WO 2013/019704 A1 discloses a hydrocarbon flow improver comprising a branched dendritic core having at least 16 terminal hydroxyl groups and wherein at least one of the terminal hydroxyl groups is esterified with at least one carboxylic acid moiety comprising from 6 to 30 carbon atoms. The dendritic core comprises a quaternary carbon center. The document furthermore relates to a method of extracting hydrocarbon fluid from a well comprising the step of adding said fluid improver to the hydrocarbon fluid. WO 2015/070121 A1 discloses the use of the same product as asphaltene inhibitor.

Khadid I. Kabel et al., Research on Chemical Intermediates, 2015, 41 (1), 457-474, describe the synthesis and evaluation of PAMAM dendrimer and PDPF-*b*-POP block copolymer as asphaltene inhibitor/dispersant.

WO 2019/185401 A1 discloses modified hyperbranched polyesters and their use as wax inhibitor or as pour point depressant. The hyperbranched polyesters are synthesized in a 2-step reaction. In a first step, a hyperbranched polyester core is synthesized which comprises terminal OH-groups. In a second step, the terminal OH-groups are reacted with hydrophobic carboxylic acids, thereby obtaining a modified hyperbranched polyester comprising terminal hydrophobic groups. Suitable carboxylic acids preferably have the formula R-COOH, wherein R is a hydrocarbon moiety having at least 6, preferably at least 10 carbon atoms. The hydrocarbon groups may be linear saturated or linear unsaturated hydrocarbon groups or branched saturated or branched unsaturated hydrocarbon groups. It has also been suggested to use a mixture of linear, saturated aliphatic hydrocarbon groups with linear, aliphatic unsaturated hydrocarbon groups or a mixture of linear, saturated aliphatic hydrocarbon groups with branched, saturated aliphatic hydrocarbon groups.

WO 2020/231994 A1 discloses a method of adding a flow improver to petroleum fluids comprising a solvent and a dendrimer-based flow improver wherein the dendrimer core is modified with a mixture of saturated and unsaturated fatty acids. A mixture of saturated and unsaturated fatty acids yields products having a lower viscosity at low temperatures as compared to products for which only saturated fatty acids are used.

Summary

In one aspect, the present disclosure relates to hydrophobically modified, hyperbranched polyesters, obtainable by the following process:

(a) reacting a mixture comprising at least a polyol (A) comprising at least 3 hydroxy groups and a molecule (B) comprising one carboxylic acid group and at least two

hydroxy groups, by heating the mixture to a temperature of at least 100°C, wherein the molar ratio (B) : (A) is from 1000 : 1 to 10 : 1, thereby obtaining a hyperbranched polyester comprising terminal hydroxy groups; and

(b) Reacting the mixture obtained in course of step (a) with a mixture of monocarboxylic acids (D) by heating to a temperature of at least 100°C, thereby esterifying at least a part of the terminal OH-groups of the polyester obtained in course of step (a), wherein the monocarboxylic acids (D) comprise

(D1) at least one linear, saturated aliphatic carboxylic acid, wherein at least one of the carboxylic acids (D1) comprises at least 20 carbon atoms, and

(D2) at least one branched, saturated aliphatic carboxylic acid (D2) comprising at least 4 carbon atoms,

wherein the molar ratio (D1) : (D2) is from 1 : 2 to 15 : 1.

In another aspect, the disclosure furthermore relates to formulations comprising at least a hydrocarbon or a mixture of different hydrocarbons having a boiling point of at least 100°C, and a hydrophobically modified, hyperbranched polyester as described above.

Furthermore, the disclosure relates to the use of such hydrophobically modified, hyperbranched polyesters or formulations thereof, as pour-point depressant or wax inhibitor for crude oil.

In another aspect, there is provided the use of a hydrophobically modified, hyperbranched polyester as defined above as pour point depressant for crude oil by adding at least a hydrophobically modified, hyperbranched polyester as defined above to the crude oil.

In another aspect, there is provided the use of a hydrophobically modified, hyperbranched polyester as defined above as wax inhibitor for crude oil by adding at least a hydrophobically modified, hyperbranched polyester as defined above to the crude oil.

Figures:

Figure 1	Schematic representation of the structure of a hyperbranched polymer.
Figure 2	Summary of pour-point measurements in crude oil

With regard to the invention, the following can be stated specifically:

Hydrophobically modified, hyperbranched polyesters

The hydrophobically modified, hyperbranched polyesters according to the present invention are obtainable by a 2-step process comprising at least the process steps (a) and (b). In step (a), a hyperbranched polyester comprising terminal hydroxy groups is synthesized. In the second step (b), the terminal hydroxy groups are at least partly esterified with a mixture comprising linear and branched carboxylic acids, thereby obtaining a hydrophobically modified, hyperbranched polyester. The hydrophobically modified, hyperbranched polyesters