Burn Point in N100DW Oil

- Commercial Product
- Polymer of This Invention

(57) Abrégé/Abstract:
Poly methacrylate copolymers are disclosed which comprising from about 60 to about 96 weight percent of a C12-C16 alkyl methacrylate and from about 40 to about 4 weight percent of a C18-C30 alkyl methacrylate and provide excellent low temperature properties to lubricating oils.
ABSTRACT

Poly methacrylate copolymers are disclosed which comprising from about 80 to about 96 weight percent of a C12-C16 alkyl methacrylate and from about 40 to about 4 weight percent of a C18-C30 alkyl methacrylate and provide excellent low temperature properties to lubricating oils.
METHACRYLATE COPOLYMER POUR POINT DEPRESSANTS

TECHNICAL FIELD

This invention relates to polyalkyl methacrylate copolymers having excellent low temperature properties. The present invention also relates to the use of these copolymers as pour point depressants or viscosity improvers at low temperatures for lubricating oils.

BACKGROUND OF THE INVENTION

Polymethacrylate pour point depressants are well known in the lubricating industry. Many attempts have been made to produce polymethacrylate pour point depressants that improve the low temperature viscometrics of various lubricating compositions.

Pour point depressants (PPD) additives improve the low-temperature performance of an oil by modifying the wax crystallization process. A wide variety of chemical types are currently available, and include polyalkylmethacrylates, styrenated polyesters, alkylated polystyrenes, ethylene-vinyl acetate, vinyl acetate-fumarate, esterified olefinic, styrene maleic anhydride, and alkylated naphthalenes. The present invention is directed to alkyl methacrylate polymers which exhibit desired low temperature properties. More specifically, the invention is directed to PPDs that exhibit outstanding low temperature properties in lubricating oils for applications such as automatic transmission fluids, manual transmission fluids, hydraulic fluids, greases, gear fluids, metal-working fluids, engine oil applications, crankcase motor oil and shock absorber fluids. The oil chemist is constantly searching for PPDs that achieve optimum low-temperature performance at low concentrations. The present invention addresses the need for an improved PPD.

In particular, the invention addresses the need for a pour point depressant which can be used in a variety of oils at lower treat rates, displays less interactions with other components of the oil such as dispersants and inhibitors, shows stability in shear fields and lower gelation indices in some instances depending on the base oil than for previous pour point polyalkylmethacrylates. It is important that the PPD be soluble and compatible
with the base oil and maintain an appropriate scanning BROOKFIELD viscosity at low temperatures.

U.S. Patent No. 2,655,479 to Munday et al. claims a pour point depressant composition consisting of a blend of two copolymers, the first copolymer having an average side chain length of about 12.7 while the second copolymer has an average side chain length of about 11.2.

U.K. Patent No. 1,559,952 discloses a mixture of two classes of oil soluble polyalkyl (meth)acrylates as pour point depressants.

U.S. Patent No. 4,146,492 discloses lubricating oil compositions comprising between about 0.5 and 30 wt. % of a specifically defined ethylene-propylene copolymer and between about 0.005 to 10 wt. % of a neat interpolymeric polyalkylacrylate of (A) C1-C15 alkylacrylate and (B) C16-C22 alkylacrylate having a weight ratio of A:B of between about 90:10 and 50:50, a molecular weight of from 1000 to 25,000 and an average alkyl side chain length of between about 11 and 16 carbons.

U.S. Patent No. 4,867,894 discloses pour point improving additives for mineral oils comprising from 10 to 30 mole percent methyl methacrylate, 10 to 70 mole percent of a linear C16 to C30 alkyl methacrylate, from 10 to 80 mole percent of a C4-C15 linear alkyl methacrylate and/or a C4 to C40 branched methacrylate, and from 0 to 30 mole percent of a free-radically polymerizable nitrogen-containing monomer having dispersing action.

U.S. Patent Nos. 5,312,884 and 5,368,761 disclose copolymers useful as pour point depressants for lubricating oils comprising 15-67 mole percent C8-C15 alkyl (meth)acrylates, 3-40 mole percent C16-C24 (meth)acrylates, and from greater than 30-65 mole percent C1-C4 methacrylates. These patents do not teach copolymers containing the specific monomers in the specific proportions required by the present claims.

U.S. Patent No. 5,281,329 discloses copolymers useful as pour point depressants for oils containing at least two species of poly alkyl (meth)acrylate, one species having an onset of crystallization temperature above 15 °C and one species having an onset of crystallization temperature below 15 °C.
U.S. Patent No. 5,534,175 discloses copolymers of unsaturated fatty esters derived from 12-20 mass % of a C1-C3 (meth) acrylate, 45-72 mass % of a C11-C15 (meth) acrylate and 14-30 mass % of a C16-C25 (meth) acrylate.

EP 0 236 844 B1 teaches pour point improving agents derived from methyl methacrylate.

U.S. Patent No. 6,255,261 discloses copolymers formed from 5 to 60 weight percent C11-C15 (meth) acrylates and 95 to 40 weight % C16-C30 (meth) acrylates for use as pour point depressants.

SUMMARY OF THE INVENTION

The present invention is directed to polyalkyl methacrylates and their use as pour point depressants for lubricating oils.

The polyalkyl methacrylate copolymers of the present invention comprise units derived from:

(A) about 60 to about 96, weight percent of a C12-C16 alkyl methacrylate; and

(B) about 40 to about 4, weight percent of a C18-C30 alkyl methacrylate.

The poly alkyl methacrylate copolymer may be crosslinked or structured.

Addition of the poly alkyl methacrylate copolymer derived as above is added to an oil of lubricating viscosity to form a lubricating oil composition.

Furthermore the composition above is used to improve the low temperature properties of a lubricating oil.

DESCRIPTION OF THE DRAWINGS
Figure 1 illustrates pour point temperature as a function of concentration for the polyalkyl methacrylate of example 1 in an hydraulic oil compared to a commercial pour point depressant.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is directed to polyalkyl methacrylate copolymers comprising units derived from:

(A) about 60 to about 96, weight percent of a C12-C16 alkyl meth acrylate; and

(B) about 40 to about 4, weight percent of a C18-C30 alkyl meth acrylate.

Molecular Weight

The copolymers of the present invention have a relative weight average molecular weight ranging from about 5,000 to about 250,000. Typically, the weight average may range from about 10,000 to about 200,000, from about 15,000 to about 150,000 and most typically from about 20,000 to about 130,000. The molecular weight distribution is usually less than 2.5 and generally ranges from about 1.5 to about 2.5.

Crosslinked or Structured Copolymer

The poly alkyl methacrylate copolymer may be crosslinked, structured or branched.

Cross linking agents are usually polyethylenically unsaturated crosslinking agents. Examples are methylene bis(meth)acrylamide, polyethyleneglycol diacrylate; polyethyleneglycol dimethacrylate; N-vinyl acrylamide; divinylbenzene; tetra(ethyleneglycol) diacrylate; diallyloctylamide; trimethylpropane ethoxylate triacrylate; N-allylacrylamide N-methylallylacrylamide, pentaerythritol triacrylate and combinations thereof. Other systems for crosslinking can be used instead of or in addition to this. For instance covalent crosslinking through pendant groups can be achieved, for instance by the use of ethylenically unsaturated epoxy monomers, or by the use of polyfunctional crosslinking agents other known crosslinking systems.
Variation in components (A) and (B)

The component (A) may for example, vary from about 65 to about 95 weight percent or about 70 to about 95, about 80 to about 95, about 85 to about 95, about 88 to about 95 weight percent of the formed poly alkyl methacrylate copolymer.

The component (B) may for example, vary from about 35 to about 5 weight percent, or about 30 to about 5, about 20 to about 5, about 15 to about 5, about 12 to about 5 weight percent of the formed poly alkyl methacrylate copolymer.

For purposes of the invention, weight percent of components (A) and (B) of the formed alkyl methacrylate is calculated by taking total weight of component (A) or (B) over the total weight of the formed polyalkyl methacrylate copolymer multiplied by 100. For example, if component (A) weighs 80 g and the formed copolymer weighs 100g, then component (A) makes up 80 percent by weight of the formed copolymer. The basis weight of the formed copolymer is the copolymer per se and does not include the diluent.

Component (A)

As used herein, C12-C16 alkyl methacrylate means an alkyl ester of methacrylic acid having a straight or branched ester alkyl group of 12 to 16 carbon atoms per group such as, lauryl methacrylate, myristyl methacrylate, cetyl methacrylate, dodecyl methacrylate, tridecyl methacrylate, tetradecyl methacrylate, pentadecyl methacrylate, hexadecyl methacrylate and mixtures thereof. The preferred source for the C12-C16 alkyl methacrylate esters is lauryl methacrylate which contains a mixture of methacrylate esters formed from a mixture of C12 to C16 alcohols. For example, about 60 to about 96 weight percent lauryl methacrylate esters, about 65 to about 95 weight percent lauryl methacrylate esters make up the formed poly methacrylate copolymer. Alternatively, the weight percent lauryl methacrylate esters may vary as described above for component (A).
In the instance where lauryl methacrylate esters are used to make up component (A) of the polyalkyl methacrylate copolymers, the lauryl ester is derived from a straight or branched distribution of C12-C16 long chain alcohols. The weight percent compositions of the lauryl methacrylate esters may range as below:

<table>
<thead>
<tr>
<th>Chain length</th>
<th>Wt. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>C12</td>
<td>68 - 74</td>
</tr>
<tr>
<td>C14</td>
<td>20 - 26</td>
</tr>
<tr>
<td>C16</td>
<td>2 - 6</td>
</tr>
</tbody>
</table>

The weight percent of the various homologues in the lauryl methacrylate means weight percent on the basis of the total weight of the lauryl methacrylate fraction. Thus if the total lauryl methacrylate fraction is 100g and the C12 contribution is 68 g then the weight percent of the C12 is 68 weight % of the total lauryl methacrylate fraction.

It is preferable that component (A) is substantially linear. Furthermore, it is preferred that the C12-C16 esters contain only even ester chain lengths (C12, C14 and C16) but even and odd ester chain lengths (C12, C13, C14, C15 and C16) are also possible. In the case where only even chain lengths are used, the component (A) contains only C12, C14 and C16 esters.

Thus (A) may consist essentially of about 60 to about 96 weight percent C12, C14 and C16 alkyl methacrylates.

"Consists essentially of" for the purposes of the invention means that minor levels of other monomers, polymerizable with the alkyl methacrylates may be present as long as they do not adversely affect the low temperature properties of the fully formulated fluids.

Component (B)

As used herein, C18-C30 alkyl methacrylate means an alkyl ester of methacrylic acid having a straight or branched alkyl group of 18 to 30 carbon atoms per group such as, stearyl methacrylate, octadecyl methacrylate, heptadecyl methacrylate, nonadecyl meth
acrylate, eicosyl methacrylate, henicosyl methacrylate, docosyl methacrylate, tricosyl methacrylate, tetracosylmethacrylate, pentacosyl methacrylate, hexacosyl methacrylate, hexacosyl methacrylate, octacosyl methacrylate, nonacosyl methacrylate, triacontyl methacrylate, behenyl methacrylate and mixture thereof.

A typical source for the C18-C30 alkyl methacrylate esters is behenyl methacrylate esters. Behenyl methacrylate contains a range of long chain methacrylate esters wherein the length of the ester chain ranges from C18 to C22. For example, about 40 to about 4 weight percent of the behenyl methacrylate esters make up the formed poly alkylmethacrylate copolymer. For example, 35 to about 5 weight percent, about 30 to about 5, about 20 to about 5, about 15 to about 5 or about 12 to about 5 of the formed poly alkyl methacrylate copolymer is formed from behenyl methacrylate esters.

In the instance where behenyl methacrylate esters are used to make up component (B) of the poly alkyl methacrylate copolymers, the behenyl esters may be derived from a C18-C22 distribution of long chain alcohols. The weight percent compositions of the behenyl methacrylate esters may range as below:

**Behenyl Methacrylate Distribution**

<table>
<thead>
<tr>
<th>Chain length</th>
<th>Wt. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>C18</td>
<td>40 - 50</td>
</tr>
<tr>
<td>C20</td>
<td>5 - 15</td>
</tr>
<tr>
<td>C22</td>
<td>40 -50</td>
</tr>
</tbody>
</table>

When referring to distribution by weight percent of the particular ester in the behenyl methacrylate, the weight percent is based on the total weight of behenyl methacrylate.

Thus behenyl methacrylate may consist essentially of about 40 to about 50, preferably 42 to about 48 weight percent C18 alkylmethacrylate, about 5 to about 15, preferably 6.5 to about 12 weight percent C20 alkyl methacrylate and about 40 to about 50, preferably 42 to about 48 weight percent C22 alkyl methacrylate based on the total weight of behenyl methacrylate.
The behenyl methacrylate is substantially linear and contains substantially only C18 to C22 alkyl methacrylates.

The C16 and C18 fractions of alkyl methacrylates cumulative weight percent in the formed copolymer generally will not exceed about 22 to 23% weight percent. For example, the combined weight percent of the C16 and C18 fractions may be about 15, 16, 17, 18, 19 or 21 weight percent of the formed alkyl methacrylate from components (A) and (B) with a minimum of at least 7, 8 or 9 weight percent for the cumulative weight percent of C16 and C18 fractions. For example, the (A) and (B) components are further defined as comprising a combined weight percent of C16 and C18 fractions which combined fractions range from about a minimum of 7 weight percent to about a maximum of 23 weight percent based on the total weight of the poly methacrylate copolymer.

Furthermore, the alkyl methacrylates esters in component (B) which are equal to or greater than C20 makes up at least about 2 to about 22 weight percent of the formed poly alkyl methacrylate copolymer. For example, about 2.5, 3, 3.5, 4, 4.5, 5, 6, 7 or 8 weight percent of the formed poly alkyl methacrylate copolymer is derived from C20 to C30 alkyl methacrylates esters. The formed poly alkyl methacrylate copolymer contains a maximum of about 15, 16, 17, 18, 19, 20 or 22 weight percent of C20 to C30 alkyl methacrylate esters.

Thus, the (B) components are further defined as comprising a combined weight percent of C20 to C30 fractions which fractions range from about a minimum of 2 weight percent to about a maximum of about 22 weight percent based on the total weight of the poly alkyl methacrylate copolymer.

The C20-C24 homologues are preferred and the C20- C22 homologues are the most preferred homolog fractions of component (B). Thus for example, the C20-C22 homologues may make up about 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5 or 8 weight percent of the formed poly alkyl methacrylate copolymer or as much as about 22 weight percent.
In a preferred embodiment the sum of (A) and (B) equals 100 weight percent of the formed poly alkyl methacrylate copolymer.

The poly methacrylate PPD copolymers according to the invention may or may not contain C1-C10 alkyl methacrylates esters, or other polymerizable non-alkyl methacrylate monomers.

Preparation of Poly Alkyl Methacrylate PPD Copolymers

The alkyl methacrylate comonomers containing 12 or more carbon atoms in the alkyl ester group are generally prepared by standard esterification procedures using technical grades of long chain aliphatic alcohols. These commercially available alcohols are mixtures of alcohols of varying chain lengths containing between 12 and 30 carbon atoms in the alkyl groups. Consequently, for the purposes of this invention, alkyl meth acrylate comonomers are intended to include not only the individual alkyl methacrylate esters named, but also to include mixtures of the alkyl methacrylate esters.

Conventional methods of free-radical polymerization can be used to prepare the copolymers of the present invention. Polymerization of the acrylic methacrylate monomers can take place under a variety of conditions, including bulk polymerization, solution polymerization, usually in an organic solvent, preferably mineral oil.

In the solution polymerization, the reaction mixture comprises a diluent, the alkyl meth acrylate monomers, a polymerization initiator and usually a chain transfer agent and optionally a crosslinker.

The diluent may be any inert hydrocarbon. The ratio of diluent to total monomer charge may range from about 2:1 to about 0.6:2.0 For example a ratio of about 0.8:2.0 or 1:1.4 is normal. As used herein, "total monomer charge" means the combined amount of all monomers in the initial, i.e., unreacted, reaction mixture.

In preparing the copolymers of the present invention by free-radical polymerization the meth acrylic monomers may be polymerized simultaneously or sequentially or the monomers may be fed over time to the reaction vessel. For example, the blend of C12 to
C30 alkyl methacrylate monomers may be fed over time to a reaction vessel along with an initiator feed.

Suitable polymerization initiators include initiators which disassociate upon heating to yield a free radical, e.g., peroxide compounds such as benzoyl peroxide, t-butyl perbenzoate, t-butyl peroctoate and cumene hydroperoxide; and azo compounds such as azoisobutyronitrile and 2,2'-azobis (2-methylbutanenitrile). The mixture includes from about 0.01 wt % to about 5.0 wt % initiator relative to the total monomer mixture. For example, 0.02 wt. % to about 4.0 wt. %, 0.02 wt. % to about 3.5 wt. % are envisioned. Typically about 0.02 wt. % to about 2.0 wt. % are used.

Suitable chain transfer agents include those conventional in the art such as mercaptanes and alcohols. For example, dodecyl mercaptan and ethyl mercaptan may be used as chain transfer agents. The selection of the amount of chain transfer agent to be used is based on the desired molecular weight of the polymer being synthesized as well as the desired level of shear stability for the polymer, i.e., if a more shear stable polymer is desired, more chain transfer agent can be added to the reaction mixture. The chain transfer agent is added to the reaction mixture or monomer feed in an amount of 0.01 to 3 weight percent relative to the monomer mixture.

By way of example and without limitation, the reaction mixture is charged to a reaction vessel that is equipped with a stirrer, a thermometer and a reflux condenser and heated with stirring under a nitrogen blanket to a temperature from about 50 °C to about 125 °C for a period of about 0.5 hours to about 15 hours to carry out the polymerization reaction.

A viscous solution of the copolymer of the present invention in the diluent is obtained as the product of the above-described process.

To form the lubricating oils of the present invention, a base oil is treated with the copolymer of the invention in a conventional manner, i.e., by adding the copolymer to the base oil to provide a lubricating oil composition having the desired low temperature properties. The lubricating oil contains from about 0.01 to about 5.0 parts by weight, for example about 0.01 to about 2.0, more typically about 0.02 to about 0.5, of the neat
copolymers (i.e., excluding diluent oil) per 100 weight of base oil. The preferred dosage will of course depend upon the base oil.

In a particularly preferred embodiment, the copolymer is added to the base oil in the form of a relatively concentrated solution of the copolymer in a diluent. The diluent oil may be any of the oils referred to below that are suitable for use as base oils.

Base Oils

Preferred base oils contemplated for use in this invention include mineral oils, poly-alpha-olefin synthetic oils and mixtures thereof. Suitable base oils also include basestocks obtained by isomerization of synthetic wax and slack wax, as well as basestocks produced by hydrocracking (rather than solvent extracting) the aromatic and polar components of the crude. In general, both the mineral and synthetic base oils will each have a kinematic viscosity ranging from about 1 to about 40 cSt at 100 °C, although typical applications will require each oil to have a viscosity ranging from about 2 to about 20 cSt at 100 °C.

The mineral oils useful in this invention include all common mineral oil base stocks. This would include oils that are naphthenic, paraffinic or aromatic in chemical structure. Naphthenic oils are made up of methylene groups arranged in ring formation with paraffinic side chains attached to the rings. The pour point is generally lower than the pour point for paraffinic oils. Paraffinic oils comprise saturated, straight chain or branched hydrocarbons. The straight chain paraffins of high molecular weight raise the pour point of oils and are often removed by dewaxing. Aromatic oils are hydrocarbons of closed carbon rings of a semi-unsaturated character and may have attached side chains. This oil is more easily degraded than paraffinic and naphthenic oils leading to corrosive by-products.

In reality a base stock will normally contain a chemical composition which contains some proportion of all three (paraffinic, naphthenic and aromatic). For a discussion of types of base stocks, see Motor Oils and Engine Lubrication by A. Schilling, Scientific Publications, 1968, section 2.2 thru 2.5.
The poly methacrylate copolymer may be used in paraffinic, naphthenic and aromatic type oils. For example, the poly methacrylate copolymer may be used in Groups I–V base oils. These Groups are well known by the art skilled. Additionally, the poly methacrylate copolymer may be used in gas to liquid oils.

Oils may be refined by conventional methodology using acid, alkali, and clay or other agents such as aluminum chloride, or they may be extracted oils produced, for example, by solvent extraction with solvents such as phenol, sulfur dioxide, furfural, dichlordiethyl ether, etc. They may be hydrotreated or hydrorefined, dewaxed by chilling or catalytic dewaxing processes, or hydrocracked. The mineral oil may be produced from natural crude sources or be composed of isomerized wax materials or residues of other refining processes. The preferred synthetic oils are oligomers of α-olefins, particularly oligomers of 1-decene, also known as poly-alphaolefins or PAO's.

The base oils may be derived from refined, re-refined oils, or mixtures thereof. Unrefined oils are obtained directly from a natural source or synthetic source (e.g., coal, shale, or tar sands bitumen) without further purification or treatment. Examples of unrefined oils include a shale oil obtained directly from a retorting operation, a petroleum oil obtained directly from distillation, or an ester oil obtained directly from an esterification process, each of which is then used without further treatment. Refined oils are similar to the unrefined oils except that refined oils have been treated in one or more purification steps to improve one or more properties. Suitable purification techniques include distillation, hydrotreating, dewaxing, solvent extraction, acid or base extraction, filtration, and percolation, all of which are known to those skilled in the art. Re-refined oils are obtained by treating used oils in processes similar to those used to obtain the refined oils. These re-refined oils are also known as reclaimed or reprocessed oils and are often additionally processed by techniques for removal of spent additives and oils breakdown products.

Optional Customary Oil Additives
The addition of at least one additional customary oil additive to the composition is possible. The mentioned lubricant compositions, e.g. greases, gear fluids, metal-working fluids and hydraulic fluids, may additionally comprise further additives that are added in order to improve their basic properties still further. Such additives include: further antioxidants, metal passivators, rust inhibitors, viscosity index enhancers, additional
pour-point depressants, dispersants, detergents, further extreme-pressure additives and anti-wear additives. Such additives are added in the amounts customary for each of them, which range in each case approximately from 0.01 to 10.0%, preferably 0.1 to 1.0%, by weight. Examples of further additives are given below:

1. Examples of Phenolic Antioxidants:

1.1. Alkylated monophenols: 2,6-di-tert-butyl-4-methylphenol, 2-butyl-4,6-dimethylphenol, 2,6-di-tert-butyl-4-ethylphenol, 2,6-di-tert-butyl-4-n-butylphenol, 2,6-di-tert-butyl-4-isobutylphenol, 2,6-dicyclopentyl-4-methylphenol, 2-(alpha-methylcyclohexyl)-4,6-dimethylphenol, 2,6-dioctadecyl-4-methylphenol, 2,4,6-tricyclohexylphenol, 2,6-di-tert-butyl-4-methoxyethylphenol, linear nonylphenols or nonylphenols branched in the side chain, such as, for example, 2,6-dinonyl-4-methylphenol, 2,4-dimethyl-6-(1′-methylundec-1′-yl)-phenol, 2,4-dimethyl-6-(1′-methylheptadec-1′-yl)-phenol, 2,4-dimethyl-6-(1′-methyltridec-1′-yl)-phenol and mixtures thereof;

1.2. Alkylthiomethylphenols: 2,4-dioctylthiomethyl-6-tert-butylphenol, 2,4-dioctylthiomethyl-6-methylphenol, 2,4-dioctylthiomethyl-6-ethylphenol, 2,6-didodecylthiomethyl-4-nonylphenol;

1.3. Hydroquinones and alkylated hydroquinones: 2,6-di-tert-butyl-4-methoxyphenol, 2,5-di-tert-butylhydroquinone, 2,5-di-tert-amylhydroquinone, 2,6-diphenyl-4-octadecyloxyphenol, 2,6-di-tert-butylhydroquinone, 2,5-di-tert-butyl-4-hydroxyanisole, 3,5-di-tert-butyl-4-hydroxyanisole, 3,5-di-tert-butyl-4-hydroxyphenyl stearate, bis (3,5-di-tert-butyl-4-hydroxyphenyl) adipate;

1.4. Tocopherols: .alpha.-, .beta.-, .gamma. or .delta.-tocopherol and mixtures thereof (vitamin E);

1.5. Hydroxylated thiodiphenyl ethers: 2,2′-thio-bis(6-tert-butyl-4-methylphenol), 2,2′-thio-bis (4-octylphenol), 4,4′-thio-bis(6-tert-butyl-3-methylphenol), 4,4′-thio-bis(6-tert-butyl-2-methylphenol), 4,4′-thio-bis(3,6-di-sec-amylphenol), 4,4′-bis(2,6-dimethyl-4-hydroxyphenyl)disulfide;
1.6. Alkyldene bisphenols: 2,2'-methylenebis (6-tert-butyl4-methylphenol), 2,2'-methylene-bis (6-tert-butyl-4-ethylphenol), 2,2'-methylene-bis [4-methyl-6-[(alpha.methylcyclohexyl)phenol], 2,2'-methylene-bis (4-methyl-6-cyclohexylphenol), 2,2'-methylene-bis (6-nonyl-4-methylphenol), 2,2'-methylene-bis (4,6-di-tert-butylphenol), 2,2'-ethyldene-bis(4,6-di-tert-butylphenol), 2,2'-ethyldene-bis(6-tert-butyl-4-isobutylphenol), 2,2'-methylene-bis[6-(alpha.-methylbenzyl)-4-nonylphenol], 2,2'-methylene-bis[6-(alpha.,alpha.-dimethyl-benzyl)-4-nonylphenol], 4,4'-methylenebis(2,6-di-tert-butylphenol), 4,4'-methylenebis(6-tert-butyl-2-methylphenol), 1,1-bis(5-tert-butyl4-hydroxy-2-methylybenzyl)butane, 2,6-bis(3-tert-butyl-5-methyl-2-hydroxybenzyl)-4-methylphenol, 1,1,3-tris(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)-3-n-dodecylmercaptobutane, ethylene glycol bis[3,3-bis(3'-tert-butyl-4'-hydroxyphenyl)-butyrate], bis(3-tert-butyl-4-hydroxy-5-methylphenyl)dicyclopentadiene, bis[2-(3'-tert-butyl-2'-hydroxy-5'-methylbenzyl)-6-tert-butyl-4-methylphenyl]terephthalate, 1,1-bis(3,5-dimethyl-2-hydroxyphenyl)butane, 2,2-bis(3,5-di-tert-butyl-4-hydroxyphenyl)-propane, 2,2-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)-4-n-dodecylmercaptobutane, 1,1,5,5-tetra(5-tert-butyl-4-hydroxy-2-methylphenyl)pentane;

1.7. O-, N- and S-benzyl compounds: 3,5,3',5'-teta-tert-butyl-4,4'-dihydroxydibenzyl ether, octadeyl-4-hydroxy-3,5-dimethylbenzyl-mercaptoacetate, tridecy1-4-hydroxy-3,5-di-tert-butylbenzyl-mercaptoacetate, tris (3,5-di-tert-butyl-4-hydroxybenzyl)amine, bis(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl)dithiophthalate, bis(3,5-di-tert-butyl-4-hydroxybenzyl)sulfide, isooctyl-3,5-di-tert-butyl-4-hydroxybenzyl-mercaptoacetate;

1.8. Hydroxybenzylated malonates: dioctadecyl-2,2-bis(3,5-di-tert-butyl-2-hydroxybenzyl)malonate, dioctadecyl-2-(3-tert-butyl-4-hydroxy-5-methylbenzyl)malonate, didodecyl-mercaptoethyl-2,2-bis(3,5-di-tert-butyl-4-hydroxybenzyl) malonate, di[4-(1,1,3,3-tetramethylbutyl)-phenyl]-2,2-bis(3,5-di-tert-butyl-4-hydroxy ybenzyl)malonate;

1.9. Hydroxybenzyl aromatic compounds: 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene, 1,4-bis(3,5-di-tert-butyl-4-hydroxybenzyl)-2,3,5,6-tetramethylbenzene, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxybenzyl)phenol;
1.10. Triazine compounds: 2,4-bis-octylmercapto-6-(3,5-di-tert-butyl-4-hydroxyanilino)-1,3,5-triazine, 2-octylmercapto-4,6-bis(3,5-di-tert-butyl-4-hydroxyanilino)-1,3,5-triazine, 2-octylmercapto-4,6-bis(3,5-di-tert-butyl-4-hydroxyphenoxo)-1,3,5-triazine, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxyphenoxo)-1,2,3-triazine, 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)isocyanurate, 1,3,5-tris(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl)isocyanurate, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxyphenylethyl)-1,3,5-triazine, 1,3,5-tris(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hexahydro-1,3,5-triazine, 1,3,5-tris(3,5-dicyclohexyl-4-hydroxybenzyl)isocyanurate;

1.11. Acylaminophenols: 4-hydroxylauric acid anilide, 4-hydroxystearic acid anilide, N-(3,5-di-tert-butyl-4-hydroxyphenyl)-carbamic acid octyl ester;

1.12. Esters of \( \beta \)-(5-tert-butyl-4-hydroxy-3-methylphenyl) propionic acid: with polyhydric alcohols, e.g. with 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl)isocyanurate, N,N'-bis (hydroxyethyl) oxalic acid diamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane;

1.13. Esters of \( \beta \)-(3,5-di-tert-butyl-4-hydroxyphenyl) propionic acid, \( \gamma \)-(3,5-dicyclohexyl-4-hydroxyphenyl) propionic acid, 3,5-di-tert-butyl-4-hydroxyphenylacetic acid: with mono- or polyhydric alcohols, e.g. with methanol, ethanol, n-octanol, isoctanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl)isocyanurate, N,N'-bis-hydroxyethyl oxalic acid diamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane;

1.14. Amides of \( \beta \)-(3,5-di-tert-butyl-4-hydroxyphenyl) propionic acid: N,N'-bis (3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hexamethylenediamine, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)trimethylenediamine, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hydrazine;
1.15. Ascorbic acid (vitamin C);

1.16. Aminic antioxidants: N,N'-diisopropyl-p-phenylenediamine, N,N'-di-sec-butyl-p-phenylenediamine, N,N'-bis(1,4-dimethylpentyl)-p-phenylenediamine, N,N'-bis(1-ethyl-3-methylpentyl)-p-phenylenediamine, N,N'-bis(1-methylheptyl)-p-phenylenediamine, N,N'-dicyclohexyl-p-phenylenediamine, N,N'-diphenyl-p-phenylenediamine, N,N'-di(naphth-2-yl)-p-phenylenediamine, N-isopropyl-N'-phenyl-p-phenylenediamine, N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine, N-(1-methylheptyl)-N'-phenyl-p-phenylenediamine, N-cyclohexyl-N'-phenyl-p-phenylenediamine, 4-(p-toluene sulfonamido)-diphenylamine, N,N'-dimethyl-N,N'-di-sec-butyl-p-phenylenediamine, diphenylamine, N-allyldiphenylamine, 4-isopropoxydiphenylamine, 4-n-butylaminophenol, 4-butrylaminophenol, 4-nanonoylamino phenol, 4-dodecanoylamino phenol, 4-octadecanoylamino phenol, di(4-methoxyphenyl)amine, 2,6-di-tert-butyl-4-dimethylaminomethyl phenol, 2,4'-diaminodiphenylmethane, 4,4'-diaminodiphenylmethane, N,N,N',N'-tetramethyl-4,4'-diaminodiphenylmethane, 1,2-di[(2-methylphenyl)amino]-ethane, 1,2-di[(phenylamino)propane, (o-toly)biguanide, di[4-(1',3'-dimethylbutyl)phenyl]amine, tert-octylated N-phenyl-1-naphthylamine, mixture of mono- and di-alkylated tert-butyl/tert-octyl-diphenylamines, mixture of mono- and di-alkylated nonyldiphenylamines, mixture of mono- and di-alkylated dodecyl diphenylamines, mixture of mono- and di-alkylated isopropyl/isohexyl-diphenylamines, mixtures of mono- and di-alkylated tert-butyl diphenylamines, 2,3-dihydro-3,3-dimethyl-4H-1,4-benzothiazine, phenothiazine, mixture of mono- and di-alkylated tert-butyl/tert-octyl phenothiazines, mixtures of mono- and di-alkylated tert-octyl phenothiazines, N-allyl phenothiazine, N,N,N',N'-tetraphenyl-1,4-diaminobut-2-ene, N,N-bis(2,2,6,6-tetramethylpiperidin-4-yl) hexamethylenediamine, bis(2,2,6,6-tetramethylpiperidin-4-yl) sebacate, 2,2,6,6-tetramethylpiperidin-4-one, 2,2,6,6-tetramethylpiperidin-4-ol.

2. Examples of further antioxidants: aliphatic or aromatic phosphites, esters of thiodipropionic acid or thiodiacetic acid or salts of dithiocarbamic acid, 2,2,12,12-tetramethyl-5,9-dihydroxy-3,7,11-trithiatridecane and 2,2,15,15-tetramethyl-5,12-dihydroxy-3,7,10,14-tetra thiahexadecane.

3. Examples of Metal Deactivators. e.g. for Copper:
3.1. Benzotriazoles and derivatives thereof: 2-mercaptobenzotriazole, 2,5-dimercaptobenzotriazole, 4- or 5-alkylbenzotriazoles (e.g. tolutriazole) and derivatives thereof, 4,5,6,7-tetrahydrobenzotriazole, 5,5'-methylene-bis-benzotriazole; Mannich bases of benzotriazole or tolutriazole, such as 1-[di(2-ethylhexyl)aminomethyl]tolutriazole and 1-[di(2-ethylhexyl)aminomethyl]benzotriazole; alkoxyalkylbenzotriazoles, such as 1-(nonyloxy-methyl)benzotriazole, 1-(1-butoxyethyl)-benzotriazole and 1-(1-cyclohexyloxybutyl)-tolutriazole;

3.2. 1,2,4-Triazoles and derivatives thereof: 3-alkyl-(or -aryl-) 1,2,4-triazoles, Mannich bases of 1,2,4-triazoles, such as 1-[di(2-ethylhexyl)aminomethyl]-1,2,4-triazole; alkoxyalkyl-1,2,4-triazoles, such as 1-(1-butoxyethyl)-1,2,4-triazole; acylated 3-amino-1,2,4-triazoles;

3.3. Imidazole derivatives: 4,4'-methylene-bis(2-undecyl-5-methyl) imidazole and bis [(N-methyl)imidazol-2-yl]carbinol-octyl ether;

3.4. Sulfur-containing heterocyclic compounds: 2-mercaptobenzothiazole, 2,5-dimercapto-1,3,4-thiadiazole, 2,5-dimercaptobenzothiadiazole and derivatives thereof; 3,5-bis [di(2-ethylhexyl)aminomethyl]-1,3,4-thiadiazolin-2-one;

3.5. Amino compounds: salicylidene-propylenediamine, salicylaminoguanidine and salts thereof.

4. Examples of Rust Inhibitors:

4.1. Organic acids, their esters, metal salts, amine salts and anhydrides: alkyl- and alkenylsuccinic acids and their partial esters with alcohols, diols or hydroxycarboxylic acids, partial amides of alkyl- and alkenyl-succinic acids, 4-nonylphenoxycetic acid, alkoxy- and alkoxyethoxy-carboxylic acids, such as dodecylxyacetic acid, dodecylxy (ethoxy) acetic acid and amine salts thereof, and also N-oleoyl-sarcosine, sorbitan monooleate, lead naphthenate, alkenylsuccinic acid anhydrides, e.g. dodecenyllsuccinic acid anhydride, 2-(2-carboxyethyl)-1-dodecyl-3-methylglycerol and salts thereof, especially sodium and triethanolamine salts thereof.
4.2. Nitrogen-containing Compounds:

4.2.1. Tertiary aliphatic or cycloaliphatic amines and amine salts of organic and inorganic acids, e.g. oil-soluble alkylammonium carboxylates, and 1-[N,N-bis(2-hydroxyethyl)amino]-3-(4-nonylphenoxy)propan-2-ol;

4.2.2. Heterocyclic compounds: substituted imidazolines and oxazolines, e.g. 2-heptadecenyl-1-(2-hydroxyethyl)-imidazoline;

4.2.3. Sulfur-containing compounds: barium dinonylnaphthalene sulfonates, calcium petroleum sulfonates, alkylthio-substituted aliphatic carboxylic acids, esters of aliphatic 2-sulfocarboxylic acids and salts thereof.

5. Examples of viscosity index enhancers: polyacrylates, polymethacrylates, nitrogen containing polymethylmethacrylates, vinylpyrrolidone/methacrylate copolymers, polyvinylpyrrolidones, polybutenes, polyisobutenes, olefin copolymers such as ethylene-propylene copolymers, styrene-isoprene copolymers, hydrated styrene-isoprene copolymers, styrene/acrylate copolymers and polyethers. Multifunctional viscosity improvers, which also have dispersant and/or antioxidancy properties are known and may optionally be used in addition to the products of this invention.


7. Examples of dispersants/surfactants: polybutenylsuccinic acid amides or imides, polybutenylphosphonic acid derivatives, basic magnesium, calcium and barium sulfonates and phenolates.

8. Examples of extreme-pressure and anti-wear additives: sulfur- and halogen-containing compounds, e.g. chlorinated paraffins, sulfurized olefins or vegetable oils (soybean oil, rape oil), alkyl- or aryl-di- or -tri-sulfides, benzotriazoles or derivatives thereof, such as bis (2-ethylhexyl) aminomethyl toltriazoles, dithiocarbamates, such as methylene-bis-dibutyldithiocarbamate, derivatives of 2-mercaptobenzothiazole, such as 1-[N,N-bis(2-ethylhexyl)aminomethyl]-2-mercapto-1H-1,3-benzothiazole, derivatives of
2,5-dimercapto-1,3,4-thiadiazole, such as 2,5-bis(tert-nonylidithio)-1,3,4-thiadiazole.

9 Examples of coefficient of friction reducers: lard oil, oleic acid, tallow, rape oil, sulfurized fats, amides, amines. Further examples are given in EP-A-0 565 487.

10. Examples of special additives for use in water/oil metal-working fluids and hydraulic fluids: Emulsifiers: petroleum sulfonates, amines, such as polyoxyethylated fatty amines, non-ionic surface-active substances; buffers: such as alkanolamines; biocides: triazines, thiazolinones, tris-nitromethane, morpholine, sodium pyridenethiol; processing speed improvers: calcium and barium sulfonates.

The inventive pour point depressant may be admixed with the above-mentioned directly in a lubricant. It is also possible to prepare a concentrate or a so-called "additive pack", which can be diluted to give the working concentrations for the intended lubricant.

Lubricating oils containing the copolymers of the present invention may be used in a number of different applications including automatic transmission fluids, manual transmission fluids, hydraulic fluids, greases, gear fluids, metal-working fluids, engine oil applications and shock absorber fluids.

EXAMPLES

Example 1

Synthesis of Lauryl-Behenyl Methacrylate Copolymer- 90/10 Monomer Weight Ratio

140 g of high temperature oil (neutral hydrotreated oil) is charged to a reactor and heated to 95 °C under nitrogen. T-butyl peroctoate, 0.406 g in 7.7 g of oil is added to the heated oil in the reactor. Two separate parallel feeds are setup for metering into the reactor. The first feed is made up of a mixture of 252.00 g of lauryl methacrylates, 28 grams of behenyl methacrylate, 1.12 grams of dodecyl mercaptan (DDM) and 235.20 grams of high temperature oil and is metered over a 2 hour period. The second feed consists of 1.22 g t-butyl peroctoate in 23.14 g of oil and is fed over a 3 hour period. At the end of 2 hours the feed rate, the second feed rate is doubled. The reaction is held for
an additional hour at 95 °C after which an additional charge of initiator, 0.560 g in 10.64 g oil is added to the reaction and held for one more hour at 95 °C.

Table I
The resulting composition of the poly alkyl methacrylate copolymer formed is:

<table>
<thead>
<tr>
<th>Polymer Components</th>
<th>Weight % Based on Total Weight of Copolymer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dodecylmethacrylate</td>
<td>61</td>
</tr>
<tr>
<td>Tetradecylmethacrylate</td>
<td>23</td>
</tr>
<tr>
<td>Hexadecylmethacrylate</td>
<td>7</td>
</tr>
<tr>
<td>Octadecylmethacrylate</td>
<td>4</td>
</tr>
<tr>
<td>Eicosylmethacrylate</td>
<td>1</td>
</tr>
<tr>
<td>Docosylmethacrylate</td>
<td>4</td>
</tr>
</tbody>
</table>

Application Data for Pour Point Depressant

Table 2
Properties of 0.2 weight percent PPD in 5W30 Engine oil

<table>
<thead>
<tr>
<th>PPD&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Pour Point (°C)</th>
<th>Scanning BROOKFIELD Viscosity -35 °C (cP)</th>
<th>Kinematic Viscosity 40 °C (cSt)</th>
<th>Gelation Temp. 0.2 wt. %, 5W30 (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison&lt;sup&gt;2&lt;/sup&gt; example</td>
<td>-42 (-39)</td>
<td>244,000</td>
<td>35.82</td>
<td>-22</td>
</tr>
<tr>
<td>Example 1</td>
<td>-45</td>
<td>80,600</td>
<td>35.5</td>
<td>-25.5</td>
</tr>
</tbody>
</table>

1. The pour point depressant (PPD) is in the solvent used to synthesis the PPD in example 1. The solvent is a neutral hydrotreated oil.
2. The comparison example is a commercially available poly alkyl methacrylate copolymer. The polymer is formed from long chain esters of methacrylate (=C12 ). The pour point in parenthesis represents a second run of the same test.
The above tests are well known to one skilled in the art. The scanning BROOKFIELD viscosity is determined by ASTM D2983. Kinematic Viscosity is determined by ASTM D445. Pour point is determined by ASTM D5950 and Gelation Temperature is determined by ASTM5153.

Pour Point as a Function of Concentration

Figure 1 illustrates the pour point as a function of concentration for a commercial pour point depressant and example 1 in an hydraulic type oil. The commercial pour point depressant is also a long chain poly alkyl methacrylate copolymer. The graph illustrates the surprising improved efficiency of example 1 as compared to the commercially available pour point depressant. Lower concentrations of example 1 are required to achieve the same or lower pour point values.

Viscosity as a Function of Temperature
The copolymer of example 1 and a commercial pour point depressant are each added separately to a fully formulated 5W30 engine oil. The viscosity for both samples is observed across a range of temperatures (-35.0 °C to -5.0 °C). The copolymer of example 1 at a concentration of 0.05 weight percent in the engine oil achieves the same viscosity profile as a 0.1 weight percent concentration for the commercially available pour point depressant. The commercial pour point depressant is also a long chain poly alkyl methacrylate. Thus the copolymer of example 1 is found to be twice as efficient as the commercial pour point depressant in achieving the same temperature/viscosity profile.

Table 3
Pour Point and Scanning BROOKFIELD Viscosity in Type II oil with 0.2 wt. % of the Poly alkylmethacrylate formed in example 1.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Pour Point (°C)</th>
<th>Scanning BROOKFIELD Viscosity at -40 °C (Cps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type II Oil</td>
<td>-58</td>
<td>14,777</td>
</tr>
<tr>
<td>Type II Oil with 0.2 wt. %</td>
<td>-56</td>
<td>8,648</td>
</tr>
<tr>
<td>example 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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We claim:

1. A polyalkyl methacrylate copolymer comprising units derived from:

   (A) about 60 to about 96, weight percent of a C12-C16 alkyl methacrylate; and

   (B) about 40 to about 4, weight percent of a C18-C30 alkyl methacrylate.

2. The copolymer of claim 1 wherein the copolymer has a weight average molecular weight of from about 5,000 to about 250,000.

3. The copolymer of claim 1 wherein the copolymer is crosslinked.

4. The copolymer of claim 1 wherein component (A) is about
   about 85 to about 95 weight percent, preferably about 70 to about 95, and most
   preferably about 80 to about 95 weight percent of the formed poly alkyl methacrylate
   copolymer.

5. The copolymer of claim 1 wherein component (B) is about
   35 to about 5 weight percent, preferably about 30 to about 5 and most preferably about
   20 to about 5 weight percent of the formed poly alkyl methacrylate copolymer.

6. The component (B) of claim 1 is a straight or branched alkyl ester of methacrylic acid
   selected from the group consisting of stearyl methacrylate, octadecyl methacrylate,
   heptadecyl methacrylate, nonadecyl meth acrylate, eicosyl methacrylate, henicosyl
   methacrylate, docosyl methacrylate, tricosyl methacrylate, tetracosylmethacrylate,
   pentacosyl methacrylate, hexacosyl methacrylate, hexacosyl methacrylate, octacosyl
   methacrylate, nonacosyl methacrylate, triacontyl methacrylate, behenyl methacrylate
   and mixture thereof.

7. The component (A) of claim 1 is a straight or branched alkyl ester of methacrylic acid
   selected from the group consisting of lauryl methacrylate, myristyl methacrylate, cetyl
   methacrylate, dodecyl methacrylate, tridecyl methacrylate, tetradecyl methacrylate,
   pentadecyl methacrylate, hexadecyl methacrylate and mixtures thereof.
8. A copolymer of claim 1 wherein component (A) is lauryl methacrylate and component (B) is behenyl methacrylate.

9. A copolymer of claim 8 wherein the behenyl methacrylate consists of essentially about 40 to about 50, preferably 42 to about 48 weight percent C18 alkylmethacrylate, about 5 to about 15, preferably 6.5 to about 12 weight percent C20 alkyl methacrylate and about 40 to about 50, preferably 42 to about 48 weight percent C22 alkyl methacrylate based on the total weight of behenyl methacrylate.

10. A copolymer of claim 1 wherein the (A) and (B) components are further defined as comprising a combined weight percent of C16 and C18 fractions which combined fractions range from about a minimum of 7 weight percent to about a maximum of 23 weight percent based on the total weight of the poly alkyl methacrylate copolymer.

11. A copolymer of claim 1 wherein the (B) components are further defined as comprising a combined weight percent of greater than C20 fractions which fractions range from about a minimum of 2 weight percent to about a maximum of 22 weight percent based on the total weight of the poly alkyl methacrylate copolymer.

12. A lubricating oil composition comprising:

(i.) an oil of lubricating viscosity; and

(ii.) a poly alkyl methacrylate copolymer according to claim 1.

13. The lubricating oil composition of claim 12 wherein component (ii.) is present in an amount of from 0.01 to about 5 parts by weight of active copolymer per 100 parts by weight of oil.

14. The lubricating oil composition of claim 13 wherein the component (ii.) is present in an amount of from 0.025 to about 1 part by weight of active copolymer per 100 parts by weight of oil.
15. The lubricating oil composition of claim 12 further comprising at least one additive selected from the group consisting of oxidation inhibitors, corrosion inhibitors, friction modifiers, antiwear and extreme pressure agents, detergents, dispersants, antifoamants, viscosity index improvers and additional pour point depressants.

16. The lubricating oil composition of claim 12 wherein the lubricating oil is an automatic transmission fluid, a manual transmission fluid, an hydraulic fluid, a grease, a gear fluid, a metal-working fluid, a crankcase engine oil or shock absorber fluid.

17. A method for improving the low temperature properties of a lubricating oil, said method comprises adding to an oil of lubricating viscosity a poly alkyl methacrylate copolymer according to claim 1.

18. A lubricating fluid comprising:

(i) an oil of lubricating viscosity;

(ii) a poly alkyl methacrylate copolymer according to claim 1; and a detergent/inhibitor package, wherein the detergent/inhibitor package comprises at least one additive selected from the group consisting of oxidation inhibitors, corrosion inhibitors, friction modifiers, antiwear and extreme pressure agents, detergents, dispersants, antifoamants, and additional pour point depressants.

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Patent Agents
Pour Point in N100DW Oil

- Commercial Product
- Polymer of This Invention

Pour Point (°C)

Concentration (Wt %)