concentration of polymers. But this requires greater amounts of solvents, and so this solution must by its nature be more costly. Higher costs are also the result of changes in the infrastructure, for example heated conduits.

It was therefore an object of the embodiments disclosed herein to provide improved formulations of modified olefin-MA copolymers for use as pour point depressants for crude oils in high-boiling organic solvents. The formulations, at a concentration of about 20% by weight of copolymers – with essentially the same effect as a pour point depressant – were to have a lower solidification temperature than known formulations.

It has been found that, surprisingly, this can be achieved through minor changes in the polymer architecture.

Accordingly, in a first aspect, copolymers (X) have been found, comprising, as monomers, at least

(A) 40 to 60 mol%, based on the amount of all monomers, of at least one α-olefin (A) of the general formula $H_2C=CH-R^1$

where R^1 is at least one linear, cyclic or branched, aliphatic and/or aromatic hydrocarbyl radical having 14 to 50 carbon atoms, and

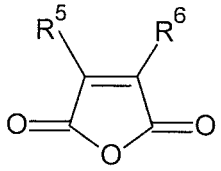
(B) 60 to 40 mol%, based on the amount of all monomers, of monoethylenically unsaturated dicarboxylic acids or derivatives thereof,

and wherein the monomers (B) are

(B1) at least one monomer $(R^2OOC)R^5C=CR^6(COOR^4)$,

(B2) at least one monomer $(R^3OOC)R^5C=CR^6(COOR^4)$ and

(B3) optionally at least one monomer selected from the group of $(HOOC)R^5C=CR^6(COOH)$ (B3a) and



(B3b)

where

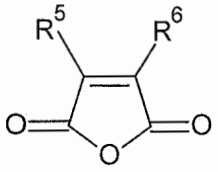
- R^2 is a linear alkyl radical having 16 to 36 carbon atoms,
- R^3 is a radical selected from the group consisting of
  - R^{3a}: linear 1-alkyl radicals having 1 to 10 carbon atoms,
  - R^{3b}: branched and/or secondary alkyl radicals having 4 to 36 carbon atoms,
  - R^{3c}: unsubstituted or alkyl-substituted, cyclic alkyl radicals having 5 to 18 carbon atoms, or
  - R^{3d}: unsubstituted or alkyl-substituted, aromatic hydrocarbyl radicals having 6 to 36 carbon atoms,
- R^4 in each case is a radical selected from the group of H, R^2 and R^3, with the proviso that at least 50 mol% of the R^4 radicals are H,
- R^5 and R^6 are each H or methyl,
- the proportion of the R^3 radicals based on the sum total of the R^2 and R^3 radicals is 1 mol% to 49 mol%,
- the proportion of the monomers (B1) + (B2) based on the sum total of all monomers (B) is at least 50 mol%, and
- the weight-average molecular weight M_w of the copolymers (X) is 2000 g/mol to 25 000 g/mol.

In an embodiment, a composition composed of the copolymer (X) described and organic solvents (Y), especially hydrocarbons having a flashpoint ≥ 60°C, has been found.

In another embodiment, a process for preparing copolymers (X) of this kind has been found, comprising at least the following process steps:

I) providing a polymeric reactant by polymerizing at least the following monomers:

- 40 to 60 mol%, based on the amount of all α-olefin monomers $H_2C=CH-R^1$ (A) used, where R^1 is at least one linear, cyclic or branched, aliphatic and/or aromatic hydrocarbyl radical having 14 to 50 carbon atoms, and
- 60 to 40 mol% of (B3b)



where R^5 and R^6 are as defined above,

where the number-average molecular weight M_n of the polymeric reactant is 1000 g/mol to 15 000 g/mol,

II) polymer-analogous esterification of the polymeric reactant provided in stage I at 130°C to 180°C with

- at least one alcohol R^2OH where R^2 is a linear alkyl radical having 18 to 36 carbon atoms, and
- at least one alcohol R^3OH, selected from the group of
  - $R^{3a}OH$ where R^{3a} represents linear 1-alkyl radicals having 1 to 10 carbon atoms,
  - $R^{3b}OH$ where R^{3b} represents branched and/or secondary alkyl radicals having 4 to 36 carbon atoms,
  - $R^{3c}OH$ where R^{3c} represents unsubstituted or alkyl-substituted, cyclic alkyl radicals having 5 to 18 carbon atoms, and
  - $R^{3d}OH$ where R^{3d} is an unsubstituted or alkyl-substituted aromatic hydrocarbyl radical having 6 to 36 carbon atoms,
- where the proportion of the alcohols R^3OH based on the sum total of the alcohols R^2OH and R^3OH is 1 mol% to 49 mol%, and
- the amount of the alcohols R^2OH and R^3OH used together is 0.5 to 1.5 mol/mol of (B3b).

In addition, copolymers (X) obtainable by means of the process described have been found.

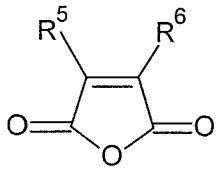
In another embodiment, the use of copolymers (X) of this kind as a pour point depressant for crude oil, mineral oil and/or mineral oil products, especially as a pour point depressant for crude oils and for avoidance of wax deposits on surfaces, has been found.

In another aspect, there is provided a process for preparing copolymers (X) as defined above, at least comprising the following process steps:

I) providing a polymeric reactant by polymerizing at least the following monomers:

- 40 to 60 mol%, based on the amount of all α-olefin monomers $H_2C=CH-R^1$ (A) used, where R^1 is at least one linear, cyclic or branched, aliphatic and/or aromatic hydrocarbyl radical having 14 to 50 carbon atoms, and

- 60 to 40 mol% of (B3b)



where R^5 and R^6 are as defined above,

where the number-average molecular weight M_n of the polymeric reactant is 1000 g/mol to 15 000 g/mol,

II) polymer-analogous esterification of the polymeric reactant provided in stage I at 130°C to 180°C with

- at least one alcohol R^2OH where R^2 is a linear alkyl radical having 18 to 36 carbon atoms, and
- at least one alcohol R^3OH, selected from the group of
  - $R^{3a}OH$ where R^{3a} represents linear 1-alkyl radicals having 1 to 10 carbon atoms,
  - $R^{3b}OH$ where R^{3b} represents branched and/or secondary alkyl radicals having 4 to 36 carbon atoms,
  - $R^{3c}OH$ where R^{3c} represents unsubstituted or alkyl-substituted, cyclic alkyl radicals having 5 to 18 carbon atoms, and
  - $R^{3d}OH$ where R^{3d} is an unsubstituted or alkyl-substituted aromatic hydrocarbyl radical having 6 to 36 carbon atoms,
- where the proportion of the alcohols R^3OH based on the sum total of the alcohols R^2OH and R^3OH is 1 mol% to 49 mol%, and
- the amount of the alcohols R^2OH and R^3OH used together is 0.5 to 1.5 mol/mol of (B3b).

In another aspect, there is provided a copolymer (X) obtainable by means of a process as defined above.

In another aspect, there is provided a composition comprising at least

- a copolymer (X) as defined above and
- at least one organic solvent (Y).

In another aspect, there is provided the use of copolymers (X) as defined above as pour point depressants for crude oil, mineral oil and/or mineral oil products, by adding at least one copolymer (X) as defined above to the crude oil, mineral oil and/or mineral oil products.

Specific details of the invention are as follows:

The inventive copolymers (X) have been formed from ethylenically unsaturated monomers. They comprise, as monomers, at least one α-olefin (A) and at least two different