

Description**FIELD OF THE INVENTION**

The present invention relates to the use of a copolymer of a polyoxyalkylene alkenyl ether and maleic anhydride, acid salt or ester as a lubricating agent.

BACKGROUND OF THE INVENTION

Polyoxyalkylene glycol derivatives are used as lubricating oils in various applications. For example, water-soluble polyoxyalkylene glycol derivatives are used as hydraulic oils, cutting oil, grinding oil, gear oil, etc., polymers of polyoxyalkylene glycol (meth)acrylates are used as water-soluble lubricants (JP-A-56-47411), and compounds obtained by esterifying alkylene oxide adducts of castor oil are used as metal-working oils (JP-A-57-207699), while oil-soluble polyoxyalkylene glycol derivatives are used as viscosity index improvers for mineral oils (JP-B-53-44196), a refrigerating machine oil (JP-A-57-51795), etc. (The terms "JP-A" and "JP-B" as used herein mean an "unexamined published Japanese patent application" and an "examined Japanese patent publication", respectively.)

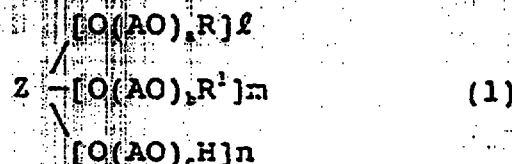
However, polymers of polyoxyalkylene glycol (meth)acrylates and derivatives of castor oil are defective in that their performances change if they are used in the form of an aqueous solution for a prolonged period of time, while oil-soluble polyoxyalkylene glycols also have the problem that their applications are limited since not only they are quite insoluble in water although quite soluble in mineral oils, but it is impossible to emulsify mineral oils or the like in water.

EP-A-0373621 and EP-A-0379676 disclose copolymers of a maleic derivative such as an ester, acid or anhydride with a polyoxyalkylene alkenyl ether. Such copolymers are used as emulsifiers, dispersants, additives for cement, or as dispersion-stabilizing agents for inorganic powders in an oily material.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide the use of a copolymer of polyoxyalkylene alkenyl ether and maleic anhydride, acid, salt or ester as a lubricating agent, alone or in any of an aqueous solution, oily solution, and water-oil emulsion form.

The lubricating oil of the present invention comprises a copolymer of monomers comprising as essential ingredients a compound represented by formula (1) and one of maleic anhydride, maleic acid, a salt of maleic acid, and an ester of maleic acid



where Z represents a residue of a compound having from 2 to 8 hydroxyl groups; AO represents one or more kinds of oxyalkylene groups each having from 2 to 18 carbon atoms, provided that in the case of two or more kinds of oxyalkylene groups, the oxyalkylene groups are linked to one another in either a block or a random arrangement; R represents an alkenyl group having from 2 to 5 carbon atoms; R¹ represents a hydrocarbon or acyl group having from 1 to 24 carbon atoms; and a ≥ 0, b ≥ 0, c ≥ 0, ℓ is a positive integer, and m and n independently are 0 or a positive integer, provided ℓ + m + n = 2 to 8, n/(ℓ + m) ≤ 1/2, and aℓ + bm + cn = 1 to 1,000.

DETAILED DESCRIPTION OF THE INVENTION

Examples of the compound a residue of which is Z in formula (1) and which has from 2 to 8 hydroxyl groups include polyhydric phenols such as catechol, resorcin, hydroquinone, and phloroglucin; polyhydric alcohols such as ethylene glycol, propylene glycol, butylene glycol, dodecylene glycol, octadecylene glycol, neopentyl glycol, styrene glycol, glycerol, diglycerol, polyglycerol, trimethylolthane, trimethylolpropane, 1,3,5-pentane-triol, erythritol, pentaerythritol, dipentaerythritol, sorbitol, sorbitan, sorbide, a sorbitol-glycerol condensate, adonitol, arabitol, xylitol, and mannitol; saccharides such as xylose, arabinose, ribose, rhamnose, glucose, fruc-

tose, galactose, mannose, sorbose, cellobiose, maltose, isomaltose, trehalose, sucrose, raffinose, gentianose, and melezitose; and products of partial etherification or partial esterification of above compounds.

Examples of the oxyalkylene group having from 2 to 18 carbon atoms and represented by AO include an oxyethylene group, an oxypropylene group, an oxybutylene group, an oxytetramethylene group, an oxystyrene group, an oxydodecylene group, an oxytetradecylene group, an oxyhexadecylene group, and an oxyoctadecylene group. Of these, oxyalkylene groups having from 2 to 4 carbon atoms are particularly preferred.

Examples of the alkenyl group having from 2 to 5 carbon atoms and represented by R include a vinyl group, an allyl group, a methallyl group, a 3-butenyl group, a 4-pentenyl group, and a 3-methyl-3-butenyl group.

Examples of the hydrocarbon group having from 1 to 24 carbon atoms and represented by R¹ include a methyl group, an ethyl group, a propyl group, an isopropyl group, a butyl group, an isobutyl group, a tert-butyl group, a pentyl group, an isopentyl group, a hexyl group, a heptyl group, a decyl group, an undecyl group, a dodecyl group, an isotridecyl group, a tetradecyl group, a hexadecyl group, an isohexadecyl group, an octadecyl group, an isooctadecyl group, an oleyl group, an octyldodecyl group, a docosyl group, a decyltetradecyl group, a benzyl group, a cresyl group, a butylphenyl group, a dibutylphenyl group, an octylphenyl group, a nonylphenyl group, a dodecylphenyl group, a dioctylphenyl group, a dinonylphenyl group, a naphthyl group, and a styrenated phenyl group. Examples of the acyl group represented by R¹ include those derived from acetic acid, propionic acid, butyric acid, isobutyric acid, caprylic acid, pelargonic acid, 2-ethylhexanoic acid, capric acid, undecylenic acid, lauric acid, myristic acid, palmitic acid, margaric acid, stearic acid, arachic acid, behenic acid, palmitoleic acid, oleic acid, linoleic acid, linolenic acid, erucic acid, isopalmitic acid, isostearic acid, benzoic acid, hydroxybenzoic acid, cinnamic acid, and gallic acid.

Examples of the salt of maleic acid include alkali metal salts such as a lithium salt, a sodium salt, a potassium salt; alkaline earth metal salts such as a magnesium salt and calcium salt; an ammonium salt; and organic amine salts.

Examples of the organic amine salt include salts of aliphatic or aromatic monoamines such as a methylamine salt, an ethylamine salt, a propylamine salt, a butylamine salt, a pentylamine salt, a hexylamine salt, an octylamine salt, a 2-ethylhexylamine salt, a decylamine salt, a dodecylamine salt, an isotridecylamine salt, a tetradecylamine salt, a hexadecylamine salt, an isohexadecylamine salt, an octadecylamine salt, an isooctadecylamine salt, an octyldodecylamine salt, a docosylamine salt, a decyltetradecylamine salt, an oleylamine salt, a linolamine salt, a dimethylamine salt, a trimethylamine salt, and an aniline salt; polyamine salts such as an ethylenediamine salt, a tetramethylenediamine salt, a dodecylpropylenediamine salt, a tetradecylpropylenediamine salt, a hexadecylpropylenediamine salt, an octadecylpropylenediamine salt, an oleylpropylenediamine salt, a diethylenetriamine salt, a triethylenetetramine salt, a tetraethylenepentamine salt, and a pentaethylenhexamine salt; alkanolamine salts such as a monoethanolamine salt, a diethanolamine salt, a triethanolamine salt, a monoisopropanolamine salt, a diisopropanolamine salt, a triisopropanolamine salt, salts of alkylene oxide adducts of these amines, and salts of alkylene oxide adducts of mono- or diamines; and amino acid salts such as a lysine salt and an arginine salt. Particularly preferred of these are alkali metal salts, an ammonium salt, and alkanolamine salts.

Examples of the maleic acid ester include esters with alcohols such as methanol, ethanol, allyl alcohol, methallyl alcohol, propanol, isopropanol, butanol, isobutanol, tert-butanol, pentanol, isopentanol, hexanol, heptanol, 2-ethylhexanol, octanol, nonanol, decanol, undecanol, dodecanol, isotridecanol, tetradecanol, hexadecanol, isocetyl alcohol, octadecanol, isostearyl alcohol, oleyl alcohol, octyldodecanol, docosanol, and decyltetradecanol, and with alkylene oxide adducts of these alcohols; and maleic acid esters with alkylene oxide adducts of phenols such as phenol, cresol, butylphenol, octylphenol, nonylphenol, dodecylphenol, catechol, resorcinol, hydroquinone, and phloroglucinol. Examples of the maleic acid ester further include maleic acid esters with: polyhydric alcohols such as ethylene glycol, propylene glycol, butylene glycol, dodecylene glycol, octadecylene glycol, neopentyl glycol, styrene glycol, glycerol, diglycerol, polyglycerol, trimethylolethane, trimethylolpropane, 1,3,5-pentanetriol, erythritol, pentaerythritol, dipentaerythritol, sorbitol, sorbitan, sorbide, a sorbitolglycerol condensate, adonitol, arabitol, xylitol, and mannitol; saccharides such as xylose, arabinose, ribose, rhamnose, glucose, fructose, galactose, mannose, sorbose, cellobiose, maltose, isomaltose, trehalose, sucrose, raffinose, gentianose, and melezitose; products of partial etherification or partial esterification of the above polyhydric alcohols and saccharides, or alkylene oxide adducts of the above polyhydric alcohols and saccharides; alkylene oxide adducts of aliphatic or aromatic monoamines such as methylamine, ethylamine, propylamine, butylamine, amylamine, hexylamine, octylamine, 2-ethylhexylamine, decylamine, dodecylamine, isotridecylamine, tetradecylamine, hexadecylamine, isohexadecylamine, octadecylamine, isooctadecylamine, octyldodecylamine, docosylamine, decyltetradecylamine, oleylamine, linolamine, dimethylamine, trimethylamine, and aniline; alkylene oxide adducts of polyamines such as ethylenediamine, tetramethylenediamine, dodecylpropylenediamine, tetradecylpropylenediamine, hexadecylpropylenediamine, octadecylpropylenediamine, oleylpropylenediamine, diethylenetriamine, triethylenetetramine, tetraethylenepentamine, and pentaethylene-

hexamine; and alkanolamines such as monoethanolamine, diethanolamine, triethanolamine, mono isopropanolamine, diisopropanolamine, and triisopropanolamine, and alkylene oxide adducts of these alkanolamines.

The copolymer employed in the present invention can be obtained by copolymerizing the compound represented by formula (1) with maleic anhydride, maleic acid, a salt of maleic acid, or an ester of maleic acid by use of a radical catalyst. However, in the case of the copolymer with maleic acid or with a salt or an ester thereof, it is convenient to obtain the copolymer through the hydrolysis, the hydrolysis and subsequent neutralization or the esterification of a copolymer with maleic anhydride.

In the copolymerization of the compound represented by formula (1) with maleic anhydride, maleic acid, a maleic acid salt, or a maleic acid ester, the ratio of the compound of formula (1) to its comonomer is from 3:7 to 7:3 in terms of equivalent based on polymerizable double bond, with the particularly preferred ratio being about 1:1. In performing the copolymerization, other monomers may be added for copolymerization with the above monomers, but the amount of such other monomers used is not more than 30 mole% based on the total amount of all the monomers.

Examples of such other monomers include acrylic acid, methacrylic acid, itaconic acid, crotonic acid, salts of these acids with mono- or divalent metals, ammonium salts of the above acids, organic amine salts of the above acids, and esters of the above acids with alcohols having 1 to 24 carbon atoms, polyhydric alcohols, or with polyoxyalkylene glycols. Examples of other monomers further include aromatic vinyl compounds such as styrene and methylstyrene, halogenated vinyl compounds such as vinyl chloride and vinylidene chloride, olefins such as isobutylene and diisobutylene, vinyl acetate, acrylonitrile, and acrylamide.

The weight-average molecular weight of the copolymer is generally from 1,000 to 2,000,000, preferably from 3,000 to 500,000.

The number of carbon atoms in R is from 2 to 5, which is the proper range since the carbon atom number affects the polymerizability of the compound of formula (1), with too long R resulting in poor polymerizability.

When the number of R, which is shown by ℓ , is 1, a linear copolymer is formed, while if the number is 2 or larger, a crosslinked copolymer is formed.

Symbol n may be in the range of from 0 to 2. If n is too large, an ester with an acid is prone to be formed during the copolymerization reaction, so that the resulting copolymer has a high molecular weight to show too high a viscosity and to be less soluble in water and oils. For the above reason, n is preferably an integer that is not so large. Therefore, with regard to the relationship among ℓ , m , and n , they should satisfy the equation $n/(\ell + m) \leq 1/2$.

Symbols a , b , and c are $a \geq 0$, $b \geq 0$, and $c \geq 0$, and $(a\ell + bm + cn)$ are from 1 to 1,000, preferably from 1 to 300, more preferably from 1 to 100.

The copolymer employed in this invention can be made either hydrophilic or lipophilic by varying the number of carbon atoms contained in AO in the compound of general formula (1), the molar amount of AO in the compound, combination of AO with R¹, and combination of the compound of formula (1) with maleic anhydride, maleic acid, a maleic acid salt, or a maleic acid ester.

The copolymer for use in the lubricating oil of this invention include those with various properties, such as a copolymer soluble in water but not in oils, a copolymer soluble in oils but insoluble in water, and a copolymer is soluble in both water and oils and emulsifying the both. Therefore, the lubricating oil of the present invention can be used in many applications.

Although the copolymer employed in this invention can be used alone as a lubricant, it may be used in combination with a mineral oil, an animal or vegetable fats and oils, a synthetic ester oil, a silicone oil, water, ethylene glycol, propylene glycol, glycerin, etc. In this case, the concentration of the copolymer is from 0.01 to 80%, preferably from 0.1 to 50%, by weight. In the case where the copolymer is for use in a refrigerating machine oil, the oil is required to be soluble in refrigerants such as Freon R-11 (trichloromonofluoromethane), Freon R-12 (dichlorodifluoromethane), Freon R-22 (monochlorodifluoromethane), Freon R-134a (1,1,1,2-tetrafluoroethane), and Freon R-152a (1,1-difluoroethane). Hence, it is preferred to use the copolymer in combination with a polyoxyalkylene glycol derivative having an average molecular weight of 1,000 or less so as to be soluble in refrigerants. Examples of such polyoxyalkylene glycol derivative include polypropylene glycol, mono- or dialkyl ethers thereof, polyoxypropylene glycerol ether, a polyoxyethylenepolyoxypropylene glycol (having an oxyethylene group content of 50 mole% or less), mono- or dialkyl ethers thereof, and a polyoxyethylenepolyoxypropylene glycerol ether. If the polyoxyalkylene glycol derivative is an adduct of two or more kinds of alkylene oxides, it may be either a block adduct or a random adduct.

The lubricating oil of this invention, which comprises a copolymer of monomers comprising as essential ingredients the compound of formula (1) and one of maleic anhydride, maleic acid, a maleic acid salt, and a maleic acid ester, shows an excellent lubricating effect in any of an aqueous solution, emulsion, and oily solution form.

Therefore, the lubricating oil of this invention can be used in various lubricating applications as a hydraulic

fluid, gear oil, cutting oil, grinding oil, pressing oil, rolling oil, drawing oil, sliding oil, etc.

The present invention is described below in further detail by way of Examples.

The following Table 1 shows the compositions (monomer proportions) and weight-average molecular weights of the copolymers used in Examples 1 to 4 below.

5

10

15

20

25

30

35

40

45

50

55

Table 1

No.	Compound of formula (I)	(mole)	Maleic anhydride (mole)	Other monomer (mole)	Base (mole)	Weight-average molecular weight
1	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_2=\text{C} \text{ CH}_2\text{O}(\text{C}_2\text{H}_4\text{O})_{40}\text{CH}_3 \end{array}$	1.0	1.0	-	triethyl-amine 1.0	100,000
2	$\text{CH}_2=\text{CHCH}_2\text{O}(\text{C}_3\text{H}_6\text{O})_{12}\text{C}_4\text{H}_9$	0.95	1.0	styrene 0.05	triethanol-amine 1.0	30,000
3	$\text{CH}_2=\text{CHCH}_2\text{O}[(\text{C}_3\text{H}_6\text{O})_5(\text{C}_2\text{H}_4\text{O})_5]\text{C}_2\text{H}_5$	1.0 ¹⁾	1.0	-	triiso-propanol-amine 1.1	40,000
4	$\text{CH}_2=\text{CHCH}_2\text{O}(\text{C}_2\text{H}_4\text{O})_{16}(\text{C}_3\text{H}_6\text{O})_{20}\text{CH}_3$	1.0	1.0	-	diethanol-amine 1.0	50,000
5	$\begin{array}{c} \text{CH}_2\text{OCH}_2\text{CH}=\text{CH}_2 \\ \\ \text{CHO}(\text{C}_2\text{H}_4\text{O})_{50}\text{H} \\ \\ \text{CH}_2\text{OCH}_3 \end{array}$	1.0	1.0	-	ethylene-diamine 0.6	45,000
6	$\text{CH}_2=\text{CHCH}_2\text{O}(\text{C}_2\text{H}_4\text{O})_{20}-\text{C}_6\text{H}_4-\text{C}_9\text{H}_{19}$	0.95	1.0	styrene 0.05	triethanol-amine 1.0	15,000

Table 1 (cont'd)

No.	Compound of formula (1)	Maleic anhydride (mole)	Other monomer (mole)	Base (mole)	Weight-average molecular weight
7	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_2 = \text{C} - \text{CH}_2\text{O} \{ (\text{C}_4\text{H}_8\text{O})_2 (\text{C}_2\text{H}_4\text{O})_8 \} \text{C}_{12}\text{H}_{25} \end{array}$	1.0 ¹⁾	-	triethyl-amine 1.1	20,000
8	$\text{CH}_2 = \text{CHCH}_2\text{O}(\text{C}_2\text{H}_4\text{O})_{30}\text{C}_{18}\text{H}_{37}$	1.0	-	potassium hydroxide 1.0	15,000
9	$\begin{array}{c} \text{CH}_2\text{OCH}_2\text{CH}=\text{CH}_2 \\ \\ \text{CHO}(\text{C}_3\text{H}_6\text{O})_5(\text{C}_2\text{H}_4\text{O})_{20}\text{CH}_2\text{C}_6\text{H}_5 \\ \\ \text{CH}_2\text{O}(\text{C}_3\text{H}_6\text{O})_5(\text{C}_2\text{H}_4\text{O})_{20}\text{CH}_2\text{C}_6\text{H}_5 \end{array}$	1.0	-	triisopropanol-amine 0.9	20,000

Note: 1) The unit in { } is a random adduct.

EXAMPLE 1

Copolymers Nos. 1 to 5 shown in Table 1 were used as a base oil to prepare water-based lubricants according to the following formulation. The thus-obtained lubricants were evaluated for properties. For the purpose of comparison, lubricants prepared using conventional polyoxyalkylene glycols as a base oil in place of the copolymers were likewise subjected to a performance test.

Formulation

10	Base oil	18.00 wt%
	Propylene glycol	37.00 wt%
15	Ion-exchanged water	40.00 wt%
	Oleic acid	3.45 wt%
20	Morpholine	0.60 wt%
	Benzotriazole	0.10 wt%
	Potassium hydroxide	0.85 wt%
25	Dimethylpolysiloxane (viscosity 350 mm ² s ⁻¹)	100 ppm based on the sum of the above.

The results of the performance test are shown in Table 2. Table 2 shows that the lubricating oils of this invention employing the specific copolymers as base oils have excellent performances.

Table 2

Copolymer	Kinematic viscosity	Viscosity index	Pour point	Foaming test	Soda 4- ball test	Timken wear test	MPa			
	40°C mm ² /s (cst)	VIE	(°C)	JIS K-2518 24°C (mm) 0 min. After 10 min.	JIS K-2519 220 rpm (kg/cm ²)	JIS K-2519 Maximum load (psi)				
Present Invention	No. 1	47.2	189	-50.0	35	0	9.5	19.1(42)	(32,000)	220.7
	No. 2	46.5	193	-50.0	25	0	10.5	21.3(47)	(33,000)	227.6
	No. 3	46.3	192	-50.0	35	0	10.0	20.4(45)	(31,500)	217.2
	No. 4	46.8	190	-50.0	30	0	10.0	20.4(45)	(30,000)	206.9
	No. 5	45.9	188	-45.0	50	0	9.0	18.1(40)	(26,000)	179.3
Comparative Example	Polyoxy-ethylene-propylene glycol	46.3	185	-45.0	80	0	8.5	16.3(36)	(18,400)	126.9
	Polyethylene glycol	44.8	187	-37.5	165	10	7.5	15.4(34)	(15,100)	104.1

1) Weight-average molecular weight 11,000; a random adduct in which oxyethylene group: oxypropylene group = 75:25 (by weight).

2) Weight-average molecular weight 20,000.

EXAMPLE 2

Copolymers Nos. 3, 4, 6, 7, 8, and 9 shown in Table 1 were used to prepare cutting oils according to the following formulation. The cutting oils thus obtained were subjected to a cutting and working test (JIS B-4012) under the following conditions. The results obtained are shown in Table 3.

Formulation

Machine oil	80.0 wt%
Copolymer	20.0 wt%

Conditions for Cutting and Working Test

Test specimen	Free-machining stainless steel (SAE 51-416F) 40 ϕ x 300 (mm)
Cutting tool	SKH-4B (JIS G-4403)
Cutting speed	70 m/min.
Working speed	8 /um./min.
Flow of cutting oil	1 l/min.

For the purpose of comparison, polyoxyethylene (7 mole) monooleate was used in place of the copolymers to perform the same test. The results obtained are shown in Table 3, in which the performance of each cutting oil is expressed in terms of the number of test specimens that were able to be cut with one cutting tool. Table 3 shows that the cutting oils of this invention employing the specific copolymers are highly effective.

Table 3

Number of specimens cut				
	Copolymer	Cutting tool 1	Cutting tool 2	Cutting tool 3
Present Invention	No. 3	1385	1402	1377
"	No. 4	1364	1388	1395
"	No. 6	1433	1405	1414
"	No. 7	1424	1413	1409
"	No. 8	1410	1412	1396
"	No. 9	1407	1400	1388
Comparative	Polyoxyethylene (7 mole) monooleate	820	831	819

EXAMPLE 3

Each of the cutting oils formulated in Example 2 was used to prepare an emulsion consisting of 2% by weight of the cutting oil and 98% by weight of ion-exchanged water. The emulsions thus obtained were subjected to a cutting test under the same conditions as in Example 2. The results obtained are shown in Table 4. Table 4 shows that the lubricants of this invention are excellent even in the form of a cutting oil of the emulsion type.

Table 4

		Number of specimens cut		
	Copolymer	Cutting tool 1	Cutting tool 2	Cutting tool 3
Present Invention	No. 3	1291	1300	1284
"	No. 4	1195	1253	1203
"	No. 6	1312	1314	1336
"	No. 7	1325	1306	1341
"	No. 8	1342	1322	1318
"	No. 9	1224	1275	1236
Compara- tive	Polyoxy- ethylene (7 mole) monooleate	706	698	721

EXAMPLE 4

With respect to the compositions shown in Table 5, a test for evaluating solubility in Freon R-12 and Freon R-134a and a Timken wear test were conducted. The results are shown in Table 6. In the solubility test, a composition shown in Table 5 and a Freon were placed in a pressure vessel made of glass and visually examined as to whether the mixture in the vessel became whitely turbid or not over a temperature range of from -5 to 60°C. Compositions that resulted in white turbidity were judged to be insoluble.

Table 6 shows that the lubricating oils of this invention are excellent not only in the solubility in refrigerants, Freons, but also in lubricating performance.

Table 5

Copolymer				Polyoxyalkylene glycol derivative			
No.	Compound of formula (1) or other monomer	Maleic anhydride		Weight-average molecular weight	Amount (%)	Structural formula 1)	Amount (%)
		(mole)	(%)				
10*	$\text{CH}_2=\text{CHCH}_2\text{O}(\text{C}_3\text{H}_6\text{O})_{12}\text{CH}_3$	1.0	1.0	18,000	5.0	$\text{CH}_3\text{O}(\text{C}_3\text{H}_6\text{O})_{12}\text{H}$	95.0
11*	$\text{CH}_2=\text{CHCH}_2\text{O}(\text{C}_2\text{H}_4\text{O})_2(\text{C}_3\text{H}_6\text{O})_7\text{C}_4\text{H}_9$	1.0	1.0	13,500	2.0	$\text{C}_4\text{H}_9\text{O}(\text{C}_3\text{H}_6\text{O})_9\text{H}$	98.0
12*	$\text{CH}_2=\text{CHCH}_2\text{O}(\text{C}_3\text{H}_6\text{O})_5\text{C}_9\text{H}_{19}$	1.0	1.0	9,000	3.0	$\text{C}_9\text{H}_{19}\text{O}(\text{C}_3\text{H}_6\text{O})_5\text{H}$	97.0
13*	$\text{CH}_2=\text{CHCH}_2\text{O}(\text{C}_3\text{H}_6\text{O})_9\text{COCH}_3$	1.0	1.0	12,800	2.0	$\text{HO}(\text{C}_3\text{H}_6\text{O})_{13}\text{H}$	98.0
14*	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_2=\text{CCH}_2\text{O}(\text{C}_3\text{H}_6\text{O})_5\text{CH}_3 \end{array}$	1.0	1.0	40,000	2.0	$\begin{array}{c} \text{CH}_2\text{O}(\text{C}_3\text{H}_6\text{O})_4\text{H} \\ \text{CHO}(\text{C}_3\text{H}_6\text{O})_4\text{H} \\ \text{CH}_2\text{O}(\text{C}_3\text{H}_6\text{O})_4\text{H} \end{array}$	98.0
15*	$\text{CH}_2=\text{CHCH}_2\text{O}(\text{C}_3\text{H}_6\text{O})_{12}\text{CH}_3$	1.0	1.0	23,000	7.0	$\text{CH}_3\text{O}(\text{C}_3\text{H}_6\text{O})_{12}\text{CH}_3$	93.0
16*	$\text{CH}_2=\text{CHCH}_2\text{O}(\text{C}_2\text{H}_4\text{O})_2(\text{C}_3\text{H}_6\text{O})_7\text{C}_4\text{H}_9$	1.0	1.0	14,000	5.0	$\text{CH}_3\{(\text{C}_3\text{H}_6\text{O})_9(\text{C}_2\text{H}_4\text{O})_3\}_\text{H}$	95.0
17*	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_2=\text{CCH}_2\text{O}(\text{C}_3\text{H}_6\text{O})_5\text{CH}_3 \end{array}$	1.0	1.0	50,000	3.0	$\text{C}_9\text{H}_{19}\text{O}(\text{C}_3\text{H}_6\text{O})_5\text{H}$	97.0
18**	-	-	-	-	-	$\text{HO}(\text{C}_3\text{H}_6\text{O})_{15}\text{H}$	100.0
19**	-	-	-	-	-	$\begin{array}{c} \text{CH}_2\text{O}(\text{C}_3\text{H}_6\text{O})_4\text{H} \\ \text{CHO}(\text{C}_3\text{H}_6\text{O})_4\text{H} \\ \text{CH}_2\text{O}(\text{C}_3\text{H}_6\text{O})_4\text{H} \end{array}$	100.0
20**	isobutylene	1.0	1.0	8,000	3.0	$\text{CH}_3\text{O}(\text{C}_3\text{H}_6\text{O})_{12}\text{H}$	97.0
21**	methyl vinyl ether	1.0	1.0	12,000	3.0	$\text{HO}(\text{C}_3\text{H}_6\text{O})_{15}\text{H}$	97.0

Note: 1) The unite in { } is a random adduct.
 * Present invention
 ** Comparative

Table 6

	No.	Solubility test		Timken wear test		
		Freon R-12	Freon R-134a	Maximum load kg (lbs)	Film strength (psi)	MPa
Present Invention	10	soluble	soluble	25.4(56)	(36,000)	248.3
"	11	"	"	23.6(52)	(32,000)	220.7
"	12	"	"	22.7(50)	(30,000)	206.9
"	13	"	"	23.1(51)	(31,000)	213.8
"	14	"	"	23.6(52)	(32,000)	220.7
"	15	"	"	25.4(56)	(35,000)	241.4
"	16	"	"	24.0(53)	(32,000)	220.7
"	17	"	"	25.9(57)	(36,000)	248.3
Comparative	18	"	"	15.9(35)	(17,000)	117.2
"	19	"	"	15.9(35)	(17,000)	117.2
"	20	insoluble	insoluble	16.3(36)	(18,000)	124.1
"	21	"	"	16.8(37)	(19,000)	131.0

While the invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the claimed subject-matter.

Claims

1. The use of a copolymer of monomers comprising as essential ingredients a compound represented by formula (1) and one of maleic anhydride, maleic acid, a salt of maleic acid, and an ester of maleic acid.



where Z represents a residue of a compound having from 2 to 8 hydroxyl groups; AO represents one or

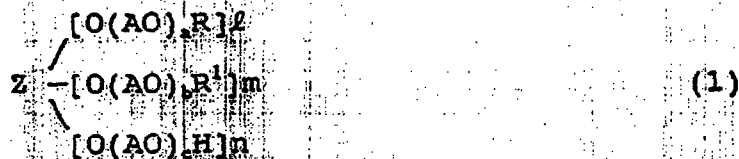
Table 6

	No.	Solubility test		Timken wear test		
		Freon R-12	Freon R-134a	Maximum load kg (lbs)	Film strength (psi)	MPa
Present Invention	10	soluble	soluble	25.4(56)	(36,000)	248.3
	11	"	"	23.6(52)	(32,000)	220.7
	12	"	"	22.7(50)	(30,000)	206.9
	13	"	"	23.1(51)	(31,000)	213.8
	14	"	"	23.6(52)	(32,000)	220.7
Comparative	15	"	"	25.4(56)	(35,000)	241.4
	16	"	"	24.0(53)	(32,000)	220.7
	17	"	"	25.9(57)	(36,000)	248.3
	18	"	"	15.9(35)	(17,000)	117.2
	19	"	"	15.9(35)	(17,000)	117.2
Comparative	20	insoluble	insoluble	16.3(36)	(18,000)	124.1
	21	"	"	16.8(37)	(19,000)	131.0

While the invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the claimed subject matter.

Claims

1. The use of a copolymer of monomers comprising as essential ingredients a compound represented by formula (1) and one of maleic anhydride, maleic acid, a salt of maleic acid, and an ester of maleic acid



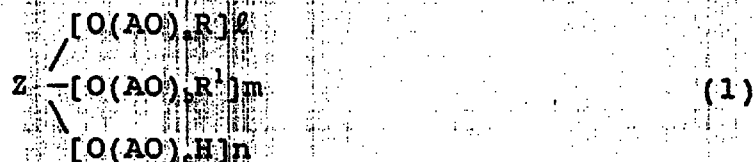
where Z represents a residue of a compound having from 2 to 8 hydroxyl groups; AO represents one or



more kinds of oxyalkylene groups each having from 2 to 18 carbon atoms, provided that in the case of two or more kinds of oxyalkylene groups, the oxyalkylene groups are linked to one another in either a block or a random arrangement; R represents an alkenyl group having from 2 to 5 carbon atoms; R¹ represents a hydrocarbon or acyl group having from 1 to 24 carbon atoms; and $a \geq 0$, $b \geq 0$, $c \geq 0$, ℓ is a positive integer, and m and n independently are 0 or a positive integer, provided $\ell + m + n = 2$ to 8, $n/(\ell + m) \leq 1/2$, and $a\ell + bm + cn = 1$ to 1,000,

as a lubricating agent.

2. The use of a composition comprising: (a) a copolymer of a compound represented by formula (1) with maleic anhydride, maleic acid, or salt or ester of maleic acid

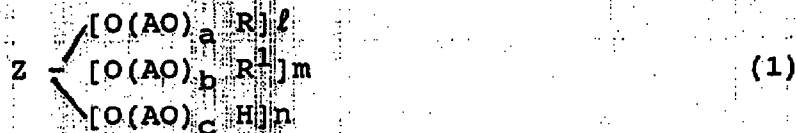


where Z represents a residue of a compound having from 2 to 8 hydroxyl groups; AO represents one or more kinds of oxyalkylene groups each having from 2 to 18 carbon atoms, provided that in the case of two or more kinds of oxyalkylene groups, the oxyalkylene groups are linked to one another in either a block or a random arrangement; R represents an alkenyl group having from 2 to 5 carbon atoms; R¹ represents a hydrocarbon or acyl group having from 1 to 24 carbon atoms; and $a \geq 0$, $b \geq 0$, $c \geq 0$, ℓ is a positive integer, and m and n independently are 0 or a positive integer, provided $\ell + m + n = 2$ to 8, $n/(\ell + m) \leq 1/2$, and $a\ell + bm + cn = 1$ to 1,000, and (b) a liquid medium selected from the group consisting of an animal or vegetable fats and oils, a synthetic ester oil, a silicone oil, water, ethylene glycol, propylene glycol, glycerin, and a polyoxyalkylene glycol derivative, as a lubricating oil composition.

3. The use of the composition as claimed in claim 2, wherein said liquid medium is an aqueous medium, an oily medium, or an emulsion consisting of an aqueous medium and an oily medium.
4. The use of the composition as claimed in claim 2, wherein said liquid medium is selected from the group consisting of a hydraulic fluid, a gear oil, a cutting oil, a grinding oil, a pressing oil, rolling oil, a drawing oil, a sliding oil, and a refrigerating machine oil.
5. The use of the composition as claimed in claim 2, wherein the content of said copolymer in the composition is from 0.01 to 80% by weight.

Patentansprüche

1. Verwendung eines Copolymer aus Monomeren, die als wesentliche Bestandteile eine Verbindung, die durch die Formel 1) dargestellt ist, und eine von Maleinsäureanhydrid, Maleinsäure, einem Salz von Maleinsäure sowie einem Ester von Maleinsäure umfassen,

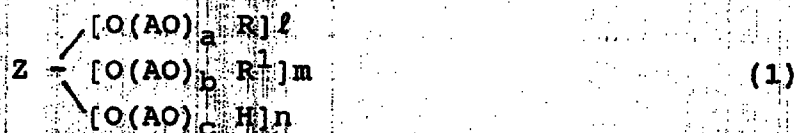


worin Z einen Rest einer Verbindung mit 2 bis 8 Hydroxylgruppen darstellt; AO eine oder mehrere Arten von Oxyalkylengruppen, von denen jede 2 bis 18 Kohlenstoffatome hat, darstellt, vorausgesetzt, daß im Fall von 2 oder mehr Arten von Oxyalkylengruppen, die Oxyalkylengruppen entweder in einer Block- oder einer Random-Anordnung aneinander gebunden sind; R eine Alkenylgruppe mit 2 bis 5 Kohlenstoffatomen darstellt; R¹ eine Kohlenwasserstoff- oder Acyl-Gruppe mit 1 bis 24 Kohlenstoffatomen darstellt; und $a \geq 0$, $b \geq 0$, $c \geq 0$, ℓ eine positive ganze Zahl ist, und m und n unabhängig 0 oder eine positive ganze Zahl



sind, vorausgesetzt, daß $l + m + n = 2$ bis 8, $n/(l + m) \leq 1/2$, und $al + bm + cn = 1$ bis 1000 sind, als Schmiermittel.

2. Verwendung einer Zusammensetzung umfassend (a) ein Copolymer einer Verbindung, die durch Formel (1) dargestellt wird, mit Maleinsäureanhydrid, Maleinsäure oder einem Salz oder Ester von Maleinsäure



worin Z einen Rest einer Verbindung mit 2 bis 8 Hydroxylgruppen darstellt; AO eine oder mehrere Arten von Oxyalkylengruppen, von denen jede 2 bis 18 Kohlenstoffatome hat, darstellt, vorausgesetzt, daß im Fall von 2 oder mehr Arten Oxyalkylengruppen, die Oxyalkylengruppen entweder in einer Block- oder einer Random-Anordnung aneinandergebunden sind; R eine Alkenylgruppe, die 2 bis 5 Kohlenstoffatome hat, darstellt; R¹ eine Kohlenwasserstoff- oder Acyl-Gruppe mit 1 bis 24 Kohlenstoffatomen darstellt; und $a \geq 0$, $b \geq 0$, $c \geq 0$, l eine positive ganze Zahl ist, und m und n unabhängig 0 oder eine positive ganze Zahl sind, vorausgesetzt, daß $l + m + n = 2$ bis 8, $n/(l + m) \leq 1/2$, und $al + bm + cn = 1$ bis 1000 sind, und (b) ein flüssiges Medium, das aus der Gruppe bestehend aus tierischen oder pflanzlichen Fetten und Ölen, einem synthetischen Esteröl, einem Siliconöl, Wasser, Ethylenglycol, Propylenglycol, Glycerin und einem Polyoxyalkylenglykol-Derivat ausgewählt ist, als eine Schmieröl-Zusammensetzung.

3. Verwendung der Zusammensetzung nach Anspruch 2, wobei das flüssige Medium ein wäßriges Medium, ein öliges Medium oder eine Emulsion, die aus einem wäßrigen Medium und einem öligen Medium besteht, ist.
4. Verwendung der Zusammensetzung nach Anspruch 2, wobei das flüssige Medium aus der Gruppe bestehend aus einer Hydraulikflüssigkeit, einem Getriebeöl, einem Schneidöl, einem Mahlöl, einem Preßöl, einem Walzöl, einem Ziehöl, einem Gleitöl und einem Kältemaschinenöl, ausgewählt ist.
5. Verwendung der Zusammensetzung nach Anspruch 1, wobei der Gehalt an Copolymer in der Zusammensetzung 0,01 bis 80 Gew.-% beträgt.

Revendications

1. Utilisation comme agent lubrifiant d'un copolymère de monomères comprenant comme ingrédients essentiels un composé de formule (1) et un composé choisi parmi l'anhydride maléique, l'acide maléique, un sel d'acide maléique et un ester d'acide maléique

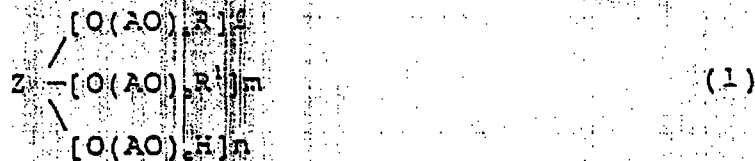


dans laquelle Z représente un résidu d'un composé ayant de 2 à 8 groupes hydroxyles; AO représente un ou plusieurs types de groupes oxyalkylène chacun en C₂-C₁₈, pourvu que dans le cas de deux ou plusieurs types de groupes oxyalkylènes, les groupes oxyalkylènes soient liés les uns aux autres soit en une chaîne séquentielle soit en une chaîne statistique; R représente un groupe alcényle en C₂-C₅; R¹ représente un groupe hydrocarboné ou un groupe acyle en C₁-C₂₄; et $a \geq 0$, $b \geq 0$, $c \geq 0$, l est un entier positif et m et n sont indépendamment 0 ou un entier positif, pourvu que $l + m + n = 2$ à 8, $n/(l + m) \leq 1/2$ et $al + bm + cn = 1$ à 1.000.

2. Utilisation comme composition lubrifiante d'une composition comprenant: (a) un copolymère d'un compo-



sé de formule (1) avec l'anhydride maléique, l'acide maléique ou un sel ou ester d'acide maléique



dans laquelle Z représente un résidu d'un composé ayant de 2 à 8 groupes hydroxyles ; AO représente un ou plusieurs types de groupes oxyalkylènes chacun en C_2-C_{18} , pourvu que dans le cas de deux ou plusieurs types de groupes oxyalkylènes, les groupes oxyalkylènes soient liés les uns aux autres soit en une chaîne séquentielle, soit en une chaîne statistique ; R représente un groupe alcényle en C_2-C_5 ; R' représente un groupe hydrocarboné ou un groupe acyle en C_1-C_{24} ; et $a \geq 0$, $b \geq 0$, $c \geq 0$, l est un entier positif et m et n sont indépendamment 0 ou un entier positif, pourvu que $l + m + n = 2$ à 8, $n/(l + m) \leq 1/2$ et $al + bm + cn = 1$ à 1 000 et (b) un milieu liquide choisi parmi les graisses et huiles animales ou végétales, les huiles d'esters synthétiques, les huiles de silicones, l'eau, l'éthylèneglycol, le propylèneglycol, le glycérol et un dérivé de polyalkylèneglycol.

3. Utilisation de la composition selon la revendication 2, dans laquelle ledit milieu liquide est un milieu aqueux, un milieu huileux ou une émulsion consistant en un milieu aqueux et un milieu huileux.
4. Utilisation de la composition selon la revendication 2, dans laquelle ledit milieu liquide est choisi parmi un fluide hydraulique, une huile de transmission, une huile de coupe, une huile de polissage, une huile de pressage, une huile de laminage, une huile d'étréage, une huile de glissement et une huile de machine frigorifique.
5. Utilisation de la composition selon la revendication 2, dans laquelle la teneur dudit copolymère dans la composition est de 0,01 à 80 % en poids.

