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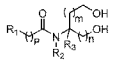
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(54) Title: FRICTION MODIFIER FOR MOTOR OIL



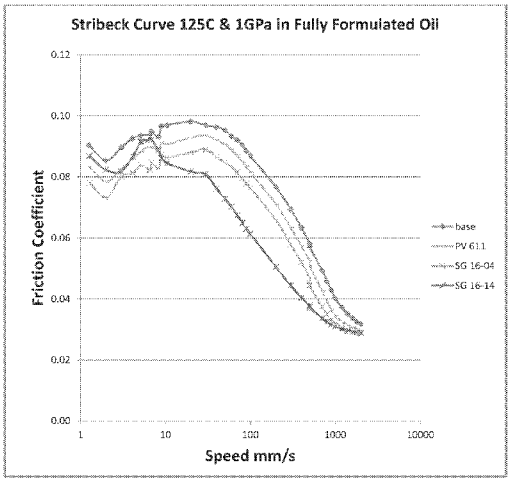


FIGURE 1

(57) Abstract: Novel friction reducing additives provide friction modification at a lower effective concentration when added to a motor oil base. A friction reducing motor oil composition may include motor oil base and a friction reducing additive having the structure of the general formula (I): wherein: R_1 is a straight or branched C_5-C_{30} alkyl or alkenyl; R_2 is H, or a straight or branched alkyl of C_1-C_{10}; R_3 is H, or a straight or branched alkyl of C_1-C_{10}; P is 0 or C_1; n is C_1-C_5; and m is C_1-C_5.

WO 2019/108785 A1

FRICTION MODIFIER FOR MOTOR OIL

BACKGROUND

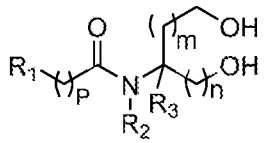
[0001] Reducing friction in an automobile engine is one of the important contributors to increasing fuel economy. As the push for higher fuel economy vehicles continues, friction modifiers play an essential function for improving motor oil performance. Improving motor oil performance can lead to better fuel economy and reduce wear and tear on metal components of engines.

[0002] Fatty acids and their derivatives are known as fuel and lubricant additives. However, it would be beneficial to provide a new oil additive that is effective at lower concentrations and can be manufactured economically.

SUMMARY

[0003] The friction reducing additives described herein provide friction modification at a low effective concentration when added to a motor oil base.

[0004] In one embodiment, a friction reducing motor oil composition includes a) motor oil base; and b) a friction reducing additive having the structure of the general formula (I):

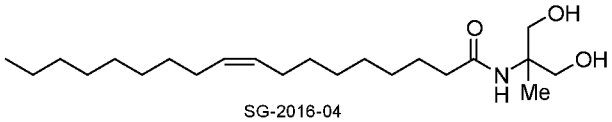


I

wherein, R_1 is a straight or branched C_5-C_{30} alkyl or alkenyl; R_2 is H, or a straight or branched alkyl of C_1-C_{10}; R_3 is H; or a straight or branched alkyl of C_1-C_{10}; P is 0 or C_1; n is C_1-C_5; and m is C_0-C_5.

[0005] In another embodiment, a friction reducing additive of the general formula I wherein: R_1 is a straight chain C_{16}-C_{18} alkyl or R_1 is a C_{16} straight alkenyl that may be unsaturated between C_9 and C_{10}; R_2 is H; R_3 is C_1; P is C_1; n is C_1; and m is 0 is provided. A friction reducing motor oil additive that is of the general formula I wherein: R_1 is C_{16} straight alkenyl that may be unsaturated between C_9 and C_{10}; R_2 is C_4; R_3 is H; P is C_1; n is C_1; and m is C_1 is also provided.

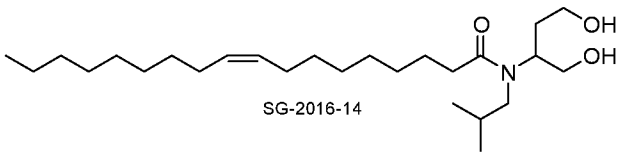
[0006] In yet another embodiment, the friction reducing additive has the structure of the formula (II):



II.

SG-2016-04

[0007] And in another embodiment, the friction reducing additive has the structure of the formula (III):



III.

[0008] The friction reducing additive may also be a combination of additives having the Formulas I, II, III, or any combination of Formula I, II, and III. Further, a friction reducing additive that is a combination of the additive of Formulas I, II, or any combination of Formula I, II, and III together with other commercially available friction reducing additives is provided.

[0009] The friction reducing motor oil composition may also include one or more additional additives selected from dispersants, detergents, antioxidants, anti-wear agents, viscosity modifiers, pour point depressants, other friction modifiers, corrosion inhibitors, anti-foamants, demulsifiers, and seal swell agents.

[0010] In addition one embodiment, the motor oil base may be present in an amount from about 50% to about 99.9 wt % and the friction reducing additive may be present in an amount from about 0.001 wt % and up to about 5.0 wt % of the total composition of the friction reducing motor oil. In other embodiments, the friction reducing additive may be present in an amount from about 0.001 wt % to about 0.6 wt % of the total composition of the friction reducing motor oil.

BRIEF DESCRIPTION OF THE DRAWINGS

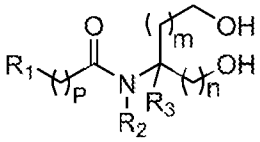
[0011] In the accompanying figures, chemical formulas, chemical structures, and experimental data are given that, together with the detailed description provided below, describe example embodiments of the claimed invention.

[0012] **FIG 1** is a Stribeck Curve comparing the Friction Coefficient for motor oils formulated with additives.

DETAILED DESCRIPTION

[0013] The friction reducing motor oil additives include novel fatty 2-amido-dialcohol compounds that provide better friction reducing behavior compared to well-known friction modifiers.

[0014] In one embodiment, a compound of Formula I, is provided:

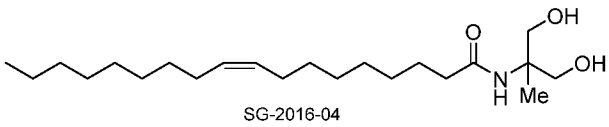


I

wherein: R_1 is a straight or branched C_5-C_{30} alkyl or alkenyl; R_2 is H, or straight, or branched alkyl of C_1-C_{10}; R3 is H, or straight or branched alkyl C_1-C_{10}; n is C_1-C_5, m is C_0-C_5.

[0015] Preferably, R_1 is a straight chain C_5-C_{30} alkyl group. Even more preferably, R_1 is a straight chain C_{16}-C_{18} alkyl group. The straight chain alkyl group of R_1 may be saturated or unsaturated. The straight chain alkyl group of R_1 may be unsaturated at one position or more than one position.

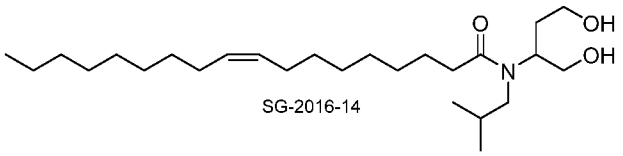
[0016] In one embodiment, a compound of Formula II, is provided:



SG-2016-04 II.

Formula II is a variation of formula I wherein: R_1 is C_{16}; R_2 is H; R_3 is C_1; P is C_1; n is C_1; and m is 0. In formula II, the straight chain alkenyl group of R_1 is unsaturated between C_9 and C_{10}

[0017] In one embodiment, a compound of Formula III is provided:



SG-2016-14 III.

Formula III is a variation of formula I wherein R_1 is C_{16}; R_2 is C_4; R_3 is H; P is C_1; n is C_1; and m is C_1. In formula III, the straight chain alkenyl group of R_1 is unsaturated between C_9 and C_{10}.

[0018] The friction reducing additive may comprise Formulas I, II, III, or any combination of Formula I, II, and III; may consist essentially of Formulas I, II, III, or any combination of Formula I, II, and III; or may consist of Formulas I, II, III, or any combination of Formula I, II, and III.

[0019] Motor oils may comprise the friction reducing motor oil additive of Formula I, II, III, or a combination of one or more of these additives; may consist essentially of the friction reducing motor oil additive of Formula I, II, III, or a combination of one or more of these additives; or may consist of the friction reducing motor oil additive of Formula I, II, III, or a combination of one or more of these additives. Further, motor oils may comprise, consist essentially of or consist of a motor oil base, an additive of the Formula I, II, III, or any combination of Formula I, II, and III, and dispersants, detergents, antioxidants, anti-wear agents, viscosity modifiers, pour point depressants, other friction modifiers, corrosion inhibitors, anti-foamants, demulsifiers, and seal swell agents.

[0020] In general, one advantage of the friction reducing motor oil additive is that it is effective in small amounts. Preferably a motor oil will contain between about 0.001 wt % and about 5 wt %; between about 0.001 wt % and about 2 wt %; preferably between about 0.5 wt % and about 1.0 wt %; and most preferably between about 0.001 wt % and about 0.6 wt % of the friction

reducing motor oil additive. The motor oil may also contain a wt % of friction reducing motor oil additive of any single number found within the range between about 0.001 wt% and about 5 wt %, for example, 0.5 wt %.

[0021] Another advantage of the friction reducing motor oil additive is that it is compatible with other motor oil additives. For example, a motor oil that already contains dispersants, detergents, antioxidants, anti-wear agents, viscosity modifiers, pour point depressants, other friction modifiers, corrosion inhibitors, anti-foamants, demulsifiers, or seal swell agents can be used as the motor oil for addition of the inventive friction reducing motor oil additive.

[0022] The dispersants, detergents, antioxidants, anti-wear agents, viscosity modifiers, pour point depressants, other friction modifiers, corrosion inhibitors, anti-foamants, demulsifiers, or seal swell agents are used in amounts generally encountered in the art, for example between about 0.01 % and about 5 % (see USPN 9,562,207, for example). The motor oil may also contain a wt % of additive of any single number found within the range between about 0.01 wt % and about 5 wt %, for example, 1.0 wt %, 2.0 wt % or 5.0 wt %.

[0023] Yet another advantage of the friction reducing motor oil additive is that it is compatible with any type of oil where friction reduction is desired. The friction reducing motor oil additive can be added to fully synthetic or partially synthetic or any commercially available motor oil. Generally, the motor oil will be largest ingredient in the final composition. The motor oil will be present in an amount between about 50 wt % to about 99.9 wt %. The motor oil base may also contain a wt % of motor oil of any single number found within the range between about 50 wt% and about 99.9 wt %, for example, 95.5 wt %.

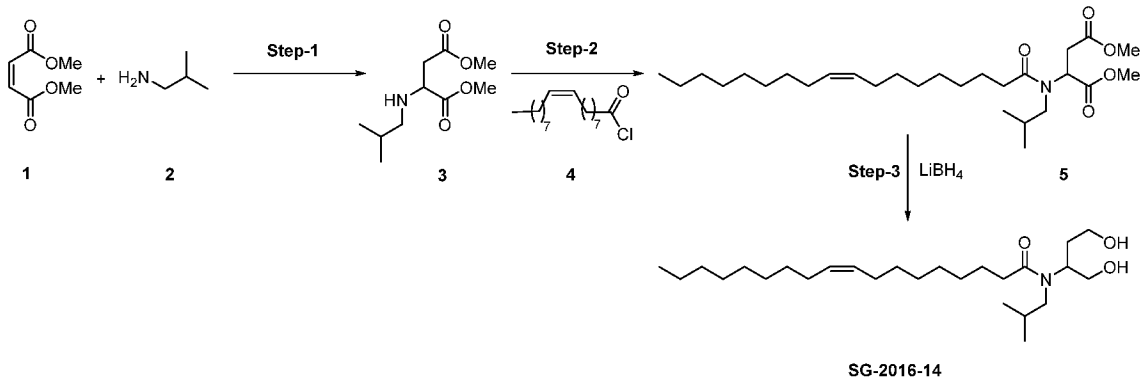
[0024] A motor oil containing the friction reducing motor oil additive will reduce friction in both boundary and mixed regime where gap between metal to metal is very narrow, which is important for getting better fuel economy.

EXAMPLES

[0025] Certain embodiments are described below in the form of examples. While the embodiments are described in considerable detail, it is not the intention to restrict or in any way limit the scope of the appended claims to such detail, or to any particular embodiment.

Example 1: Synthesis of exemplary compound

[0026] While any appropriate synthesis of compounds of the formula I, II or III are encompassed by the invention, one scheme for synthesis of a compound of the formula III (SG-2016-14) will be described.



III

[0027] **Step-1:** To compound **1** (10.0 g, 69.38 mmol) was added isobutylamine (**2**) (6.09 g, 83.26 mmol) dropwise at 26 °C while stirring the mixture under nitrogen atmosphere. After complete addition, the reaction mixture was allowed to stir for 16 hours at 26 °C under nitrogen atmosphere. After 16 hours of stirring, excess isobutylamine was removed under reduced pressure as much as possible to get a crude product which was purified using silica gel (Eluent: 50% ethyl acetate/hexane) to afford a pure compound **3** (13.0 g, 87%).

[0028] **Step-2:** To a stirring solution of compound **3** (13.0 g, 59.8 mmol) in dichloromethane (100 mL) was added triethylamine (12.5 mL, 89.7 mmol) and oleic acid chloride **4** (freshly prepared by known method) (18.0 g, 59.8 mmol) dropwise at 26 °C under nitrogen atmosphere. The reaction mixture was allowed to stir for 15 hours at 26 °C under nitrogen atmosphere. After 15 hours of stirring, 1M HCl was added to the mixture and stirred for 15 minute then extracted with dichloromethane. The organic layer was dried over Na_2SO_4, concentrated under reduced pressure to get a crude product which was purified using silica gel (Eluent: 20% Ethyl acetate /hexane) to afford a pure compound **5** (20.8 g, 72%).

[0029] **Step-3:** To a stirring solution of compound **5** (7.0 g, 14.53 mmol) in dry THF (70 mL) was added $LiBH_4$ (635 mg, 29.15 mmol) portionwise at 0 °C under nitrogen atmosphere and the reaction mixture was allowed to stir for 15 hours at 26 °C. After complete consumption of the starting material MeOH was added slowly at 0 °C under nitrogen atmosphere until a clear solution was formed and then the solvent was evaporated to get a crude material. 1M HCl was added to the crude viscous material and then extracted with Ethyl acetate. The organic layer was dried over Na_2SO_4, concentrated under reduced pressure to get a crude product which was purified using silica gel (Eluent: 60% Ethyl acetate /hexane) to afford a pure compound **SG-2016-14**, or Formula III, (4.0 g, 65%).

Example 2: Production and Analysis of Motor oil with Formula II and III as an additive

[0030] As can be seen in **FIG 1**, motor oils containing either formula II or III additive are compared with previously produced motor oils PV611 and an additive free motor oil base. Motor oils with the additive of either formula II or formula III showed enhanced friction reduction over the motor oil base and the previously available friction reducing formulated oil, PV611. The additives are effective at a concentration of 0.5 wt%.

[0031] The performance of motor oils containing Formula II and III as additives was compared to a PV611 and a motor oil with no additive in a corrosion test. The Results are shown in Table 1:

----------ADDITIVE----------				
	None	PV611	Formula II	Formula III
Cu, ppm	5	5	11	7
Pb, ppm	29	71	142	87

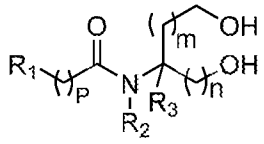
[0032] To the extent that the term "includes" or "including" is used in the specification or the claims, it is intended to be inclusive in a manner similar to the term "comprising" as that term is interpreted when employed as a transitional word in a claim. Furthermore, to the extent that the term "or" is employed (e.g., A or B) it is intended to mean "A or B or both." When "only A or B but not both" is intended, then the term "only A or B but not both" will be employed. Thus, use of the term "or" herein is the inclusive, and not the exclusive use. As used in the specification and the claims, the singular forms "a," "an," and "the" include the plural. Finally, where the term "about" is used in conjunction with a number, it is intended to include ± 10% of the number. For example, "about 10" may mean from 9 to 11. The term wt % is meant to describe a comparison of the weight of one compound to the weight of the whole composition expressed as a percent. It can also be described as wt. %, or (w/w) %. Motor oil includes oil used to lubricate any type of motor or machine where an oil is used. The straight chain alkyl or alkenyl groups described herein may also be referred to as fatty acids, fatty acyls, or fatty acids chains.

[0033] As stated above, while the present application has been illustrated by the description of embodiments, and while the embodiments have been described in considerable detail, it is not the intention to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art, having the benefit of this application. Therefore, the application, in its broader aspects, is not limited to the specific details and

illustrative examples shown. Departures may be made from such details and examples without departing from the spirit or scope of the general inventive concept.

CLAIMS

1. A friction reducing motor oil additive, wherein the additive has the structure of the general formula (I):



I

wherein, R_1 is straight or branched C_5-C_{30} alkyl, or alkenyl; R_2 is H, or a straight or branched alkyl of C_1-C_{10}; R_3 is H, or a straight or branched alkyl of C_1-C_{10}; P is 0 or C_1; n is C_1-C_5; and m is C_0-C_5.

2. The friction reducing motor oil additive of Claim 1, wherein R_1 is straight chain C_{16}-C_{18} alkyl.

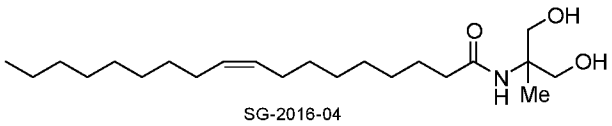
3. The friction reducing motor oil additive of Claim 1, wherein: R_1 is a C_{16} straight alkenyl; R_2 is H; R_3 is C_1; P is C_1; n is C_1; and m is 0.

4. The friction reducing motor oil additive of Claim 3, wherein R_1 is unsaturated between C_9 and C_{10}.

5. The friction reducing motor oil additive of Claim 1, wherein: R_1 is C_{16} straight alkenyl; R_2 is C_4; R_3 is H; P is C_1; n is C_1; and m is C_1.

6. The friction reducing motor oil additive of Claim 5, wherein R_1 is unsaturated between C_9 and C_{10}.

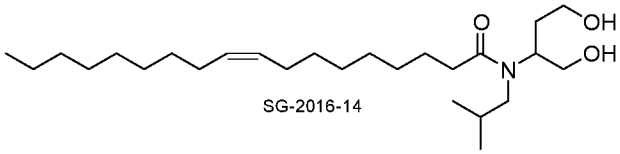
7. The friction reducing motor oil additive of Claim 1, wherein the additive has the structure of the formula (II):



SG-2016-04

II.

8. The friction reducing motor oil additive of Claim 1, wherein the additive has the structure of the formula (III):



SG-2016-14

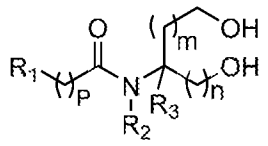
III.

9. The friction reducing motor oil additive of Claim 1, wherein the additive is a combination of additives having the general Formula I, II or III.

10. A friction reducing motor oil composition comprising:

a) motor oil base; and

b) a friction reducing additive having the structure of the general formula (I):



I

wherein: R_1 is a straight or branched C_5-C_{30} alkyl or alkenyl; R_2 is H, or a straight or branched alkyl of C_1-C_{10}; R_3 is H, or a straight or branched alkyl of C_1-C_{10}; P is 0 or C_1; n is C_1-C_5; and m is C_0-C_5.

11. The friction reducing motor oil composition of Claim 10, wherein R_1 is straight chain C_{16}-C_{18} alkyl.

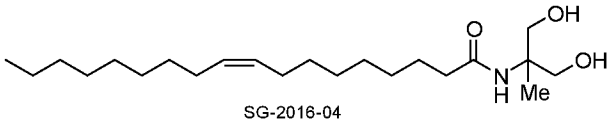
12. The friction reducing motor oil composition of Claim 10, wherein: R_1 is a C_{16} straight alkenyl; R_2 is H; R_3 is C_1; P is C_1; n is C_1; and m is 0.

13. The friction reducing motor oil composition of Claim 12, wherein R_1 is unsaturated between C_9 and C_{10}.

14. The friction reducing motor oil composition of Claim 10, wherein: R_1 is C_{16} straight alkenyl; R_2 is C_4; R_3 is H; P is C_1; n is C_1; and m is C_1.

15. The friction reducing motor oil composition of Claim 14, wherein R_1 is unsaturated between C_9 and C_{10}.

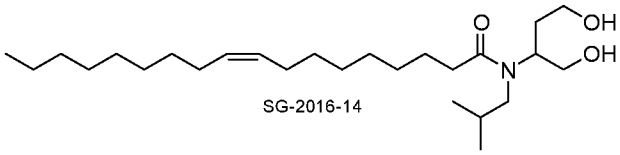
16. The friction reducing motor oil composition of Claim 10, wherein the friction reducing additive has the structure of the formula (II):



SG-2016-04

II.

17. The friction reducing motor oil composition of Claim 10, wherein the friction reducing additive has the structure of the formula (III):



SG-2016-14

III.

18. The friction reducing motor oil composition of Claim 10, wherein the friction reducing additive is a combination of additives having the general Formula I, II or III.

19. The friction reducing motor oil composition of Claim 10, wherein the composition further comprises one or more additional additives selected from the group consisting of:

dispersants, detergents, antioxidants, anti-wear agents, viscosity modifiers, pour point depressants, other friction modifiers, corrosion inhibitors, anti-foamants, demulsifiers, and seal swell agents.

20. The friction reducing motor oil composition of Claim 10, wherein the motor oil base is present in an amount from about 50% to about 99.9 wt % and the friction reducing additive is present in an amount from about 0.001 wt % to about 5.0 wt % of the total composition of the friction reducing motor oil

Attorney Docket No.: 47075.33

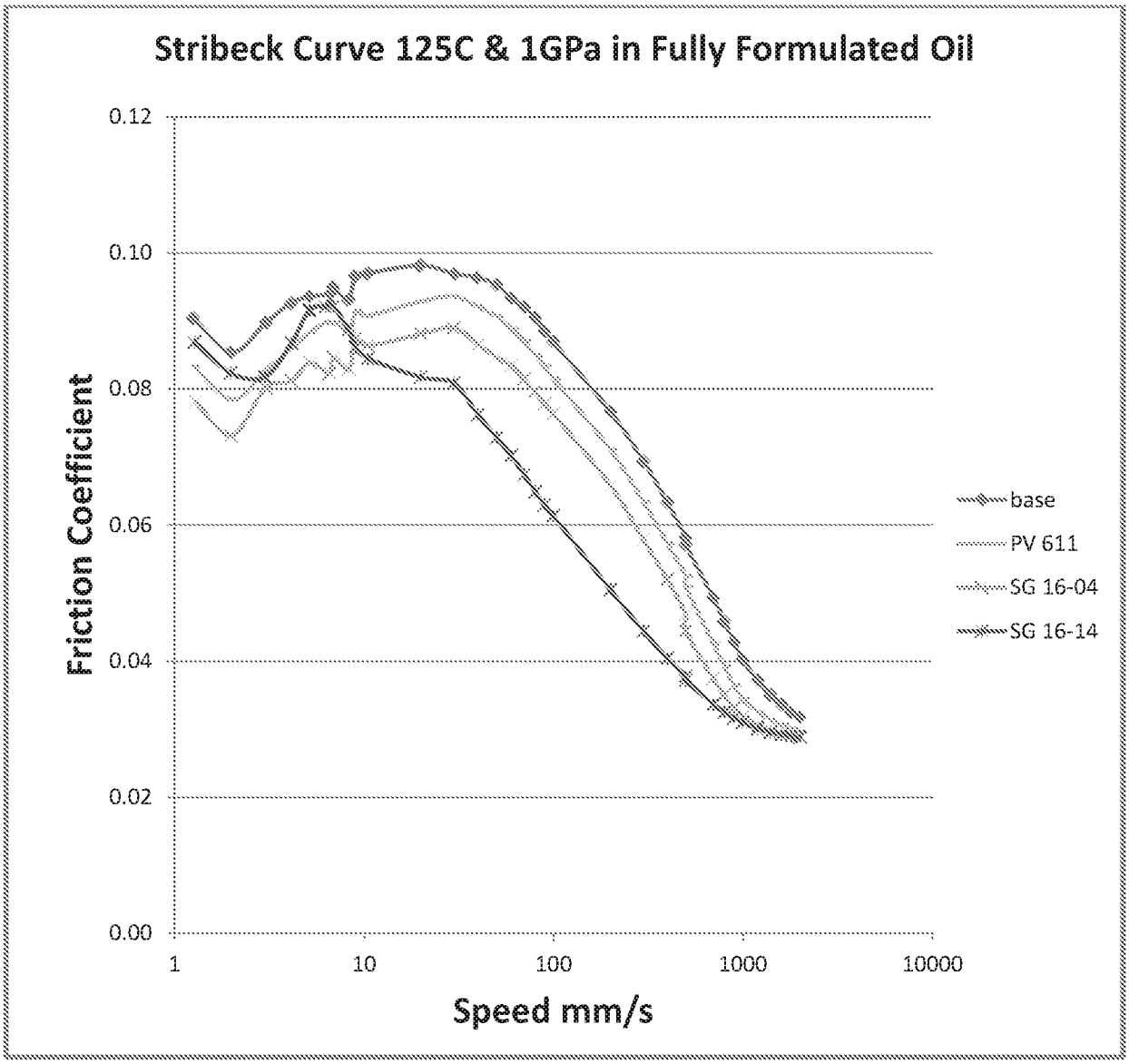


FIGURE 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 18/63053

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - C10M 133/16 (2018.01)
CPC - C10M 133/16, C10M 133/56, C10M 2203/1025

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History Document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History Document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2014/0179571 A1 (AFTON CHEMICAL COROPORATION) 26 June 2014 (26.06.2014); para [0002], [0014], [0046], [0189], abstract	1-20
A	US 5,286,394 A (Moore) 15 February 1994 (15.02.1994); col 7, ln 10-16, col 10, ln 10-12, abstract	1-20
A	US 6,410,597 B1 (Bieberich et al.) 25 June 2002 (25.06.2002); Fig. 1B	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
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Date of the actual completion of the international search	Date of mailing of the international search report
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