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Oldfield et al.(10) **Pub. No.: US 2008/0221002 A1**(43) **Pub. Date: Sep. 11, 2008**(54) **DISPERSANT****Publication Classification**(75) Inventors: **Andrew S Oldfield**, Reading (GB);
Derek J. Irvine, Cleveland (GB)

Correspondence Address:

JONES DAY**222 EAST 41ST ST****NEW YORK, NY 10017 (US)**(73) Assignee: **IMPERIAL CHEMICAL**
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(51) **Int. Cl.****C10M 129/95** (2006.01)**C10M 133/54** (2006.01)**C10M 129/00** (2006.01)**C10M 129/02** (2006.01)(52) **U.S. Cl. 508/463; 508/110; 508/545; 508/577**(57) **ABSTRACT**

A novel ashless polymeric dispersant is claimed which is suitable for use in an automotive lubricant composition. The ashless polymeric dispersant has a number average molecular weight of between 200 and 15,000 and derived from the reaction of a polar head group, which comprises a polar moiety having more than one amine, alcohol, acid or halogen functionality with two or more polar tail groups where each polar tail group comprises a polymeric backbone of 2 to 30 monomeric repeat units, each repeat unit comprising a hydrocarbon chain functionalised by the presence of at least one electronegative element or moiety. The dispersant has good dispersancy properties, when used as a sole dispersant or in combination with other dispersants. It provides enhanced seal resistance and has good oxidative stability in automotive applications as compared to current commercial products. Furthermore the low temperature viscosity of an automotive lubricant composition containing the dispersant is superior to that of a composition with current commercial dispersants.

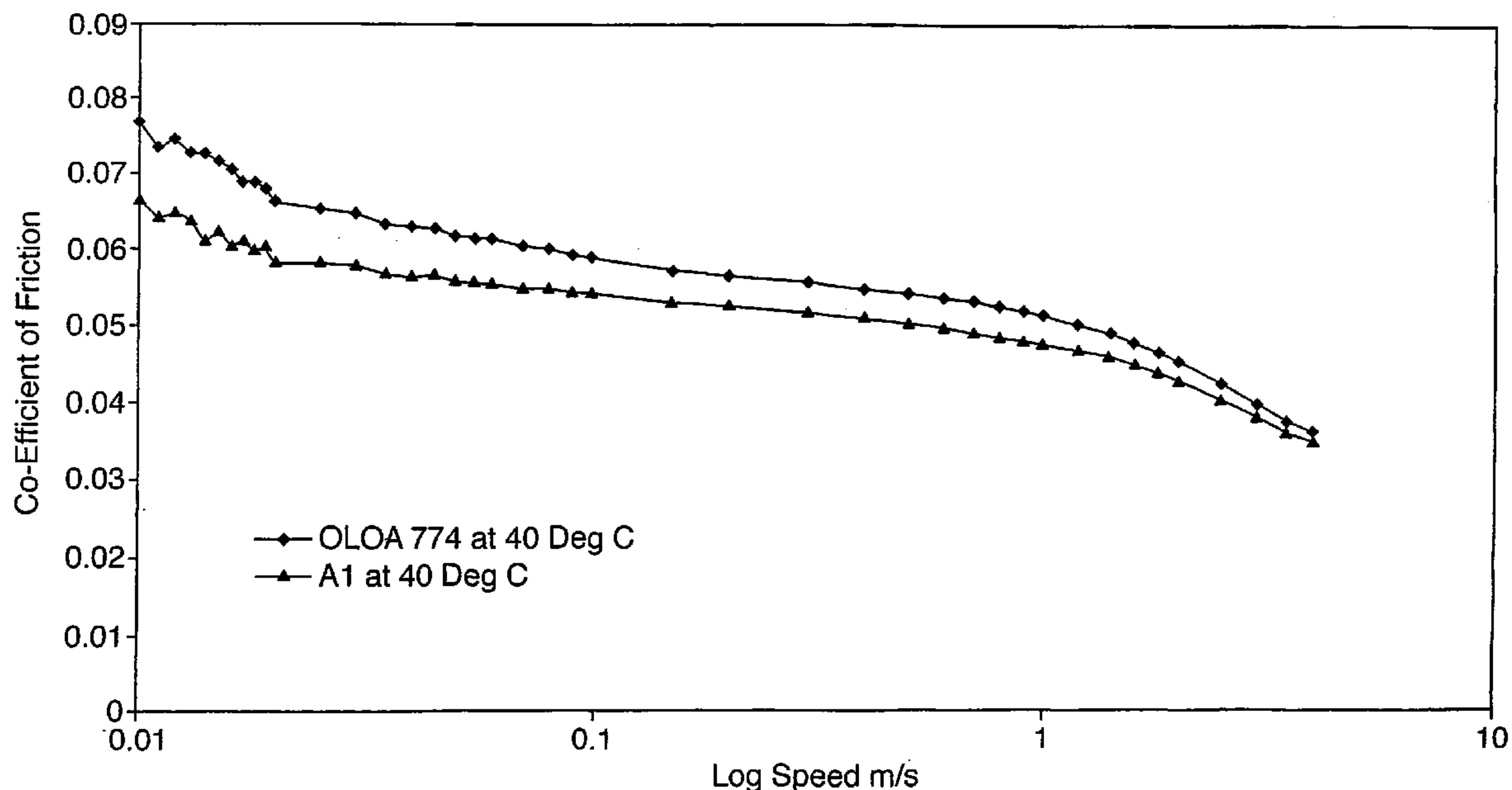


Fig.1.

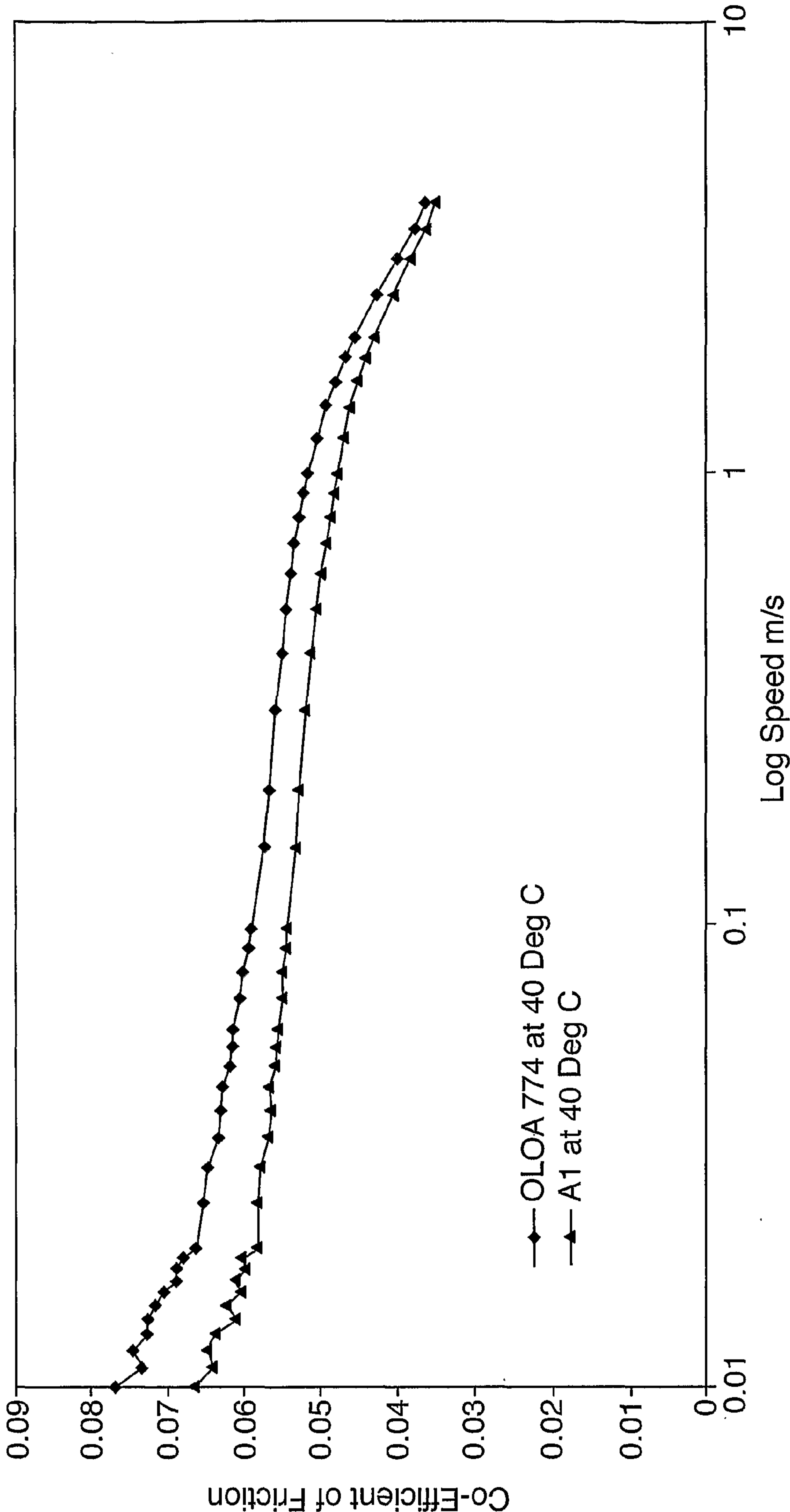
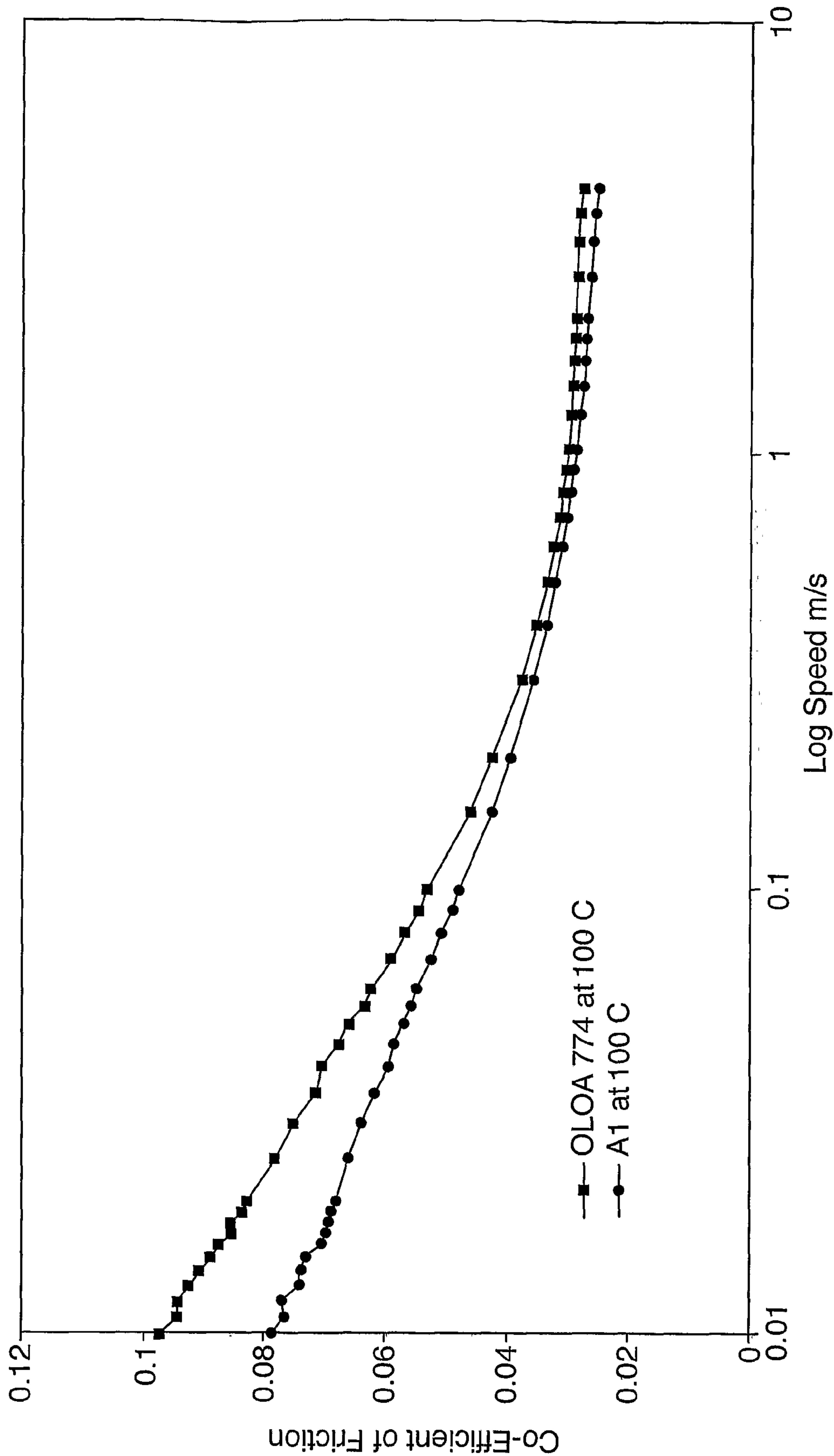


Fig.2.



DISPERSANT

[0001] The present invention relates to a novel ashless polymeric dispersant and its use in an automotive lubricant composition.

[0002] For automotive applications all functions performed by the lubricant base fluid and the range of additives are important. The suspending of insoluble contaminants and keeping surfaces clean are critical additive functions, which are undertaken by the combined presence of detergents and dispersants. The dispersant typically has a higher molecular weight than the "soap part" of the detergent so it is more effective in fulfilling the suspending and cleaning requirements.

[0003] In automotive engine oils dispersants can suspend insoluble contaminants in the lubricant base fluid in a variety of ways in order to reduce engine oil viscosity build up due to soot, reduce engine sludge and reduce deposit formation on engines. Dispersants are key additives in transmission fluids to control sludge build up derived from extensive lubricant base fluid oxidation as certain parts of the transmission are at very high temperatures. Dispersants can also be used in gear oils. Gear oils typically contain thermally labile extreme pressure additives, which can decompose to form highly polar byproducts. Dispersants are used to contain these byproducts to avoid corrosion and deposit formation.

[0004] As described above the primary function of the dispersant in automotive lubricant compositions is to disperse soot, deposit precursors and deposits. However dispersants require other properties in order to perform effectively. These properties include thermal and oxidative stability, good low temperature properties, i.e. maintenance of low viscosity, and maintenance of the integrity of seals in the automotive equipment.

[0005] A dispersant, which has poor thermal stability, will break down, thereby losing its ability to associate with and suspend potentially harmful products. A dispersant, which has poor oxidative stability, will itself contribute towards deposit formation and oil thickening.

[0006] The combination of the amount of dispersant present in automotive lubricant compositions (for example up to 20% in automotive engine oils) and the fact that it is often the highest molecular weight additive apart from the viscosity index improver can alter the viscosity of the lubricant composition. A boost in viscosity at high temperatures is desired but at low temperatures it is a disadvantage. Automotive engine oils require low to moderate viscosities for cranking viscosity and pumping viscosity during cold weather operation. It is important to have good low temperature properties of an automotive lubricant composition for ease of cold cranking, good lubricant circulation and fuel economy. For automotive applications fuel economy is an important factor.

[0007] Seals in automotive equipment are used for many purposes, in particular to enable access to malfunctioning parts to perform repair, to minimise contamination and the loss of lubricant and to join parts together which are vibrating or parts which could expand or contract when exposed to differing temperatures. Therefore maintenance of the integrity of the seals, which can fail by shrinking, elongation or becoming brittle, is crucial to the on-going performance of the automotive equipment. Dispersants are often implicated

as additives most likely to cause seal damage although this can be alleviated to some extent by the addition of seal swell agents.

[0008] Dispersants that are currently commercially available typically consist of a non-polar hydrocarbon chain tail group linked to a connecting group which is linked to a polar head group. Typically the polar group associates with the polar particles and the non-polar group keeps these particles suspended in the bulk lubricant solution. One of the most prevalent of these types of dispersants is polyisobutylene succinimide which is derived from the reaction of polyisobutylene with maleic anhydride followed by reaction with a polyalkylenepolyamine. Such products are known to have good dispersancy properties but cause damage to seals.

[0009] The present inventors have designed a dispersant for use with a lubricant base fluid in automotive applications that has improved dispersancy properties, when used as a sole dispersant or in combination with other dispersant(s) and also provides enhanced seal resistance when compared to current commercial products. Furthermore the low temperature viscosity of the automotive lubricant composition with the dispersant is superior to that of a composition with current commercial dispersants.

[0010] According to the present invention an ashless polymeric dispersant suitable for use in an automotive lubricant composition having a number average molecular weight of between 200 and 15,000, wherein the dispersant is derived from the reaction of a polar head group, which comprises a polar moiety having more than one amine, alcohol, acid or halogen functionality with two or more polar tail groups where each polar tail group comprises a polymeric backbone of 2 to 30 monomeric repeat units, each repeat unit comprising a hydrocarbon chain functionalised by the presence of at least one electronegative element or moiety.

[0011] According to a further embodiment of the invention use of an ashless polymeric dispersant having a number average molecular weight of between 200 and 15,000, wherein the dispersant is derived from the reaction of a polar head group, which comprises a polar moiety having more than one amine, alcohol, acid or halogen functionality with two or more polar tail groups where each polar tail group comprises a polymeric backbone of 2 to 30 monomeric repeat units, each repeat unit comprising a hydrocarbon chain functionalised by the presence of at least one electronegative element or moiety in an automotive lubricant composition.

[0012] According to a further embodiment of the invention an automotive lubricant composition comprising a base fluid and an ashless polymeric dispersant having a number average molecular weight of between 200 and 15,000, wherein the dispersant is derived from the reaction of a polar head group, which comprises a polar moiety having more than one amine, alcohol, acid and halogen functionality with two or more polar tail groups where each polar tail group comprises a polymeric backbone of 2 to 30 monomeric repeat units, each repeat unit comprising a hydrocarbon chain functionalised by the presence of at least one electronegative element or moiety.

Ashless Polymeric Dispersant

[0013] The polar head group comprises a polar moiety having more than one amine, alcohol, acid or halogen functionality. Preferably the polar moiety has more than one amine or alcohol moiety. Preferably the polar moiety has two to four amine moieties. Examples of polar head groups include polyamines, for example tetraethylene pentamine, ethylene

diamine, N,N-dimethylaminopropylamine, diethylenetriamine and triethylenetetramine and polyols, for example glycerol, sorbitol, trimethylolpropane, neopentylglycol and pentaerythritol. The polar head group is chosen such that, when it has reacted with the two or more tail groups, it is able to associate with the particles to be dispersed in the automotive lubricant composition. The polar moiety is chosen such that its polarity, once it has reacted with the two or more tail groups, does not render the polymeric ashless dispersant insoluble in the chosen base fluid with additives.

[0014] Each polar tail group exhibits a level of polarity such that it is soluble in the combination of chosen base fluid with other polar additives that may be present in the automotive lubricant composition. Each tail group may be the same or different. Preferably each tail group is the same.

[0015] Each monomeric repeat unit of the polymeric backbone of each polar tail group comprises a hydrocarbon chain functionalised by the presence of at least one electronegative element or moiety. The hydrocarbon chain may be a saturated or unsaturated, preferably saturated aliphatic chain. The hydrocarbon chain may be straight chained or branched. It is preferably branched. It is preferably a divalent radical. It preferably contains from 8 to 35, more preferably 10 to 25 and especially 12 to 20 carbon atoms. Preferably the electronegative element or moiety is chosen from oxygen, ester (defined as —COO—), amide (defined as —CONH—). More preferably the electronegative element or moiety is chosen from oxygen or ester and especially ester. Preferably the electronegative element or moiety is in the backbone of the monomeric repeat unit rather than being a pendant group. An especially preferred monomeric repeat unit is where the hydrocarbon chain is $\text{CH}_3\text{—(CH}_2)_5\text{—CH—(CH}_2)_{10}\text{—}$ and the electronegative element or moiety is ester.

[0016] The number of monomeric repeat units ranges from 2 to 30, preferably 2 to 20 and more preferably 3 to 15.

[0017] For the dispersant there are two or more polar tail groups, preferably 2 to 4 tail groups each linked to the polar head group. Preferably one end of each tail group has a functionalised group, for example an acid, anhydride, halogen or alcohol group which reacts with the polar moiety of the polar head group.

[0018] The other end of the tail group is terminated with a chain terminating group. The precise structure of the chain terminating group is not critical provided it is inert to other components of the composition under the normal processing conditions to which it is subjected. Preferably it has a molecular weight of less than 800, more preferably less than 500 and especially less than 300. Preferably it contains only carbon, hydrogen and oxygen atoms.

[0019] The ashless polymeric dispersant may be an ABA block copolymer, where A is a tail group and B is a polar head. Alternatively the dispersant may be a star shaped polymer or a comb graft polymer.

[0020] A preferred dispersant is derived from reaction of two tail groups, where each tail group is the product obtained from the polyesterification of a hydroxyalkyl acid, where the alkyl group has from 8 to 35 carbon atoms, preferably 10 to 25 and especially 12 to 20 carbon atoms, with a polyamine polar head group.

[0021] For each of these tail groups an especially preferred hydroxyalkyl acid is 12-hydroxystearic acid. In this case the chain terminating group is derivable from the hydroxyalkyl acid itself or from the non-hydroxyl analogue of the hydroxy acid which is generally present in the commercial grades of

the hydroxy acids available. The chain terminating group can also be derived from any convenient acid that may be added to the polyesterification reaction mixture. Such convenient acids include saturated or unsaturated, preferably saturated monocarboxylic acids having 12 to 22 carbon atoms. A specific example is isostearic acid. The end of each tail group that reacts with the polar head is a carboxylic acid group.

[0022] Examples of the polyamine polar head group for this preferred dispersant include tetraethylene pentamine, ethylene diamine, N,N-dimethylaminopropylamine, diethylenetriamine and triethylenetetramine. Tetraethylene pentamine is especially preferred.

[0023] The dispersant has a number average molecular weight of between 200 and 15,000, preferably 500 to 10,000, more preferably 500 to 7,000. The number average molecular weight of the polymer can be determined by many techniques. Gel permeation chromatography (GPC) is a well known technique that has been employed to determine the number average molecular weight for the dispersant of the invention.

Base Fluid

[0024] The term base fluid includes engine oil, transmission oil and fuel. The term engine oil includes both gasoline and diesel four stroke (including heavy duty diesel) engine oils. The engine oil may be chosen from any of the Group I to Group VI base oils as defined by the American Petroleum Institute (API) or a mixture thereof. Preferably the engine oil has not more than 20%, more preferably not more than 10% of Group I base oil. Preferably the engine oil has not more than 50% of Group V base oil. The viscosity of the four stroke engine oil at 100° C. is from 3 to 15 cSt, preferably 4 to 8 cSt. The viscosity index is preferably at least 90 and more preferably at least 105. The Noack volatility, measured according to ASTM D-5800, is preferably less than 20%, more preferably less than 15%.

[0025] The term engine oil also includes two stroke engine oil. A particularly preferred two stroke engine oil is a Group I base oil, specifically polyisobutylenes. Other preferred two stroke engine oils include some Group V base oils, for example esters and vegetable oil.

[0026] Transmission oil includes automatic, gear, rear axle and continuously variable. Preferably preferred transmission oils are Group II to Group VI, in particular high viscosity polyalphaolefin and highly refined mineral oils.

[0027] Fuel includes both gasoline and diesel fuel. Preferably the gasoline fuel should meet EN 228 standard and the diesel fuel should meet EN 590 standard.

[0028] Preferably the base fluid is an engine oil, more preferably a four stroke engine oil.

[0029] The % weight of ashless polymeric dispersant in the automotive lubricant composition when the base fluid is an engine oil is preferably 1 to 20%. The % weight of ashless polymeric dispersant in the automotive lubricant composition when the base fluid is a transmission oil is preferably 0.1 to 5%. The % weight of ashless polymeric dispersant in the automotive lubricant composition when the base fluid is a fuel is preferably 0.001 to 1%.

[0030] When the base fluid is a four stroke engine oil the automotive lubricant composition also comprises other types of additives of known functionality at levels between 0.1 to 30%, more preferably between 1 to 20% more especially between 2 to 15% of the total weight of the automotive lubricant composition. These can include oxidation inhibi-

tors, corrosion inhibitors, rust inhibitors, friction modifiers, foam depressants, pour point depressants, viscosity index improvers, anti-wear agents, extreme pressure agents, ash-containing detergents, metal deactivators, demulsifiers and mixtures thereof. Viscosity index improvers include polyisobutylenes, polymethacrylate acid esters, polyacrylate acid esters, diene polymers, polyalkyl styrenes, alkenyl aryl conjugated diene copolymers and polyolefins. Foam depressants include silicones and organic polymers. Pour point depressants include polymethacrylates, polyacrylates, polyacrylamides, condensation products of haloparaffin waxes and aromatic compounds, vinyl carboxylate polymers, terpolymers of dialkylfumarates, vinyl esters of fatty acids and alkyl vinyl ethers. Friction modifiers include amides, amines, molybdenum containing compounds and partial fatty acid esters of polyhydric alcohols. Ash-containing detergents include neutral and overbased alkaline earth metal salts of an acidic organic compound. Oxidation inhibitors include hindered phenols, sulphur containing compounds and alkyl diphenylamines. Antiwear agents include zinc dialkyldithiophosphate (ZDDP), ashless and ash containing organic phosphorous and organo-sulphur compounds, boron compounds, and organo-molybdenum compounds. Metal deactivators include benzotriazoles, mercaptobenzimidazoles, thiadiazoles, and tolutriazole derivatives. Extreme pressure agents include sulphurised esters, sulphurised olefins, diaryl disulphides, dialkyldithiophosphate esters, heavy metal naphthenates, ashless and ash containing dialkyldithiophosphates, ashless and ash containing dialkyldithiocarbamates, ashless and ash containing salts of phosphate esters, chlorinated waxes, complex esters, borate esters, and oil insoluble sheet structure compounds such as graphite and molybdenum disulphide suspensions. Demulsifiers include polyalkoxylated phenols, polyalkoxylated polyols, and polyalkoxylated polyamines.

[0031] Additives may include more than one functionality in a single additive.

[0032] When the base fluid is a two stroke engine oil the automotive lubricant composition also comprises other types of additives of known functionality at levels between 0.1 to 30%, more preferably between 0.5 to 20% more especially between 1 to 10% of the total weight of the automotive lubricant composition. These can include oxidation inhibitors, corrosion inhibitors, rust inhibitors, friction modifiers, foam depressants, pour point depressants, viscosity index improvers, lubricity agents, ash-containing detergents, and mixtures thereof. Viscosity index improvers include polyisobutylenes, polymethacrylate acid esters, polyacrylate acid esters, diene polymers, polyalkyl styrenes, alkenyl aryl conjugated diene copolymers and polyolefins. Foam depressants include silicones and organic polymers. Pour point depressants include polymethacrylates, polyacrylates, polyacrylamides, condensation products of haloparaffin waxes and aromatic compounds, vinyl carboxylate polymers, terpolymers of dialkylfumarates, vinyl esters of fatty acids and alkyl vinyl ethers. Friction modifiers include amides, amines, molybdenum containing compounds and partial fatty acid esters of polyhydric alcohols. Ash-containing detergents include neutral alkaline earth metal salts of an acidic organic compound. Oxidation inhibitors include hindered phenols, sulphur containing compounds and alkyl diphenylamines. Lubricity agents include fatty acids, bright stock, ZDDP, ashless and ash containing organic phosphorous and organo-sulphur compounds, boron compounds, sulphurised esters, sulphurised olefins, diaryl disulphides, dialkyldithiophosphate

esters, ashless and ash containing dialkyldithiophosphates, ashless and ash containing dialkyldithiocarbamates, ashless and ash containing salts of phosphate esters, complex esters and borate esters.

[0033] When the base fluid is a transmission oil the automotive lubricant composition also comprises other types of additives of known functionality at levels between 0.1 to 30%, more preferably between 0.5 to 20% more especially between 1 to 10% of the total weight of the automotive lubricant composition. These can include oxidation inhibitors, corrosion inhibitors, rust inhibitors, friction modifiers, foam depressants, pour point depressants, viscosity index improvers, anti-wear agents, detergents, metal deactivators, extreme pressure agents, demulsifiers and mixtures thereof. Viscosity index improvers include polyisobutylenes, polymethacrylate acid esters, polyacrylate acid esters, diene polymers, polyalkyl styrenes, alkenyl aryl conjugated diene copolymers and polyolefins. Foam depressants include silicones and organic polymers. Pour point depressants include polymethacrylates, polyacrylates, polyacrylamides, condensation products of haloparaffin waxes and aromatic compounds, vinyl carboxylate polymers, terpolymers of dialkylfumarates, vinyl esters of fatty acids and alkyl vinyl ethers. Friction modifiers include amides, amines, molybdenum containing compounds and partial fatty acid esters of polyhydric alcohols. Ash-containing detergents include neutral and overbased alkaline earth metal salts of an acidic organic compound. Oxidation inhibitors include hindered phenols, sulphur containing compounds and alkyl diphenylamines. Antiwear agents include ZDDP, ashless and ash containing organic phosphorous and organo-sulphur compounds, boron compounds, and organo-molybdenum compounds. Metal deactivators include benzotriazoles, mercaptobenzimidazoles, thiadiazoles, and tolutriazole derivatives. Extreme pressure agents include sulphurised esters, sulphurised olefins, diaryl disulphides, dialkyldithiophosphate esters, heavy metal naphthenates, ashless and ash containing dialkyldithiophosphates, ashless and ash containing dialkyldithiocarbamates, ashless and ash containing salts of phosphate esters, chlorinated waxes, complex esters, borate esters, and oil insoluble sheet structure compounds such as graphite and molybdenum disulphide suspensions. Demulsifiers include polyalkoxylated phenols, polyalkoxylated polyols, and polyalkoxylated polyamines.

[0034] When the base fluid is a fuel the automotive lubricant composition also comprises other types of additives of known functionality at levels between 50 ppm to 5%, more preferably between 100 ppm to 3% more especially between 150 ppm to 2% of the total weight of the automotive lubricant composition. These can include cetane number improver, for example iso-octyl nitrate, octane number improver, for example oxygenated compounds such as methyltertiarybutyl ether, ashless detergent, for example Polyisobutylene monosuccinimide, lubricity additive, for example fatty acid and fatty acid esters, smoke suppressants, for example organometallic compounds, antifoam agents, for example organosilicone, de-icing additives, for example glycols, low temperature operability additives, for example polymeric wax, drag reducing additives, for example high molecular weight polymers, antioxidants, for example hindered phenols and aromatic amines, metal deactivators, for example benzotriazoles, corrosion inhibitors, for example imidazolines, demulsifier and antihazing additives, for example polyalkoxylated polyols, friction modifiers, for example fatty acid

esters, emulsifiers, for example partial esters of polyols, anti-static agents, for example glycerol esters and mixtures thereof.

[0035] The automotive lubricant composition may further comprise a surfactant additive. Preferably the surfactant additive has at least one alkoxyated or at least one ester moiety. Preferably the surfactant additive has not more than 40 carbon atoms. Especially preferred esters are derived from the reaction of a polyol, having from 2 to 8 hydroxyl groups with an aliphatic, straight chained or branched, saturated or unsaturated monocarboxylic acid having from 8 to 24 carbon atoms. Examples of especially preferred esters include sorbitan monolaurate, sorbitan monopalmitate, sorbitan monostearate, sorbitan tristearate, sorbitan monooleate and sorbitan trioleate. The % weight of surfactant additive with respect to the % weight of the ashless polymeric dispersant is 0.1 to 20%, preferably 1 to 15%.

[0036] Other known dispersants may be present in the automotive lubricant composition, for example OLOA 774 available ex Chevron Oronite, at a level of up to 20%, preferably up to 15% by weight.

[0037] According to a further embodiment of the invention use of an automotive lubricant composition comprising a base fluid and 0.001 to 20% by weight of a polymeric ashless dispersant having a number average molecular weight of between 200 and 15,000 wherein the dispersant is derived from the reaction of a polar head group, which comprises a polar moiety having more than one amine, alcohol, acid or halogen functionality with two or more polar tail groups where each polar tail group comprises a polymeric backbone of 2 to 30 monomeric repeat units, each repeat unit comprising a hydrocarbon chain functionalised by the presence of at least one electronegative element or moiety in an engine or a transmission or a fuel supply line.

[0038] According to a further embodiment use of an ashless polymeric dispersant having a number average molecular weight of between 200 and 15,000, wherein the dispersant is derived from the reaction of a polar head group, which comprises a polar moiety having more than one amine, alcohol, acid or halogen functionality with two or more polar tail groups where each polar tail group comprises a polymeric backbone of 2 to 30 monomeric repeat units, each repeat unit comprising a hydrocarbon chain functionalised by the presence of at least one electronegative element or moiety in an engine or transmission oil or a fuel.

[0039] The dispersant for use with a lubricant base fluid in automotive application has good dispersancy properties for dispersion of soot, when used as a sole dispersant or in combination with other dispersants.

[0040] The dispersant provides enhanced seal resistance as compared to current commercial dispersants.

[0041] The low temperature viscosity of the automotive lubricant composition is superior to that of compositions comprising commercial dispersants. The automotive lubricant composition has a low temperature viscosity at -20°C . of not more than 12,000 cSt, preferably not more than 10,000 cSt, especially not more than 8000 cSt.

[0042] Automotive lubricant compositions having the dispersant present have lower coefficients of friction at both 40°C . and 100°C . than compositions containing current commercial dispersants.

[0043] The invention will now be described further by way of example only with reference to the following Examples.

EXAMPLE 1

Preparation of an Example of Dispersant, A1

a) Preparation of Each Polar Tail Group

[0044] A 1 litre distillation rig fitted with a stirrer was charged with 600 g of commercial grade 12-hydroxystearic acid (12-HSA) at 80°C . under nitrogen. The temperature was then set to 190°C . 1.2 g of tetra butyl titanate being added once the temperature had exceeded 125°C . When the acid value reached 35 mg KOH/g the heat was removed and the reaction allowed to cool. The product poly-12-hydroxystearic acid was then filtered at 80°C .

b) Preparation of Dispersant A1

[0045] A 1 litre distillation rig fitted with a stirrer was charged with 664.3 g (2.1 mole) of poly-12-hydroxystearic acid and 35.2 g (1 mole) of tetraethylene pentamine under nitrogen. The temperature was then set to 170°C . When the acid value reached 0.32 mg KOH/g the heat was removed and the reaction allowed to cool.

EXAMPLE 2

[0046] The ability of the ashless polymeric dispersant of the invention to disperse soot deposits was measured according to the following experimental details. 20 mg of a mixture of an automotive lubricant composition for use in a four stroke engine comprising an ashless polymeric dispersant, A1 and Vulcan XC72R carbon black, containing about 6% by weight carbon black was added to a polyethylene bottle containing 20 0.24 cm diameter stainless steel ball bearings and shaken for 1 hour. After allowing to stand for one hour the mixture was transferred to a Brookfield viscometer and the viscosity measured using a spindle with a fixed rotational speed of 50 revolutions per minute (rpm) (reading 1). The viscosity was then measured for an automotive lubricant composition without carbon black (reading 2). The absolute viscosity increase due to the presence of the carbon black was calculated as reading 1 minus reading 2.

The results are illustrated in Table One below. In each case the base fluid for the automotive lubricant composition is a mixture of Nexbase™ 3060 and Nexbase™ 3043 (colourless, catalytically hydroisomerised and dewaxed base oils comprising of hydrogenated, highly isoparaffinic hydrocarbons) with a standard additive package which includes 7% ashless dispersant (C9265 ex Infineum). OLOA 774 is a commercial dispersant, which is polyisobutylene succinimide available ex Chevron Oronite. The commercial dispersant contains about 36% active dispersant. The % in Table One are to added actual active dispersant.

TABLE ONE

Added ashless polymeric dispersant	Absolute Viscosity Increase (cP)
0%	1000 (Baseline for dispersant already present in base fluid)
1% A1	453
3% A1	289
5% A1	240
7.5% A1	223
10% A1	227

TABLE ONE-continued

Added ashless polymeric dispersant	Absolute Viscosity Increase (cP)
1% OLOA 774 - Comparative	413
3% OLOA 774 - Comparative	319
5% OLOA 774 - Comparative	261
7.5% OLOA 774 - Comparative	280
10% OLOA 774 - Comparative	351

The results in Table One illustrate that use of an ashless polymeric dispersant according to the invention in an automotive lubricant composition is better at dispersing soot particles than a current commercial product.

EXAMPLE 3

[0047] The automotive lubricant composition as disclosed in Example 2, where the weight % of added dispersant is 5%, was subjected to the VW seal compatibility test according to PV 3344 where the seal material was an AK6 elastomer. The seal samples were immersed at 150° C. for 94 hours in the automotive lubricant composition. The automotive lubricant composition was replaced and the samples immersed for a further 94 hours. The automotive lubricant composition was then replaced again and the samples immersed for 94 hours for a third time. After this third immersion the tensile strength, elongation at break, number of cracks and change of seal hardness were measured. The results are shown in Table Two below.

TABLE TWO

Dispersant (5 wt %)	Tensile Strength (Mpa)	Elongation at break (%)	Number of cracks	Change of seal Hardness
A1	6.5	143	Broke	+3
OLOA 774 - comparative	5.3	124	Broke	+4

The results in Table 2 illustrate that an automotive lubricant composition according to the invention performs better in seal tests than a current commercial product.

EXAMPLE 4

[0048] The coefficient of friction of an automotive lubricant composition comprising 5% by weight of ashless polymeric dispersant as disclosed in Example 2 was determined at temperatures of 40 and 100° C. using a mini-traction machine (MTM) of a steel ball on a smooth steel disc. The load applied was 36N and the speed of rotation was varied from 0.01 m/s to 4 m/s to measure the Stribeck curve of the composition. The results are illustrated in Table Three below and Figure One for a temperature of 40° C. and Table Four and Figure Two for a temperature of 100° C.

TABLE THREE

Speed in m/s	Coefficient of friction for dispersant A1	Coefficient of friction for comparative dispersant OLOA 774
4	0.035577	0.036627
3.5	0.03672	0.038033
3	0.038863	0.040477
2.5	0.041087	0.043123
2	0.04347	0.046023

TABLE THREE-continued

Speed in m/s	Coefficient of friction for dispersant A1	Coefficient of friction for comparative dispersant OLOA 774
1.8	0.044523	0.04716
1.6	0.045637	0.048363
1.4	0.046587	0.049753
1.2	0.047527	0.050827
1	0.048277	0.052057
0.9	0.04874	0.0526
0.8	0.04921	0.053163
0.7	0.04974	0.053703
0.6	0.05031	0.054333
0.5	0.050917	0.05493
0.4	0.051577	0.055423
0.3	0.052273	0.05614
0.2	0.053067	0.057007
0.15	0.053427	0.057533
0.1	0.05465	0.059317
0.09	0.05481	0.05962
0.08	0.055307	0.06037
0.07	0.055323	0.060653
0.06	0.05584	0.061653
0.055	0.055993	0.061637
0.05	0.056187	0.0621
0.045	0.056937	0.063043
0.04	0.0567	0.063113
0.035	0.057023	0.063317
0.03	0.058027	0.064937
0.025	0.058433	0.06557
0.02	0.058403	0.06634
0.019	0.060503	0.068277
0.018	0.059913	0.069007
0.017	0.061283	0.06898
0.016	0.060403	0.07064
0.015	0.062403	0.071737
0.014	0.061147	0.07268
0.013	0.063783	0.07276
0.012	0.064853	0.07463
0.011	0.06422	0.073287
0.01	0.06667	0.07678

TABLE FOUR

Speed in m/s	Coefficient of friction for dispersant A1	Coefficient of friction for comparative dispersant OLOA 774
4	0.02552	0.02813
3.5	0.026137	0.02867
3	0.026447	0.029007
2.5	0.026837	0.029143
2	0.02727	0.02938
1.8	0.027553	0.029493
1.6	0.02782	0.029637
1.4	0.028123	0.0299
1.2	0.028587	0.030123
1	0.029243	0.030533
0.9	0.02967	0.030943
0.8	0.030163	0.03136
0.7	0.030813	0.031907
0.6	0.031567	0.03271
0.5	0.0326	0.03388
0.4	0.03401	0.035417
0.3	0.03612	0.03798
0.2	0.039813	0.042797
0.15	0.042783	0.046553
0.1	0.04821	0.053367
0.09	0.04923	0.05477
0.08	0.051023	0.057037
0.07	0.052677	0.059123
0.06	0.055027	0.06223
0.055	0.055813	0.063347

TABLE FOUR-continued

Speed in m/s	Coefficient of friction for dispersant A1	Coefficient of friction for comparative dispersant OLOA 774
0.05	0.05707	0.066027
0.045	0.058843	0.067753
0.04	0.059503	0.070397
0.035	0.061737	0.07129
0.03	0.063983	0.07518
0.025	0.066027	0.078353
0.02	0.067907	0.082767
0.019	0.068883	0.083787
0.018	0.069343	0.08568
0.017	0.069693	0.085433
0.016	0.070423	0.087607
0.015	0.07289	0.08904
0.014	0.073587	0.090903
0.013	0.073913	0.092627
0.012	0.076827	0.094297
0.011	0.076377	0.094513
0.01	0.078737	0.097427

The results in Tables Three and Four illustrate that an automotive lubricant composition containing an ashless polymeric dispersant according to the invention has a lower coefficient of friction in the boundary, mixed and film lubrication regimes as compared to an automotive lubricant composition containing a current commercial dispersant product at both high and low temperatures.

EXAMPLE 5

[0049] The viscosity of an automotive lubricant composition, where the base oil is as disclosed in Example 2, with 5% of dispersant added was measured at -20° C. using a SVM3000 Stabinger Viscometer. The results are illustrated in Table Five below.

TABLE FIVE

Dispersant	Viscosity (cSt) at -20° C.
A1	7,650
OLOA 774 - comparative	Solid

1. An ashless polymeric dispersant suitable for use in an automotive lubricant composition having a number average molecular weight of between 200 and 15,000, wherein the dispersant is derived from the reaction of a polar head group, which comprises a polar moiety having more than one amine, alcohol, acid or halogen functionality with two or more polar tail groups where each polar tail group comprises a polymeric backbone of 2 to 30 monomeric repeat units, each repeat unit comprising a hydrocarbon chain functionalised by the presence of at least one electronegative element or moiety.

2. An ashless polymeric dispersant as claimed in claim 1 wherein the dispersant has a number average molecular weight of between 500 and 10,000, more preferably 500 and 7,000.

3. An ashless polymeric dispersant as claimed in claim 1 wherein the polar moiety of the polar head group has more than one amine or alcohol functionality.

4. An ashless polymeric dispersant as claimed in claim 3 wherein the polar moiety of the polar head group has two to four amine functionalities.

5. An ashless polymeric dispersant as claimed in claim 1 wherein each of the two or more polar tail groups has the same chemistry.

6. An ashless polymeric dispersant as claimed in claim 1 wherein the hydrocarbon chain of the two or more polar tail groups is a divalent radical which may be straight chained or branched and contains from 8 to 35 carbon atoms.

7. An ashless polymeric dispersant as claimed in claim 6 wherein the hydrocarbon chain is $\text{CH}_3-(\text{CH}_2)_5-\text{CH}-(\text{CH}_2)_{10}-$.

8. An ashless polymeric dispersant as claimed in claim 1 wherein the electronegative element or moiety of the hydrocarbon chain is chosen from oxygen, ester and amide and is positioned either in the backbone or is a pendant group to the monomeric repeat unit.

9. An ashless polymeric dispersant as claimed in claim 8 wherein the electronegative element or moiety of the hydrocarbon chain is an ester which is positioned in the backbone of the monomeric repeat unit.

10. An ashless polymeric dispersant as claimed in claim 1 wherein the number of monomeric repeat units ranges from 2 to 30, preferably 2 to 20, more preferably 3 to 15.

11. An ashless polymeric dispersant as claimed in claim 1 wherein the polymeric ashless dispersant is derived from the polyesterification of a hydroxyalkyl acid where the alkyl group has 8 to 35 carbon atoms.

12. An ashless polymeric dispersant as claimed in claim 11 wherein the hydroxyalkyl acid is 12-hydroxystearic acid.

13. An ashless polymeric dispersant as claimed in claim 1 wherein the polymeric ashless dispersant has a number average molecular weight of between 500 and 10,000, preferably between 500 and 7,000, more preferably 500 and 5,000, especially 500 and 3,000.

14. An automotive lubricant composition comprising a base fluid and an ashless polymeric dispersant having a number average molecular weight of between 200 and 15,000, wherein the dispersant is derived from the reaction of a polar head group, which comprises a polar moiety having more than one amine, alcohol, acid or halogen functionality with two or more polar tail groups where each polar tail group comprises a polymeric backbone of 2 to 30 monomeric repeat units, each repeat unit comprising a hydrocarbon chain functionalised by the presence of at least one electronegative element or moiety.

15. An automotive lubricant composition as claimed in claim 14, which further comprises 0.1 to 20% by weight of a surfactant additive with respect to the weight of the ashless polymeric dispersant.

16. An automotive lubricant composition as claimed in claim 14, which further comprises other dispersants present at a level of up to 20% by weight.

17. Use of an automotive lubricant composition comprising a base fluid and 0.001 to 20% by weight of a polymeric ashless dispersant having a number average molecular weight of between 200 and 15,000 wherein the dispersant is derived from the reaction of a polar head group, which comprises a polar moiety having more than one amine, alcohol, acid or halogen functionality with two or more polar tail groups where each polar tail group comprises a polymeric backbone of 2 to 30 monomeric repeat units, each repeat unit comprising a hydrocarbon chain functionalised by the presence of at least one electronegative element or moiety in an engine or a transmission or a fuel supply line.

18. Use of an ashless polymeric dispersant having a number average molecular weight of between 200 and 15,000, wherein the dispersant is derived from the reaction of a polar head group, which comprises a polar moiety having more than one amine, alcohol, acid or halogen functionality with two or more polar tail groups where each polar tail group

comprises a polymeric backbone of 2 to 30 monomeric repeat units, each repeat unit comprising a hydrocarbon chain functionalised by the presence of at least one electronegative element or moiety in an engine or transmission oil or a fuel.

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