive treat rate is desired.

It was surprisingly found that a composition, comprising at least one polyalkyl(meth)acrylate polymer, a graft polymer comprising a copolymer based on ethylene as graft base and one or more polyalkyl(meth)acrylates grafted thereon and at least one non-grafted ethylene-based copolymer having a low number average molecular weight, significantly reduced pour point (PP) and cold filter plugging point (CFPP) of mineral diesel, biodiesel and mixtures thereof better than either of the components alone or mixtures of only two of the components.

In an aspect, there is provided a composition comprising:

(A) at least one polyalkyl(meth)acrylate polymer composition comprising

(A1) at least one polymer comprising one or more ethylenically unsaturated compounds of general formula (I)



(I),

wherein

R is H or CH_3 and

$\mathbf{R^1}$ is a linear or branched, saturated or unsaturated alkyl group with 1 to 22 carbon atoms,

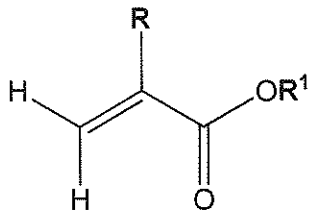
wherein the average carbon number of said alkyl group $\mathbf{R^1}$ throughout the molecule is 11-16 and in at least 60% by weight, based on the total amount of compounds of general formula (I) used, of the compounds of general formula (I) the residue $\mathbf{R^1}$ denotes an alkyl group with 12-18 carbon atoms, and

(A2) at least one diluent;

(B) at least one graft copolymer composition comprising

(B1) a copolymer based on ethylene as graft base, said graft base comprising 60 to 85% by weight of ethylene and 15 to 40% by weight of a compound selected from vinyl esters, acrylates, methacrylates and alpha-olefines, preferably vinyl acetate and vinyl propionate;

(B2) a polyalkyl(meth)acrylate polymer comprising one or more ethylenically unsaturated compounds of general formula (I)



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(B3) at least one diluent; and

(C) at least one ethylene-based copolymer composition comprising

(C1) 80 to 88 mol% of ethylene;

(C2) 12 to 20 mol% of one or more compound(s) selected from vinyl esters, acrylates, methacrylates and alpha-olefines, preferably vinyl acetate and acrylates, and

(C3) at least one diluent,

wherein the ethylene-based copolymer of composition (C) has a number average molecular weight M_n of 2000 to 10000 g/mol.

In another aspect, there is provided use of a composition as defined above for improving the cold flow properties of middle distillates, biodiesel and blends thereof.

In another aspect, there is provided use of the composition as defined above for lowering the pour point of middle distillates, biodiesel and blends thereof.

In another aspect, there is provided use of the composition as defined above for lowering the cold filter plugging point of middle distillates, biodiesel and blends thereof.

In another aspect, there is provided use of the composition as defined above to reduce the tendency of diesel injector nozzle fouling in combustion engines operated with middle distillates, especially diesel fuels, biodiesel and blends thereof.

In another aspect, there is provided a fuel oil composition comprising

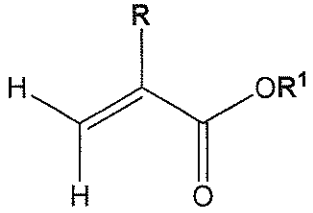
(a) 0.001 to 1% by weight, preferably 0.005 to 0.5% by weight, of the composition as defined above, based on the total amount of components (a), (b) and (c);

(b) 0 to 100% by weight, preferably 0 to 98% by weight, diesel fuel of mineral origin, based on the total amount of components (a), (b) and (c); and

(c) 0 to 100% by weight, preferably 2 to 100% by weight, biodiesel fuel, based on the total amount of components (a), (b) and (c).

In another aspect, there is provided a concentrate comprising

(A) at least one polyalkyl(meth)acrylate polymer comprising one or more ethylenically unsaturated compounds of general formula (I)



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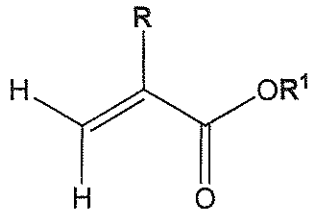
(B) at least one graft copolymer comprising

(B1) a copolymer based on ethylene as graft base, said graft base comprising 60 to 85% by weight of ethylene and 15 to 40% by weight of a compound selected from vinyl esters, acrylates, methacrylates and alpha-olefines, preferably vinyl acetate and vinyl propionate, and

(B2) a polyalkyl(meth)acrylate polymer comprising one or more ethylenically unsaturated compounds of general formula (I)



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(C) at least one ethylene-based copolymer having a number average molecular weight M_n of 2000 to 10000 g/mol comprising

(C1) 80 to 88 mol% of ethylene;

(C2) 12 to 20 mol% of one or more compound(s) selected from vinyl esters, acrylates, methacrylates and alpha-olefines, preferably vinyl acetate and acrylates;

(D) optionally one or more further fuel additives and

(E) one or more diluent(s).

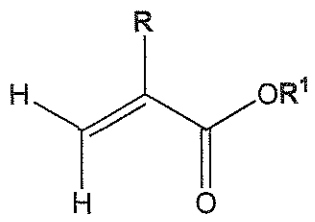
The present disclosure further allows improving cold flow properties of mineral fuel, biodiesel fuel and mixtures thereof with the same additive. The achievable CFPP and/or PP value is lower than with state-of-the-art products.

Detailed Description of the Invention

According to a first aspect of the invention, there is provided a composition comprising:

(A) at least one polyalkyl(meth)acrylate polymer composition comprising

(A1) *at least one polymer comprising one or more ethylenically unsaturated* compounds of general formula (I)



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