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Area of the Invention

The invention relates to the use of co-oligomers
5 synthesised from (meth)acrylic acid esters and α -olefins
as synthesis oils in Tribology.

Prior art

The frequently extreme lubrication requirements of
10 modern machines have resulted in the development of
synthetic lubricants (synthesis oils) (cf. Ullmanns
Encyclopädie der Techn. Chemie, 4th ed., vol. 20, 503 -
530, Verlag Chemie 1981).

Conventional synthesis oils belong to different
15 classes of substances; apart from polyethers, esters (of
monobasic and polybasic carboxylic acids with mono-basic
and polybasic alcohols), phosphoric and phosphonic acid
esters, silicones, silicate esters, polyhalocarbons and
fluorinated esters, they include polyolefins and alkyl
20 aromatic substances.

Polymers obtained from α -olefins of different
origins, using different polymerisation methods, are of
particular interest. Because of their excellent VI and
pour-point values, the polymers of α -olefins having 8-12
25 C-atoms obtained, for example, by using Ziegler-
catalysts or ionic polymerisation catalysts, are
essential.

Mixtures of such α -olefin oligomers with ester oils
are said to have a relatively high compatibility with
30 rubber materials. A further advantage is said to be the
better miscibility of the olefin oligomer/ester mixtures
with polar additives, compared to the pure components.
Cooligomers and copolymers of α -olefins with
(meth)acrylic acid esters have become of interest to
35 industry as mineral oil additives. Compared to the pure
polymethacrylate polymers which have been used for a
long time, the thermostability of the additives is
greatly improved because of the α -olefin incorporated

therein.

US-A 4 419 106 discloses oil preparations which contain a hydrocarbon oil and an amount of a pour-point depressant consisting of a copolymer of about 10 to 90 wt.% of alkyl acrylate units containing 8 to 20 alkyl C-atoms, and 90 to 10 wt.% of α -monoolefin units with 12 to 40 C-atoms per 100 wt.% of copolymer having a molecular weight Mw of 1,000 to 100,000.

US-A 3 968 148 and DE-A 22 43 064 disclose, for example, oligomers of this type which are synthesised from three monomer groups and are used as VI improvers. These are oligomers consisting of:
about 10 to 90 wt.% of a 1-alkene having 4 to 32 C-atoms
about 1 to 35 wt.% of one or more alkyl(meth)acrylic acid esters having 8 to 34 carbon atoms in the alkyl group and
about 1 to 35 wt.% of one or more alkyl esters of (meth)acrylic acid or homologous, terminally unsaturated carboxylic acids having 1 to 4 carbon atoms in the alkyl group.

The molecular weight $\bar{M}_n$ of such oligomers is preferably 1,000 to 4,000. Special mention is made of the narrow molecular weight range achieved and the high uniformity of the products.

Furthermore, US-A 4 009 195 discloses an oligomerisation process in which, in addition to (meth)acrylic acid esters of C8-C34 alkanols added in amounts of 1 to 45 wt.%, various (meth)acrylic acid derivatives such as C1-C4 alkyl esters are, in amounts of 1 to 35 wt.%, continuously and simultaneously added to a mixture of radical initiators and 10 to 90 wt.% of 1-alkenes having 4 to 32 carbon atoms in such a way that the molar ratio between acid derivatives and 1-alkene in the reaction, which occurs more or less immediately, is kept relatively constant within the range of 0.001 to 0.2. The admixture must be added at a temperature which

does not interfere with the oligomerisation process.

US-A 3 994 958 is based on the same priority application as the above US document. Here, an oligomer, the composition of which was disclosed by the above US document, is subsequently reacted with an alkylene diamine in order to obtain VI improvers effecting dispersion.

Furthermore, DE-A 32 23 694 discloses copolymers of α, β -unsaturated dicarboxylic acid esters with α -olefins. By definition, α, β -unsaturated dicarboxylic acid esters contain straight-chained or branched mono alcohols having 3 to 10 carbon atoms as the alcohol component; the α -olefins have 10 to 16 carbon atoms. The copolymers may, optionally, be cross-linked and their pour-point should be between -60 and 0°C .

Copolymers with a content of isocyanate groups in the molecular weight range of 500 to 10,000 may be prepared by solution polymerisation of C1-C20 alkyl esters of (meth)acrylic acid and olefins with 1-alkenyl isocyanates (cf. DE-A 32 45 298). US-A 4 526 950 discloses a process for preparing copolymers, in which the mixture of components based on at least 1 α -olefin having at least 6 carbon atoms, and at least one unsaturated carboxylic acid and derivatives, copolymerisable with olefins, is heated to at least 135°C , in the presence of a radical initiator and in the absence of solvents or diluents, whilst none of the reactive monomers are used in excess, in order to avoid a thinning effect. Furthermore, copolymers of decylmethacrylate and tetradecene having a molecular weight of 8,000 to 13,000 are disclosed as lubricating oil thickening agents by SU-A 1 135 752.

Oil additives based on ethylene copolymers and the like with ethylenically unsaturated mono or dicarboxylic acids or the esters thereof which have a molecular weight M_n of $< 1,000$ are known from EP-A 217 602.

Object and Solution

It is apparent from the above prior art that a relatively large amount of attention has been given to the class of methacrylate α -olefin copolymers and their use as mineral oil additives. This class of compounds, however, has so far had no direct technological connection with the known "synthesis oils".

Prior art synthesis oils are normally synthesised from hydrocarbons such as oligomers of 1-decene and/or esters such as dicarboxylic acid esters (cf. Ullmanns Encyclopädie der Techn. Chemie, 4th ed., vol. 20, 503 - 530, Verlag Chemie 1981).

But both classes of substances used have disadvantages. Because of their non-polar structure, the polyolefins have too low a solubility when intended for use in conjunction with polar components, for example high-pressure (EP) additives.

It is known that because of their polar structure, the esters have great disadvantages such as problems of miscibility with mineral oils and base oils not based on mineral oils, as well as an unsatisfactory density compatibility. The ester function may, moreover, cause hydrolysis thereby expediting the corrosion of metal parts. Attempts are being made to overcome the above disadvantages by mixing hydrocarbons with esters which requires, however, considerable development efforts in practice.

Should the synthesis oil admixtures used exhibit a dispersing action in respect of e.g. black sludge, it is necessary, additionally, to add low- or high-molecular weight substances (for example "ashless dispersants" of the polyisobutenyl succinimide type or VI improvers with polar groups). This necessitates considerable expenditure. Furthermore, these compounds which mainly contain nitrogen may cause density problems. If the cooligomers CM used, according to the invention, contain the Component C), dispersing action is achieved without

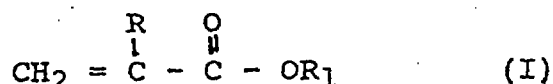
causing the known problems which occur when nitrogen-containing monomers are used, more particularly density incompatibility.

5 It has now been found that the (meth)acrylic acid ester- α -olefin-cooligomers of this invention meet the industrial requirements particularly well.

The present invention relates to the use of cooligomers CM as synthesis oils in Tribology, synthesised from

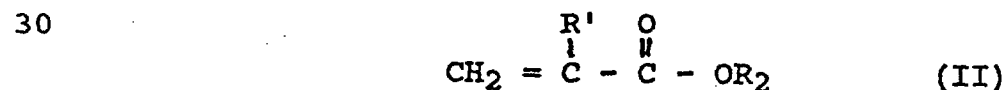
10 A) 10 to 40 wt.% of at least one 1-alkene having 4 to 32 carbon atoms, preferably 10 to 14 carbon atoms in the molecule

15 B) 40 to 90 wt.% of at least one (meth)acrylic acid ester of Formula I

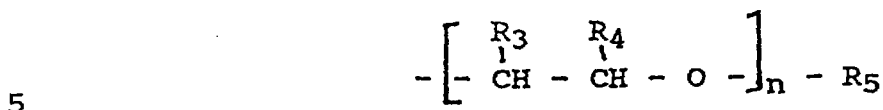


20 wherein R represents hydrogen or methyl and R_1 represents an unbranched and/or branched alkyl group or a cycloalkyl group having 4 to 32 carbon atoms, preferably 8 to 20 carbon atoms in the alkyl group,

25 C) 0 to 65 wt.%, preferably 5 to 40 wt.% of a (meth)acrylic acid ester of Formula II



35 wherein R' represents hydrogen or methyl and R_2 represents an alkyl group having 2 to 6 carbon atoms which is substituted by at least one hydroxyl group, or R' represents a group



wherein R_3 and R_4 represent hydrogen or methyl,
 R_5 represents hydrogen or an optionally
 10 branched alkyl group having 1 to 40,
 preferably 1 to 20 carbon atoms and n is an
 integer of 1 to 60, with the proviso that if n
 represents 1, R_5 is at the same time
 exclusively an optionally branched alkyl group
 15 having 1 to 40 carbon atoms, the cooligomers
 having a molecular weight M_w within the range
 of 1,500 to 25,000.

The Components A), B) and C) in the cooligomers CM
 20 must add up to a total of 100%. By definition, the
 cooligomers used according to the invention are within
 the molecular weight range M_w of 1,500 to 25,000
 (determination by gel permeation chromatography, cf.
 H.F. Mark et al. Encyclopedia of Polymer Science &
 25 Technology Vol. 10, 1 - 19, J. Wiley 1987).

The following are examples of representatives of
 Component A):

1-Butene, 1-pentene, 1-hexene, 1-heptene, 1-octene,
 1-nonene, 1-decene, 1-undecene, 1-dodecene,
 30 1-tridecene, 1-tetradecene, 1-pentadecene,
 1-hexadecene, 1-heptadecene, 1-octadecene,
 1-nonadecene, 1-eicosene, 1-heneicosene,
 1-docosene, 1-trocosene, 1-tetracosene,
 1-pentacosene, 1-hexacosene, 1-heptacosene,
 35 1-octacosene, 1-nonacosene, 1-triacontene,
 1-hentriacontene, 1-dotriacontene, or the like.
 Furthermore, branched-chained alkenes such as
 vinylcyclo hexane, 3,3-dimethylbut-1-ene, 3-

methylbut-1-ene, diisobutylen-4-methylpent-1-ene or the like.

5 In addition, 1-alkenes having 10 to 32 carbon atoms obtained during the polymerisation of ethylene, propylene or mixtures thereof are suitable, these materials, themselves, having been obtained from hydro-cracked materials.

10 The variant in which the Component A) of the cooligomers CM is 1-decene, dodecene or tetradecene is particularly preferred. The use of decene which exhibits the best low-temperature behaviour (pour-point) is particularly preferred.

15 Also of special interest are cooligomers CM, whose Component B) consists of (meth)acrylic acid esters having 4 to 24, preferably 8 to 22 carbon atoms in the alkyl group, or mixtures thereof. They include, for example, the following monomers:

20 Butylacrylate, 2-ethylhexylacrylate, cyclohexylacrylate, isodecylacrylate, decylacrylate, undecylacrylate, dodecylacrylate, tridecylacrylate, tetradecylacrylate, pentadecylacrylate, dodecylpentadecylacrylate, hexadecylacrylate, heptadecylacrylate, 25 octadecylacrylate, cetylstearylacrylate, oleylacrylate, nonadecylacrylate, eicosylacrylate, cetyleicosylacrylate, stearyleicosylacrylate, docosylacrylate, eicosyltetriacontylacrylate or the corresponding methacrylates.

30 Special mention must be made of the alkylmethacrylates with $\geq C_{10}$ in the alkyl group having a greater amount of iso-isomers. They include, for example, C_{12} - C_{15} -alkyl esters of methacrylic acid having about 60 to 90% of iso-isomers parts as well as isodecyl 35 methacrylate. Here, a higher degree of branching has an advantageous effect on the low-temperature behaviour including the pour-point, and a certain C-number distribution improves the viscosity temperature

behaviour.

5 The cooligomers CM described, when used as synthesis oils, are fully comparable with the synthesis oil components of prior art with respect to their characteristics such as viscosity, VI index, low-temperature behaviour, evaporation and oxidation stability and further properties of relevance in practice.

10 Compared to prior art, however, they have the following advantages:

15 As the polar monomers are combined with non-polar ones, there are no miscibility problems with respect to mineral oils, poly- α -olefins (PAO), esters or other base liquids and no solubility problems with additives. The density behaviour is entirely neutral. There is also no corrosion due to acid formation.

20 Surprisingly, it has been found that synthesis oil admixtures of cooligomers CM, for example, and polyolefins and/or esters have a clearly higher VI index than the individual components which is due to the influence of the oligomer. It is also due to the oligomer component CM, that distinctly lower low-temperature viscosities may be achieved than is the case for example, with synthetic hydrocarbons (measured in the cold cranking simulator, see Example 12). Despite 25 partially existing residual double bonds, the behaviour is excellent under great thermal-oxidative load (Example 18, VW engine test carried out by the Technical Service, comparison with PAO formulation).

30 If oligomers are used as a component of synthesis oil, which also contains Component C) in a sufficient quantity, there is a good dispersion action, whilst, because of the oxygen-containing dispersing group, density problems are avoided and there is no loss in the shearing stability of the admixture as is the case, for 35 example, when high-molecular weight VI improvers are used.

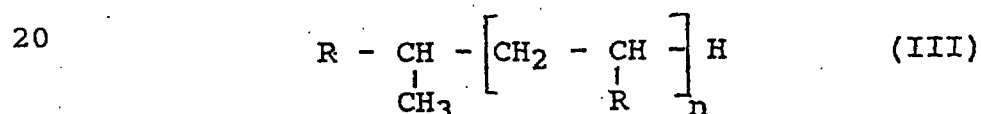
As a result, the characteristics of the different

oil specifications may be achieved either with or without a small amount of high-molecular weight VI improvers. This provides advantages, for example, with respect to the shearing stability. Furthermore, the risk of deposit formation is less likely.

A particularly advantageous mixture with other synthesis oils is described below:

"Synthesis oils" are poly- α -olefins (PAO), which are particularly preferred by the industry, and the organic esters (OE) such as dicarboxylic acid and polyol esters (cf. E.I. Williamson, J. Synth. Lubr. 2(4) 329 - 341 (1986); 3 (1) 45 - 53 (1987); A. Plagge, Tribologie and Schmierungstechnik 34, 148 - 156 (1987); Ullmann, 4th ed. vol. 20, loc.cit. p. 514 - 821).

The starting materials for the poly- α -olefins are primarily crack olefins, mainly with a boiling point of between 30 and 300°C. The poly- α -olefins normally have general Formula III



wherein R represents an alkyl group, more particularly having 6 to 10 carbon atoms, at a molar weight of normally 300 to 6,000 ($\bar{M}_w$).

Organic esters (OE) are, on the one hand, esters of dicarboxylic acids having 3 to 17 carbon atoms such as adipic acid, azelaic acid and sebacic acid with primary alcohols, the most important alcohol component in this case being polyalkylene glycols, and, on the other hand, the mono carboxylic acid esters, more particularly esters of C6-C12-carboxylic acids, with alcohols, especially those with the neopentyl structure such as neopentyl alcohols, trimethylolpropane and pentaerythritol. The ester oils exhibit a high adsorption capacity on metal surfaces and therefore a good lubricating power which means, however, that they are relatively sensitive to (hydrolytic) decomposition

which may produce corrosive decomposition products.

The viscosities range from e.g. values of about 5.9 [mm²/s at 38°C] for the neopentyl glycol ester of the n-C7 acid to 16.2 for the corresponding ester of the n-C12 acid, or from a value of 12.1 for the trimethylolpropane ester of the n-C6 acid to a value of 36.4 for the corresponding ester of the n-C12 acid.

Preparation of cooligomers CM

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As known from prior art, the claimed cooligomers may be prepared under certain conditions by radical-induced polymerisation, for example by thermal polymerisation and by adding a suitable initiator or a Redox system. The polymerisation may be carried out in the absence of a solvent but also in the presence of a suitable solvent. Therefore, it is possible to use any conventional solvent suitable as a polymerisation medium, as well as mineral oils, HC-oils, PAO, esters or oligomers already prepared. Here, 1-alkene of Component A) may, for example, be introduced into a suitable reaction vessel and heated to a suitable reaction temperature. Generally, a temperature range of 80 to 200°C, more particularly 160 ± 20°C may be considered suitable. Within the same temperature range, Component B) or B) + C) may, in the required amounts, be added to the preparation mixture preferably by being fed in over a certain period of time, for example 0.25 to 10 hours, more particularly within 5½ hours. This mixture is then suitably polymerised out in the batch for a certain time, normally for a few hours, about 6 hours being given as a guide. It has proved advantageous to add the initiator during the entire reaction, for example in batches of about 30 minute intervals or else continuously using a feed method. The radical starters used as initiators are known per se (cf. Kirk-Othmer, 3rd. Ed. Vol. 13, pg. 355 - 373, Wiley Interscience 1981; Rauch-Puntigam loc.cit.). The initiator amounts used are normally within the range of 0.1-10 wt.%,

preferably within the range of 0.1-5 wt.%, based on the total amount of monomers. Suitable initiators are those whose decomposition characteristics are adapted to the polymerisation procedure. A half-life of the initiator, (in benzene) at the reaction temperature, of about 0.25 hours is given as a guide. Such initiators include, for example, peroxides such as di-tert butyl peroxide. If the initiator is added in batches, the addition of an amount of 0.001 to 0.005 mol of initiator per batch is given as a guide. According to the results obtained, about 98% of the monomers are, for example, reacted thus obviating in many cases a separation of the monomers or even a further working-up. If the flashpoint is, for example, required to be high, the residual monomer must be removed.

The products are colourless, oily liquids which are completely miscible with mineral oils, PAO, HC oils and ester oils.

The following Examples serve to illustrate the invention:

Here, the physical data are determined using the following specifications: (cf. Ullmann, 4th ed. vol. 20, loc.cit., F.H. Mark et al. vol. 10 loc.cit.).

Viscosity :	η (100°C and 40°C) (according to DIN 51 562 or ASTM D 445 in the Ubbelohde capillary viscosimeter)
:	VIB calculated from the 40 and 100°C viscosity of the base oil
Pour-point:	in the automatic pour-point measuring apparatus according to DIN 51 583,
Molar weight:	(Using gel chromatography compared to PMMA as standard) .
Refractive Index:	According to DIN 51 774
Noack-Index:	According to DIN 51 581
Non-uniformity:	$U = \frac{\bar{M}_w}{\bar{M}_n} - 1$ (according to GPC)

The abbreviation "AMA" used below refers to alkylmethacrylates, "PAO" to poly- α -olefin, "TMA-OD-Ester" to the ester of trimethylolpropane with adipic acid.

5

EXAMPLES

Preparation of the synthesis oil components

10 Example 1

1 mol of 1-decene (140 g) is heated to 160°C in the reaction vessel. Then, a mixture of 0.5 mol of isodecylmethacrylate (113 g) and 0.5 mol of C12-C15-alkylmethacrylate with a 60% iso-isomer content (136 g) is fed in over 4 hours. After the feed-in, the mixture is polymerised out in the batch for another 12 hours. Thereafter, during the entire reaction time of 16 hours, apart from the last hour, di-tert-butylperoxide is added as initiator in 30 minute intervals (in this case 30 batches, total amount 2.8 weight % based on the monomers).

At the end of the reaction, the yield of monomers is about 98%. The product is a colourless, oily liquid which is completely miscible with mineral oils, polyolefins or ester oils.

Substance data:

30 η (100°C) = 45.1 mm²/s,
 η (40°C) = 489.0 mm²/s

VIB = 146

Pour-point = -43.2°C

$\bar{M}_w$ = 4,000

35 $\bar{M}_n$ = 1,790 U = 1.23

Evaporation loss according to Noack = 4 - 5 wt. %.

Example 2

Method as used in Example 1, but the methacrylate mixture is fed in over 1.5 hours.

5

Physical characteristics:

η (100°C) = 94.9 mm²/s,

η (40°C) = 1,210.8 mm²/s

VIB = 164

10 Pour-point = -33.6°C

$\bar{M}_w$ = 8,330

$\bar{M}_n$ = 2,280

U = 2.65

Yield of monomers = 95%

15

Example 3

Method as used in Example 1, but with a reaction temperature of 140°C, initiator used: tert.-butylperbenzoate

20

Physical characteristics:

η (100°C) = 87.8 mm²/s,

η (40°C) = 1,188.3 mm²/s

25 VIB = 154

Pour-point = -34.7°C

$\bar{M}_w$ = 6,890

$\bar{M}_n$ = 2,240

U = 2.00

30 Yield of monomers = 97%

Example 4

2 mol of 1-decene (280 g) is heated to 160°C in the reaction vessel. 1 mol of isodecylmethacrylate (227 g) is fed in at this temperature over 5 hours. After the feed, the mixture is polymerised again in the batch for 6 hours. During the entire reaction time of 11 hours,

35

apart from the last hour, di-tert-butylperoxide is added as initiator in 30 minute intervals (in this case 20 batches, a total of 4.3 wt.% based on the monomers).

- 5 At the end of the reaction, the yield of monomers is about 92%.

Physical characteristics:

- η (100°C) = 25.9 mm²/s,
10 η (40°C) = 250.3 mm²/s
VIB = 134
Pour-point = -48.4°C
 $\bar{M}_w$ = 2,240
 $\bar{M}_n$ = 1,370
15 U = 0.64

Example 5

- 20 As in Example 4, but isodecylmethacrylate/decene 1 : 1 mol, total initiator amount 2.8 wt.%.

Physical characteristics:

- η (100°C) = 47.6 mm²/s,
 η (40°C) = 603.8 mm²/s
25 VIB = 132
Pour-point = -38.9°C
 $\bar{M}_w$ = 3,120
 $\bar{M}_n$ = 1,610
30 U = 0.94

Example 6

- 35 As in Example 4, but isodecylmethacrylate/decene in a molar ratio of 1 : 0.25, total initiator amount = 2.8 wt.%.

Physical characteristics:

η (100°C) = 424.6 mm²/s,

η (40°C) = 1,219.7 mm²/s

VIB = 170

5 Pour-point = -10.7°C

$\bar{M}_w$ = 12,300

$\bar{M}_n$ = 2,890

U = 3.26

Yield of monomers = 98%

10

Example 7

As in Example 6, but isodecylmethacrylate is fed in over 2.5 hours, total initiator amount = 2.8 wt.%.
15

Physical characteristics:

η (100°C) = 888.2 mm²/s,

η (40°C) = 27,162 mm²/s

VIB = 206

20 Pour-point = (too viscous)

$\bar{M}_w$ = 24,800

$\bar{M}_n$ = 3,480

U = 6.12

Yield of monomers > 99%

25

Example 8

As in Example 5, but a reaction temperature of 140°C, initiator: tert.-butylperbenzionate 4.8 wt.%.
30

Physical characteristics:

η (100°C) = 130.7 mm²/s,

η (40°C) = 2,335.1 mm²/s

VIB = 147

35 Pour-point = -25.9°C

$\bar{M}_w$ = 6,690

$\bar{M}_n$ = 2,200

U = 2.04

Yield of monomers = 96%

Example 9

- 5 As in Example 5, but a reaction temperature of 126°C,
initiator: tert.-butylpernonoate 4.8 wt.%.

Physical characteristics:

- 10 η (100°C) = 460.1 mm²/s,
 η (40°C) = 12,321.7 mm²/s
VIB = 180
Pour-point = -8.5°C
 $\bar{M}_w$ = 11,800
 $\bar{M}_n$ = 2,560
15 U = 2.31
Yield of monomers = 88%

Example 10

- 20 Method used as in Example 4, but in addition to 1 mol of
1-decene, another 280 g of synthesis oil prepared
according to Example 4 is used as solvent in the
preparation mixture.

25 Physical characteristics:

- η (100°C) = 28.0 mm²/s,
 η (40°C) = 294.0 mm²/s
VIB = 127
Pour-point = -44.5°C
30 $\bar{M}_w$ = 2,180
 $\bar{M}_n$ = 1,350
U = 0.61
Yield of monomers = 98%

35 Example 11

As in Example 1, but the methacrylate component is
butylmethacrylate, feeding-in time 3.5 hours.

Physical characteristics:

η (100°C) = 148.0 mm²/s,

η (40°C) = 2,836.2 mm²/s

VIB = 147

5 Pour-point = -26.3°C

$\bar{M}_w$ = 6,500

$\bar{M}_n$ = 1,860

U = 2.51

Yield of monomers = 91%

10

Example 12

3 mol of dodecane (523 g) is heated to 160°C in the reaction vessel, 1 mol of C12-C15-alkylmethacrylate with a 90% iso-isomer content (272 g) is circulated for 5.5 hours. After the feed-in, the mixture is polymerised again in the batch for another 11 hours. The initiator is added as in Example 1. After the reaction, the solvent is removed by distillation. The resultant product is a colourless, oily liquid which is completely miscible with mineral oils, PAO or ester oils.

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Physical characteristics:

η (100°C) = 16.7 mm²/s,

25 η (40°C) = 128.1 mm²/s

VIB = 141

Pour-point = < -52,1°C

$\bar{M}_w$ = 1,510

$\bar{M}_n$ = 1,230

30 U = 0.23

Evaporation loss according to Noack 6%

Yield of monomers = 95%

Example 13

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As in Example 12, but instead of dodecane, the same amount by weight of hydrocrack oil is used as solvent.

Physical data of hydrocrack oil:

η (100°C) = 3.62 mm²/s,

VIB = 126

5 Pour-point = -33,0°C

Physical data of the resultant oligomer/oil mixture

η (100°C) = 5.08 mm²/s,

η (40°C) = 24.1 mm²/s,

10 VIB = 144

Pour-point = -34,5°C

Example 14

15 400 g (0.28 mol) of Cl* is dissolved in 450 g (1.99 mol) of isodecylmethacrylate. 250 g (1.78 mol) of 1-decene are heated to 140°C in the reaction vessel. The methacrylate mixture is fed in over 1.5 hours. After the feed-in, the mixture is polymerised again in the
20 batch for another 15 hours. The initiator is added as described in Example 1. The initiator is tert-butylperbenzoate, total amount ≈ 3 wt.%. The resultant product is a yellowish oil which is soluble in mineral oil.

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* Cl is a methacrylic acid ester of an ethoxylated C16-C18 fatty alcohol mixture, average ethoxylation degree 25, the alcohol used here is marlipal 1618/25^R, product of Hüls AG.

30

Physical characteristics:

η (100°C) = 1,006 mm²/s,

η (40°C) = 15,756 mm²/s

VIB = 276

35 Pour-point: too viscous

$\bar{M}_w$, $\bar{M}_n$ cannot be determined via GPC because of excessive adsorption

Yield: > 98%

Example 15

300 g (0.37 mol) of Component C2** is dissolved in 400 g
(1.77 mol) of isodecylmethacrylate. 300 g (2.14 mol) of
5 1-decene is heated to 160°C in the reaction vessel. The
methacrylate mixture is fed in over 2 hours. Total
reaction time 16.5 hours, initiator addition as in
Example 1. Initiator: di-tert.-butylperoxide, total
amount 3 wt.%. The product is soluble in mineral oil.

10

** C2 is the methacrylic acid ester of
methoxypolyethyleneglycol of an average
ethoxylation degree ≈ 16 ; the alcohol used here is
Carbowax 750 ® (Trademark of Union Carbide).

15

η (100°C) = 293.4 mm²/s,

η (40°C) = 3,999.0 mm²/s

VIB = 217

Pour-point = 22,1°C

20

$\bar{M}_w$, $\bar{M}_n$ cannot be determined via GPC because of too great
an adsorption

Yield approximately 100%

Example 16

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As in Example 5, but instead of isodecylmethacrylate
C12-C15-alkylmethacrylate with a 90% iso-isomer content.

η (100°C) = 41.8 mm²/s,

30

η (40°C) = 417.6 mm²/s

VIB = 152

Pour-point = -44,1°C

$\bar{M}_w$ = 3,430

$\bar{M}_n$ = 1,830

35

U = 0.78

Example 17

As in Example 1, but the methacrylate component is C12-C15-alkylmethacrylate (90% iso-isomer content),

5 AMA/decene-ratio: 1 : 0.5 mol, AMA fed in for over one hour.

η (100°C) = 234.4 mm²/s,

η (40°C) = 4,810.6 mm²/s.

10 VIB = 165

Pour-point = -25.6°C

$\bar{M}_w$ = 23,100

$\bar{M}_n$ = 3,230

U = 6.14

15

Applicational Examples

Example 18

20 Comparison of an oligomer/ester oil mixture with a poly- α -olefin/ester oil mixture with respect to the viscosity data.

	20% PAO 100 in TMA-OD ®-ester	20% oligomer from Example 17 in TMA-OD ®- ester
25 n (100°C)	6.68 mm ² /s	7.70 mm ² /s
VIB	193	212
CCS (-30°C)	1,800 mPa s	1,600 mPa s

30 It is clearly noticeable that with the use of cooligomers in the mixture, in spite of the viscosity being higher at 100°C, a lower viscosity can be achieved at -30°C and therefore a better low-temperature behaviour.

Example 19

Comparison of an oligomer/PAO formulation with a
PAO6/PAO40 formulation in the VW engine test carried out
5 by the Technical Service.

	PAO40 in PAO 6	Oligomer from Example 18 in PAO6	
10			
	Formulation	45% PAO 40	45% oligomer
		14.2% conventional	14.2% conventional
		DI package	DI package
15		40.8% PAO6	40.8% PAO6
	η (100°C)	19.5 mm ² /s	18.7 mm ² /s
	VI	147	148
	SAE-Class	10W-50	10W-50
	result obtained	63.7 points, no	67.2 points, no
20	by the	ticks	ticks
	Technical Service		
	with VW		

When the oligomer/PAO is used, an excellent diesel
25 evaluation may be obtained which is proof of a high
thermal-oxidative stability. Account must also be taken
of the fact that the pure PAO formulation used for the
comparison has a very high diesel performance, as is
known.



Claims

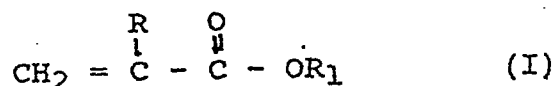
1. Use of co-oligomers as synthesis oil in Tribology, synthesised from

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A) 10 to 40 wt.% of at least one 1-alkene having 4 to 32 carbon atoms in the molecule,

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B) 40 to 90 wt.% of at least one (meth)acrylic acid ester of Formula I



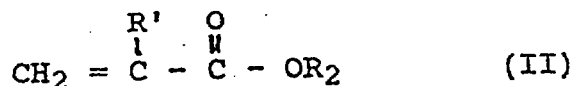
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wherein R represents hydrogen or methyl and R₁ represents an optionally branched alkyl group or a cycloalkyl group having 4 to 32 carbon atoms in the alkyl group,

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C) 0 to 65, preferably 5 to 40 wt.% of a (meth)acrylic acid ester of Formula II

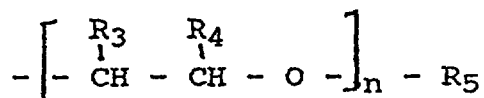
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wherein R' represents hydrogen or methyl and R₂ represents an alkyl group having 2 to 6 carbon atoms, which is substituted by at least one hydroxyl group, or R' represents a group

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wherein R₃ and R₄ represent hydrogen or methyl, R₅ represents hydrogen or an optionally



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5 branched alkyl group having 1 to 40 carbon
 atoms and n is an integer of 1 to 60, with the
 proviso that if n represents 1, R_5 is at the
 same time an optionally branched alkyl group
 having 1 to 40 carbon atoms,

 the co-oligomers having a molecular weight M_w within
the range of 1,500 to 25,000.