EUROPEAN PATENT SPECIFICATION

(54) SHEAR-STABLE VISCOSITY IMPROVER FOR LUBRICATING OILS
SHERBESTÄNDIGER, VISKOSITÄTSVERBESSERER FÜR SCHMIERÖLE
AMELIORANT DE VISCOSITE STABLE AU CISAILEMENT DESTINE AUX HUILES DE LUBRIFICATION

(84) Designated Contracting States:
BE DE ES GB IT NL SE

(30) Priority: 04.02.1993 FR 9301229

(43) Date of publication of application:
08.02.1995 Bulletin 1995/06

(73) Proprietor: THE LUBRIZOL CORPORATION Wickliffe, Ohio 44092-2298 (US)

(72) Inventors:
• CANTIANI, Robert
F-92800 Puteaux (FR)

• RICHARD, Joel
F-60500 Chantilly (FR)

(74) Representative: Crisp, David Norman
D. YOUNG & CO.
21 New Fetter Lane
London EC4A 1DA (GB)

(56) References cited:
GB-A- 1 001 474 GB-A- 1 163 807

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).
The invention relates to a shear-stable viscosity improver for lubricating oils, especially for mineral oils of paraffinic type.

It is also aimed at the compositions based on this improver as well as at lubricating oils comprising an effective proportion of the said improver, optionally introduced by means of the said compositions.

Viscosity improvers are usually macromolecular compounds.

FR-A-1 390 228 discloses copolymers with improved relationship between viscosity and temperature.

The objective of the invention is, above all, to provide a new viscosity improver for lubricating oils, which, besides the characteristics which are conventionally sought after, namely improving the viscosity index of the said oils, exhibits a markedly improved shear strength when compared with improvers that are already known.

It is known that when lubricating oils are placed under extreme use conditions such as are encountered, for example, in gearboxes, differentials and gears of all kinds, especially in motor vehicles, the viscosity improvers incorporated in these oils are subjected to high shear stresses which cause them to lose their properties at least partially and which consequently lead to losses in viscosity in the lubricating oils.

These losses in viscosity are of two types: they are, on the one hand, temporary losses in viscosity and, on the other hand, irreversible losses in viscosity.

Irreversible losses in viscosity are due to scissions of the macromolecular chains which takes place in the shear field, and are reversible.

Users of the oils of the kind in question are increasingly demanding and want the irreversible losses in viscosity, in other words the number of scissions of the macromolecular chains, to be as small as possible.

To characterize the shear strength of a viscosity improver, a strength which is proportionately greater the lower the irreversible losses in viscosity of a lubricating oil treated with this additive, use is made of the following tests, according to which the said additive, which is predissolved in a formulating oil, is subjected to high shear stresses with the aid of a shearing tool.

In general, use is made of two types of tests, the use of which then characterizes the test.

In the first case this is a system of toothed wheels contained by a "FZG" machine and, in the other case, this is a bearing system with frustoconical needles contained in a "VKA" machine.

In the first case, consequently, reference will be made to the "FZG" shear strength established by the standard CEC-L-37-T-85 and, in the second, to "VKA" shear strength determined according to standard VW 1437 or CEC PT-6.

Procedure CEC-L-37-T-85 is a test procedure promulgated by the Coordinating European Council (CEC) for the Development of Performance Tests for Lubricants and Engine Fuels. This procedure is used to determine shear stability of polymer-containing oils employing the FZG (Forschungsstelle für Zahnrad- und Getriebebau) apparatus.

Specifically, the purpose of the test is to determine the permanent viscosity loss of polymer-containing oils when a sample is mechanically stressed under the test conditions described.

Special gear wheels are run in the lubricant under test in a dip lubrication system at constant speed for a fixed time. The bulk oil temperature is controlled and the loading of the gear teeth is set according to the procedure.

At the end of the test period the oil is assessed for permanent viscosity loss and the difference in viscosity between the new and sheared oil is used to characterize the shear stability of the oil.

The FZG gear test rig consists of drive and test gearing connected by two shafts. One shaft has a positive clutch for the application of the load.

The test gear case contains a system for heating the test oil and a water-cooled coil to assist in cooling the test oil. A temperature sensor controls the heating system according to the preset temperature.

The test rig is powered by a two speed electric motor at speeds of approximately 1500/3000 rpm.

A sequence of operations is conducted wherein the test lubricant is subjected to the FZG test for 7.5 minutes at load stages 1-4 followed by 19.5 hours at load stage 5, all at 90°C. The kinematic viscosity of the test oil is measured and the loss of viscosity is reported as percentage viscosity loss.

The "VKA" procedure is also promulgated by the CEC. This procedure measures viscosity shear stability of polymer-containing transmission lubricants.

This procedure provides a means for testing lubricating oils in a taper roller bearing to determine lubricant shear stability as characterized by a reduction in the kinematic viscosity of the lubricant. It allows conclusions to be drawn on the permanent viscosity loss to be expected under operating conditions, for example, in gear boxes, and which is caused by mechanical stress.

The degree of shear stability is the relative viscosity loss (Rv) in % as defined by the following equation:
where:

- \( V_i \) is the kinematic viscosity of the oil before shear in mm\(^2\)/sec at 100°C
- \( V_f \) is the kinematic viscosity of the oil after shear in mm\(^2\)/sec at 100°C

[0025] The smaller the value \( R_v \) the higher the viscosity stability.

[0026] A lubricant is tested in a taper roller bearing fitted into a Four Ball EP Test Machine. The taper roller bearing runs submerged in 40 ml of lubricant at a constant speed and load with a test oil temperature of 60°C during a defined number of motor revolutions (respectively during a defined running period). The kinematic viscosity of the test oil at 100°C is measured (in accordance with DIN 51562 or equivalent) before and after the test.

[0027] The test conditions are given in the table below:

<table>
<thead>
<tr>
<th>Test Duration</th>
<th>Revolutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>348,000</td>
</tr>
<tr>
<td>B</td>
<td>696,000</td>
</tr>
<tr>
<td>C</td>
<td>1,740,000</td>
</tr>
</tbody>
</table>

N.B.: The basis for determining test duration or the number of revolutions of the motor was a theoretical speed for asynchronous motors of 1450 rpm. For motors with speeds that differ from the above, the test durations are to be corrected accordingly.

Each test duration is conducted employing a fresh lubricant sample of known kinematic viscosity.

After each test duration the kinematic viscosity at 100°C is determined for the sample and the relative viscosity change \( R_v \) is determined.

The inventors have observed that the test performed with the aid of the FZG machine or "FZG" test induces at the end of twenty hours about the same irreversible drop in viscosity as the "VKA" test at the end of four hours; in both cases the viscosity changes from an initial value \( V_i \) at a given temperature \( T \) to a final viscosity \( V_f \) at the same temperature \( T \); the stability to shear is then characterized by the relative drop in viscosity which is given by the formula shown below:

\[
\text{Relative Viscosity loss } R_v = \frac{V_i - V_f}{V_i} \times 100\%
\]

More particularly, the objective of the invention is to provide a viscosity improver which is not only capable generally of imparting a VIE of at least 155 to a lubricating oil exhibiting, before incorporation of the said improver, a viscosity at 100°C of 4.8 to 5.5 mm\(^2\)/s and a VIE of 85 to 100, but which, in addition, desirably exhibits a shear strength such that the relative drop in viscosity after four hours in the "VKA" test or after twenty hours in the "FZG" test is lower than 13 %, preferably lower than 12 % and, still more preferably, lower than 11 %.

VIE is used to denote "Viscosity Index Extended", which is a quantity defined by ASTM standard D-2270 entitled Standard Practice for Calculating Viscosity Index from Kinematic Viscosity at 40°C and 100°C, and which is represented by an arbitrary number employed to characterize the variation in the kinematic viscosity of a petroleum product with temperature.

Additives which are already known, which consist of copolymers of esters of methacrylic acid with \( C_4 \) to \( C_{18} \) alkanols, exhibit a shear strength which, in the above conditions of the "VKA" and "FZG" tests, is reflected in a relative drop in viscosity of the order of 20%.

In one aspect, the invention provides a shear stable polymethacrylate viscosity improver for lubricating oils derived from alkyl methacrylate monomers wherein from 30% to 50% by weight of said monomers are \( C_{1-4} \) alkyl methacrylates and the balance are \( C_{10-18} \) alkyl methacrylates, and having a number average molecular mass in the range...
from 27000 to 32000 grams per mole.

Various preferred features and embodiments of the invention are described below.

It is surprising that the properties of the viscosity improvers could be improved so that these additives satisfy the conditions referred to above, in the case of a copolymer of constant composition obtained from monomers consisting of esters of methacrylic acid with short alkanols and with long alkanols, the proportion by weight of short alkyl methacrylates being between 30 % and 50 %, by increasing the number-average molecular mass above a particular critical value which is characteristic for a given copolymer and starting from which the drop in viscosity in the VKA and FZG tests decreases. For purposes of this invention "short" refers to groups containing from 1 to 4 carbon atoms and "long" refers to groups containing about 10 to about 18 carbons.

The above mentioned critical value of the number-average molecular mass is determined experimentally in each case.

It follows that the viscosity improver in accordance with the invention is capable of imparting a VIE of at least 155 to a lubricating oil exhibiting, before incorporation of the said improver, a viscosity at 100 °C of 4.8 to 5.5 mm²/s and a VIE of 85 to 100, in that it has a shear strength such that the relative drop in viscosity after four hours in the "VKA" test or after twenty hours in the "FZG" test is lower than 13 %, preferably lower than 12 % and, still more preferably, lower than 11 %, and in that it consists of a copolymer essentially obtained by copolymerization from at least one of the monomers of the group consisting of the esters of methacrylic acid with a long alkanol, more particularly C₁₀ to C₁₈ and preferably C₁₁ to C₁₅, and of at least one of the monomers of the group consisting of the esters of methacrylic acid with a short alkanol, more particularly C₁ to C₄, the weight proportion of short alkyl methacrylates being between 30 % and 50 %, the number-average molecular mass of this copolymer being higher for a constant composition of the said copolymer than the critical value starting from which the drop in viscosity in the VKA and FZG tests decreases.

According to an advantageous embodiment the above mentioned viscosity improver consists of a copolymer essentially obtained by copolymerization from 65 to 55 parts by weight of at least one of the monomers of the group consisting of the esters of methacrylic acid with a C₁₁ to C₁₅ long alkanol and from 35 to 45 parts by weight of at least one of the monomers of the group consisting of the esters of methacrylic acid with a C₁ to C₄ short alkanol, the critical value of the number-average molecular mass of this copolymer being from 27,000 to 32,000 g/mol.

The copolymers constituting the viscosity improvers in accordance with the invention can be employed as they are or in combination with a lubricating oil, the quantity of copolymers used corresponding to a proportion of 2 to 40 %, preferably of 3 to 30 %, and, still more preferably, from 4 to 25 % by weight of the mass of lubricating oil to be treated.

It is convenient, however, to use them in the form of a composition comprising the copolymers of this invention with a normally liquid organic diluent, preferably mineral oil, forming the reaction medium within which the copolymerization is performed. The mineral oil may be the same as the lubricating oil which is to be treated. The composition in accordance with the invention normally comprises from 30 to 90 %, preferably from 40 to 80 % by weight of at least one copolymer in accordance with the invention, the remainder to 100 % consisting essentially of a normally liquid organic diluent, preferably mineral oil.

The oils to be treated with the copolymers of this invention are oils of lubricating viscosity, including natural or synthetic lubricating oils and mixtures thereof. Natural oils include animal oils, vegetable oils, mineral oils, solvent or acid treated mineral oils, and oils derived from coal or shale. Synthetic lubricating oils include hydrocarbon oils, halo-substituted hydrocarbon oils, alkylene oxide polymers, esters of carboxylic acids and polyols, esters of polycarboxylic acids and alcohols, esters of phosphorus-containing acids, polymeric tetrahydrofurans, silicone-based oils and mixtures thereof.


The lubricating oil composition in accordance with the invention is characterized in that it comprises at least one copolymer constituting the viscosity improver in accordance with the invention in a proportion of 2 to 40 %, preferably of 3 to 30 %, and, still more preferably, of 4 to 25 % by weight of the mass of lubricating oil to be treated.

To prepare the copolymers constituting the viscosity improvers in accordance with the invention it is possible to make use of the conventional methods of radical copolymerization in solution in oil.


These methods include free-radical initiated polymerization employing azo compounds or peroxides. Also described therein are photochemical and radiation initiated methods.

Useful initiators include organic peroxides, hydroperoxides and azo compounds.

Polymerization of acrylic and methacrylic monomers can take place under a variety of conditions, among
which are bulk polymerization, solution polymerization, usually in an organic solvent, preferably mineral oil, emulsion polymerization, suspension polymerization and nonaqueous dispersion techniques.

[0051] Solution polymerization is preferred, especially in mineral oil diluent.

[0052] Molecular weights of the polymers can be controlled employing a number of techniques including choice of initiator, reaction temperature, concentration of monomers and initiator and solvent type. Chain transfer agents can be used.

[0053] Molecular weights can be determined employing standard analytical methods such as gel permeation chromatography (GPC) using a polystyrene standard.

[0054] Ionic polymerization techniques are known including cationic and anionic methods; however, cationic methods are generally ineffective for acrylate and methacrylate monomer polymerization.

[0055] Free radical initiation is preferred.

[0056] Because acrylic polymerizations are usually accompanied by liberation of considerable heat, care must be taken to avoid uncontrolled reaction. Temperatures can be controlled by using reactors with cooling jackets, controlling rates of addition and use of reaction solvents.

[0057] A typical procedure for preparing the polymers of this invention is to charge at room-temperature about one-third of the monomers, diluent, chain transfer agent and a portion of a peroxide initiator. The mixture is heated to about 90°C at which time heating is discontinued and the temperature is allowed to rise exothermically, moderated with cold water cooling, if desired, to about 125°C. At this temperature, the remaining two-thirds of monomer, additional oil, chain transfer agent and a portion of initiator are added over about 1.5 hours. During this time cold water cooling is applied, if desired, until the temperature drops to about 90°C at which time any external cooling is discontinued. After monomer addition is completed the materials are held at 90°C for 1 hour, then four additional portions of initiator are added at hourly intervals. After the final addition of initiator, the reaction mixture is held at 90°C for 1 hour, stripped and diluted with oil to final concentration and filtered.

[0058] Using these methods, the following non-limiting Examples illustrate the preparation of copolymers that may be used as viscosity improvers in accordance with the invention in oil solution.

**EXAMPLE 1: Copolymers containing short alkyl methacrylates and long alkyl methacrylates**

[0059] A copolymer constituting a viscosity improver is prepared by making use of the methods described above.

[0060] To do this, a mixture of 20 parts by weight of ester of methacrylic acid with methanol, of 20 parts by weight of ester of methacrylic acid with butanol and of 60 parts by weight of ester of methacrylic acid with a mixture of C11 to C15 alkanols is copolymerized, the percentages by weight of the alkanols in the alkanol mixture being

\[
C_{11}/C_{12}/C_{13}/C_{14}/C_{15} = 1\% / 20\% / 30\% / 28\% / 21\%.
\]

[0061] The copolymer thus obtained was referred to as "Viscosity improver C".

[0062] Its number-average molecular mass Mn is 30,000 g/mol, its weight-average molecular mass Mw 76,000 g/mol and its polydispersity value P 2.5.

[0063] In the case of this copolymer the critical molecular mass Mn determined experimentally is 28,000 g/mol.

**EXAMPLE 2: Comparison copolymers**

[0064] Two additives according to the prior art are used for the purpose of comparison.

[0065] The first of these additives ("Viscosity improver D") is obtained by copolymerization of a mixture of

- 15 parts by weight of esters of methacrylic acid with methanol,
- 85 parts by weight of ester of methacrylic acid with a mixture of C11-C15 alkanols, the percentages by weight of the alkanols in this mixture being

\[
C_{11} / C_{12} / C_{13} / C_{14} / C_{15} = 1\% / 20\% / 30\% / 28\% / 21\%.
\]

[0066] The number-average molecular mass Mn of this copolymer is 20,000 g/mol and its weight-average molecular mass 46,000 g/mol, the polydispersity value P being 2.3.

[0067] The second of these additives ("Viscosity improver E") is also obtained by copolymerization of a mixture of

- 15 parts by weight of ester of methacrylic acid with methanol,
- 85 parts by weight of ester of methacrylic acid with a mixture of C_{11}-C_{15} alkanols, the percentages by weight of the alkanols in this mixture being

\[ C_{11} / C_{12} / C_{13} / C_{14} / C_{15} = 1\% / 20\% / 30\% / 28\% / 21\% \]

but the polymerization conditions differ from those adopted for the viscosity improver D in that the concentration of polymerization initiator is 1.5 times as high.

[0068] The copolymer constituting the viscosity improver E exhibits a number-average molecular mass Mn of 12,000 g/mol, a weight-average molecular mass Mn of 23,000 g/mol and a polydispersity value P of 1.9.

[0069] In contrast with the viscosity improvers in accordance with the invention, the two copolymers constituting the viscosity improvers D and E according to the prior art exhibit compositions of short alkyl methacrylates lower than 30 % but higher than 0 %.

[0070] Compositions in accordance with the invention were prepared from the viscosity improver C.

[0071] Furthermore, comparison compositions were prepared from the additives D and E.

[0072] In the case of additive C an oil of formulation M was employed (corresponding to the lubricating oil which was to be treated), the characteristics of which are:

- kinematic viscosity at 100°C: 5.3 mm²/s
- VIE: 100.

[0073] In the case of additives D and E, oil K was employed, the characteristics of which are:

- kinematic viscosity at 100°C: 4.8 mm²/s
- VIE: 90.

[0074] The final additive concentration in these compositions was:

C: 55 % by weight
D: 69 % by weight
E: 69 % by weight.

[0075] The abovementioned compositions containing the additives C to E respectively were incorporated into the lubricating oils K and M to be treated and the following were then measured on the oils thus treated:

- the kinematic viscosity at 100°C for C to E
- the kinematic viscosity at 40°C for C
- the value of VIE

and the VKA and FZG tests were performed.

[0076] The values found are assembled in the table which follows, together with the final concentration of viscosity improver for each case in the lubricating oil treated.

<table>
<thead>
<tr>
<th>Viscosity improver</th>
<th>Concentration (%) in the oil to be treated</th>
<th>Kinematic viscosity at 100°C (mm²/s)</th>
<th>Kinematic viscosity at 40°C (mm²/s)</th>
<th>VIE</th>
<th>Drop in relative viscosity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>VKA</td>
</tr>
<tr>
<td>Invention</td>
<td>C</td>
<td>7.9</td>
<td>9.1</td>
<td>47.7</td>
<td>175</td>
</tr>
<tr>
<td>Prior art</td>
<td>D</td>
<td>20.0</td>
<td>15.0</td>
<td>175</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>20.2</td>
<td>14.1</td>
<td>170</td>
<td></td>
</tr>
</tbody>
</table>

[0077] When the results assembled in this table are examined, it is seen that the viscosity improvers of the prior art do not meet the conditions required in the case of the additives in accordance with the invention insofar as the shear strength is concerned.
Claims

1. A shear stable polymethacrylate viscosity improver for lubricating oils derived from alkyl methacrylate monomers wherein from 30 % to 50 % by weight of said monomers are C1-4 alkyl methacrylates and the balance are C10-18 alkyl methacrylates, and having a number average molecular mass is in the range from 27000 to 32000 grams per mole.

2. The polymethacrylate viscosity improver of claim 1 wherein from 55 % to 65 % by weight of said monomers are C11-15 alkyl methacrylates and from 45 % to 35 % by weight are C1-4 alkyl methacrylates.

3. A viscosity improver according to claim 1 which comprises a copolymer obtained from 60 percent by weight of the esters of methacrylic acid with C11 to C15 long alkanols, and 20 percent by weight of each of the esters of methacrylic acid with, on the one hand, methanol and, on the other hand, butanol, the number-average molecular mass of this copolymer being about 30,000 g/mol and its shear strength such that the relative drop in viscosity in the VKA test is 9.6.

4. A composition comprising from 30 % to 90 % by weight of a polymethacrylate according to any preceding claim and the balance comprising a normally liquid organic diluent.

5. A lubricating oil composition comprising an oil of lubricating viscosity and from 2 % to 40 % by weight of the polymethacrylate according to any one of claims 1 to 3.

6. The lubricating oil composition of claim 5 wherein the oil of lubricating viscosity is a mineral oil.

7. The lubricating oil composition of claim 6 wherein the mineral oil is a paraffinic oil.

8. The lubricating oil composition of any one of claims 5 to 7 wherein the oil of lubricating viscosity has a viscosity at 100 °C of 4.8 to 5.5 mm/sec and a viscosity index of about 85 to about 100.

9. A method comprising the step of adding to an oil of lubricating viscosity from 2 % to 40 % by weight of a polymethacrylate of any one of claims 1 to 3.

10. A polymethacrylate according to claim 1 prepared by a process comprising reacting in an organic diluent in the presence of a free radical initiator at least one monomer selected from C1-4 alkyl methacrylates, and at least one other monomer selected from C10-18 alkyl methacrylates.

Patentansprüche


3. Viskositätsverbesserer nach Anspruch 1, der ein Copolymer umfasst, das aus 60 Gew.-% der Ester von Methacrylsäure mit C11- bis C15-lang Alkanolen und jeweils 20 Gew.-% der Ester von Methacrylsäure mit einerseits Methanol und andererseits Butanol erhalten wird, wobei das Zahlenmittel des Molekulargewichts dieses Copolymers etwa 30 000 g/mol beträgt und dessen Scherfestigkeit derart ist, dass die relative Abnahme der Viskosität in dem VKA-Test 9.6 beträgt.


5. Schmiervoizsammensetzung, umfassend ein Öl mit Schmierviskosität und 2 Gew.-% bis 40 Gew.-% des Polymethacrylats nach einem der Ansprüche 1 bis 3.

7. Schmierölzusammensetzung nach Anspruch 6, wobei das Mineralöl ein Paraffinöl ist.

8. Schmierölzusammensetzung nach einem der Ansprüche 5 bis 7, wobei das Öl mit Schmierviskosität eine Viskosität bei 100 °C von 4,8 bis 5,5 mm/s und einen Viskositätsindex von etwa 85 bis etwa 100 aufweist.


Revendications

1. Agent améliorant la viscosité à base de polyméthacrylate, stable au cisaillement, pour des huiles lubrifiantes dérivées de monomères de méthacrylate d’alkyle, dans lesquels de 30 % à 50 % en poids desdits monomères sont des méthacrylates d’alkyle en C4 à C8 et le reste des méthacrylates d’alkyle en C10 à C18, ayant une masse moléculaire moyenne en nombre dans la gamme de 27 000 à 32 000 g/mole.

2. Agent améliorant la viscosité à base de polyméthacrylate de la revendication 1, dans lequel de 55 % à 65 % en poids desdits monomères sont des méthacrylates d’alkyle en C11 à C15 et de 45 % à 35 % en poids sont des méthacrylates d’alkyle en C1 à C4.

3. Agent améliorant la viscosité selon la revendication 1, qui comprend un copolymère obtenu à partir de 60 % en poids des esters de l’acide méthacrylique avec de longs alcanole en C1 à C15, et 20 % en poids de chacun des esters d’acide méthacrylique avec, d’une part, du méthanol, et, d’autre part, du butanol, la masse moléculaire moyenne en nombre de ce copolymère étant d’environ 30 000 g/mole et sa résistance au cisaillement, telle que la chute relative de viscosité dans l’essai VKA est de 9,6.

4. Une composition comprenant de 30 % à 90 % en poids d’un polyméthacrylate selon l’une quelconque des revendications précédentes, le reste consistant en un diluant organique, liquide sous les conditions normales.

5. Une composition d’huile lubrifiante comprenant une huile de viscosité lubrifiante et de 2 % à 40 % en poids du polyméthacrylate selon l’une quelconque des revendications 1 à 3.

6. La composition d’huile lubrifiante de la revendication 5, dans laquelle l’huile de viscosité lubrifiante est une huile minérale.

7. La composition d’huile lubrifiante de la revendication 6, dans laquelle l’huile minérale est une huile paraffinique.

8. La composition d’huile lubrifiante de l’une quelconque des revendications 5 à 7, dans laquelle l’huile de viscosité lubrifiante présente une viscosité à 100 °C de 4,8 à 5,5 mm/s et un indice de viscosité d’environ 85 à environ 100.

9. Un procédé comprenant l’étape d’ajouter à une huile de viscosité lubrifiante de 2 % à 40 % en poids d’un polyméthacrylate de l’une quelconque des revendications 1 à 3.

10. Un polyméthacrylate selon la revendication 1, préparé par un procédé consistant à faire réagir dans un diluant organique en la présence d’un initiateur de radicaux libres au moins un monomère choisi parmi les méthacrylates d’alkyle en C1 à C4, et au moins un autre monomère choisi parmi les méthacrylates d’alkyle en C10 à C18.