

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
9 April 2009 (09.04.2009)

PCT

(10) International Publication Number
WO 2009/045880 A2

(51) International Patent Classification:
C10M 129/16 (2006.01) *C10M 141/12* (2006.01)

(74) Agent: FINERMAN, Terry, M.; Dobrusin & Thennisch
PC, 29 W. Lawrence Street, Suite 210, Pontiac, MI 48342
(US).

(21) International Application Number:
PCT/US2008/077805

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(22) International Filing Date:
26 September 2008 (26.09.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/976,010 28 September 2007 (28.09.2007) US

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(71) Applicant (for all designated States except US): DOW
GLOBAL TECHNOLOGIES, INC. [US/US]; Wash-
ington Street, 1790 Building, Midland, MI 48674 (US).

(72) Inventors; and

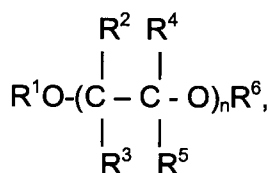
(75) Inventors/Applicants (for US only): ZHAO, Jin
[US/US]; 2615 Brookwood, Midland, MI 48640 (US).
BOUCHARD, Kenn, L. [US/US]; 2169 2nd Street, Bay
City, MI 48708 (US). KILLEBREW, Tina, M. [US/US];
6121 Woodpark, Midland, MI 48640 (US).

Published:

— without international search report and to be republished
upon receipt of that report

(54) Title: FUNCTIONAL FLUID COMPOSITION

FORMULA I



(57) Abstract: The fluid compositions of the present invention include an glycol component that includes a mixture of glycols according the formula: Wherein, typically, at least one of R^2 , R^3 , R^4 and R^5 is an alkyl group. The physical properties of the compositions include a high dry equilibrium reflux boiling point (ERBP), a high wet equilibrium reflux boiling point (WERBP), a low temperature viscosity or any combination thereof. These compositions are particularly useful because their physical properties (e.g., WERBP, ERBP, and low temperature viscosity) meet or exceed the provisions for DOT 3, 4, or 5 brake fluids.

FUNCTIONAL FLUID COMPOSITION

CLAIM OF PRIORITY

[001] The present application claims the benefit of the filing date of Provisional Application No. 60/976,010 (filed September 28, 2007), the contents of which are hereby incorporated by reference in their entirety.

FIELD OF THE INVENTION

[002] This invention relates to functional fluids that are useful in a variety of applications. The functional fluids of the present invention are particularly useful as hydraulic fluids such as brake fluids for anti-lock brake systems, stability control systems or regenerative braking systems for automotive vehicles that benefit from lower viscosity fluids for sudden movement (e.g., sudden braking) and/or satisfactory operation at low temperatures.

BACKGROUND OF THE INVENTION

[003] Newly developed equipment such as electronic or automated anti-lock braking systems, stability control systems and regenerative braking systems have created a need for high performance hydraulic fluids (e.g., brake fluids) having appropriate physical and performance properties. In particular, there is a strong demand for high performance brake fluids having good low temperature viscosities while meeting or exceeding the desired minimum dry equilibrium reflux boiling point (ERBP) and wet equilibrium reflux boiling point (WERBP) temperatures. The most current international standards for brake fluids are set forth below:

Table 1 – DOT 3, DOT 4 and DOT 5 Brake Fluid Standard

Standard	FMVSS 116, SAE 1703, ISO, 4925	FMVSS 116, SAE 1704	ISO 4925	FMVSS 116, ISO 4925	ISO 4925
Classification (FMVSS, SAE)	DOT 3	DOT 4		DOT 5.1	
Classification (ISO)	Class 3		Class 4	Class 5.1	Class 6
ERBP	Min 205° C	Min 230° C	Min 205° C	Min 260° C	Min 250° C
Wet ERBP (3.5 % water per FMVSS 116)	Min 140° C	Min 155° C	Min 155° C	Min 180° C	Min 165° C
KINEMATIC VISCOSITY at -40°C	max. 1500 cSt	max. 1800 cSt	max. 1500 cSt	max. 900 cSt	Max. 750 cSt

[004] One exemplary solution to providing such desirable functional fluids was introduced in commonly owned U.S. Patent Application Publication 2007/0027039, titled Low Viscosity Functional Fluids, and incorporated herein by reference for all purposes. Advantageously, it has been found that the desirable properties of these prior functional fluids can be improved upon through provision of functional fluids having new and or alternative ingredients relative to the ingredients of these prior functional fluids. Moreover, it has been discovered that such improvements can be achieved without incurring significant cost. Even further, it may be possible to actually reduce cost through the use of new ingredients as well as prior ingredients or other alternative ingredients of such functional fluids.

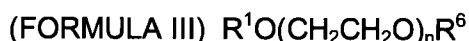
SUMMARY OF THE INVENTION

[005] In one aspect, the invention is directed at a functional fluid composition comprising about 50 wt % to about 100 wt % of a glycol component wherein the glycol component includes one or more glycols of FORMULA I:



wherein R^1 and R^6 are H or an alkyl group containing 1 to 8 carbon atoms or mixtures thereof and n is at least 1, the glycol having n repeat units which may be the same or different, including at least one repeat unit wherein at least one of R^2 , R^3 , R^4 , and R^5 is an alkyl group containing 1 to 8 carbon atoms.

[006] This aspect of the invention may be further characterized by one or any combination of the following features: the one or more glycols of FORMULA I is present at a concentration of at least 5 wt. %, based on the total weight of the glycol component; the one or more glycols of FORMULA I is present at a concentration of at least 15 wt. %, based on the total weight of the glycol component; R^6 is H; exactly one of R^2 , R^3 , R^4 , and R^5 (of FORMULA I) is an alkyl group containing 1 to 8 carbon atoms and the rest are H; at least two of (e.g., two, three or all four of) R^2 , R^3 , R^4 , and R^5 (of FORMULA I) are alkyl groups containing 1 to 8 carbon atoms and the rest are H; the glycol component further comprises at least one glycol of FORMULA III:



wherein R^1 and R^6 are H or an alkyl group containing 1 to 8 carbon atoms or mixtures thereof and n is at least 1 (e.g., n is at least 3); the glycol of FORMULA I includes at least one first repeat unit wherein R^2 , R^3 , R^4 , and R^5 are each H and at least one second repeat unit wherein

at least one (e.g., one, two, three or four) of R^2 , R^3 , R^4 , and R^5 are each an alkyl group containing 1 to 8 carbon atoms; the one or more glycols of FORMULA I includes a glycol of FORMULA IV:



where either (i) n is at least 1 and R^7 is all propyl groups, or (ii) n is at least 2 and R^7 is a mixture of ethyl and propyl groups; the one or more glycols of FORMULA I comprises a propylene glycol ether, an ethylene-propylene glycol ether, or both; the glycol component includes an alkoxyated polypropylene glycol, an alkoxyated polyethylene-propylene glycol, or both; the glycol component includes alkoxyated glycols of FORMULA I and FORMULA III



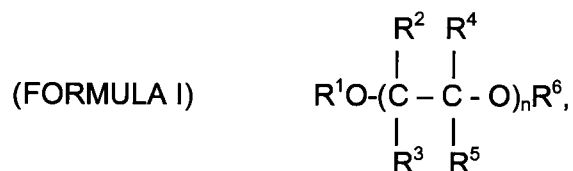
where at least one of R^1 and R^6 is an alkyl having from 1 thru 8 carbon atoms, wherein the concentration of the alkoxyated glycols is greater than about 30 wt% based on the total weight of the glycol component; the composition is substantially free of glycol borate esters; the composition comprises about 0.1 wt % to about 10 wt % of a glycol borate ester comprising the FORMULA V:



wherein each of R^1 , R^2 , R^3 , R^4 , and R^5 (of FORMULA V) is H or an alkyl group containing 1 to 8 carbon atoms or mixtures thereof, n is 1 to 4, and about 0.3 wt % to about 10 wt % of an additive package including a corrosion inhibitor; the borate ester with $n = 3$ is greater than about 90 wt % of the borate ester, an amount of the borate ester with $n = 2$ is from about 0.5 wt % to about 5.0 wt % of the borate ester, and an amount of the borate ester with $n = 4$ is from about 0 or 0.1 wt % to about 15 wt % of the borate ester; an amount of glycol component with $n = 3$ is greater than about 90 wt % of the glycol component, an amount of glycol component with $n = 2$ is from about 0.5 wt % to about 5.0 wt % of the glycol component, and the glycol component with $n = 4$ is from about 0 or 0.1 wt % to about 15 wt % of the glycol component; the composition has a dry equilibrium reflux boiling point of about 205°C or more, a wet equilibrium reflux boiling point of about 140°C or more, and a viscosity of about 1500 cSt or less at a temperature of about -40°C; the composition has a dry equilibrium reflux boiling point of about 250°C or more, a wet equilibrium reflux boiling point of 145°C or more, a viscosity of about 1400 cSt or less at a temperature of about -40°C; the glycol component comprises one or more high purity glycol components; the composition includes an additives package which comprises an

antioxidant, an anti-foaming agent, a corrosion inhibitor, a pH stabilizer, or any combination thereof; the glycol component comprises at least 50 wt% of alkoxyated glycols of FORMULA I and FORMULA III, wherein one of R^1 and R^6 is H and the other is selected from the group consisting of methyl, ethyl, propyl, butyl, or any combination thereof; the glycol component comprises at least 70 wt% of alkoxyated glycols of FORMULA I and FORMULA III, wherein one of R^1 and R^6 is H and the other is selected from the group consisting of methyl, ethyl, propyl, butyl, or any combination thereof; the glycol component is present at a concentration of at least 70 wt% based on the total weight of the fluid composition; the glycol component is present at a concentration of at least 85 wt% based on the total weight of the fluid composition.

[007] This aspect of the invention may also be further characterized by a functional fluid composition comprising: at least about 70 wt % of a glycol component wherein the glycol component includes one or more alkoxyated glycols of FORMULA I:



wherein R^6 is H, R^1 is an alkyl group containing 1 to 4 carbon atoms or mixtures thereof and n is at least 2, the glycol having n repeat units which may be the same or different, including at least one repeat unit wherein at least one of R^2 , R^3 , R^4 , and R^5 is a methyl group and the other are H, wherein the additional repeat units are the same as the first repeat unit, (CH_2-CH_2-O) , or a combination, wherein the one or more alkoxyated glycols of FORMULA I is present at a concentration of at least 15 wt% based on the total weight of the glycol component; optionally one or more alkoxyated glycols of FORMULA III:



wherein R^6 is H, R^1 is an alkyl group containing 1 to 4 carbon atoms or mixtures thereof and n is at least 2; and an additives package which comprises an antioxidant, an anti-foaming agent, a corrosion inhibitor, a pH stabilizer, or any combination thereof; wherein the total of the alkoxyated glycols of FORMULA I and the alkoxyated glycols of FORMULA III are present at a concentration of at least 50 wt.% based on the total weight of the glycol component.

[008] Another aspect of the invention is directed at a braking system including a fluid composition described herein. This aspect of the invention may be further characterized by the braking system is free of a booster.

[009] Yet another aspect of the invention is directed at the use of a fluid composition described herein as a fluid in a braking system. For example, this aspect of the invention may be directed

at the use of a fluid composition described herein as a fluid in a braking system that is free of a booster.

DETAILED DESCRIPTION OF THE INVENTION

[0010] The functional fluid compositions of the present invention have a number of applications; however, they are especially useful as hydraulic fluids such as brake fluids. The fluid compositions of the present invention include a glycol component of glycols, alkoxy glycols or both. The fluid composition can also include borate ester, but preferably includes no more than about 10 wt % of a borate ester based on the weight of the composition. The physical properties of the compositions include a high dry equilibrium reflux boiling point (ERBP), a high wet equilibrium reflux boiling point (WERBP), and a low temperature viscosity.

[0011] Certain embodiments of functional fluid compositions of the present invention are particularly useful because their physical properties (e.g., WERBP, ERBP, and low temperature viscosity) meet the provisions for DOT 3, DOT 4 or DOT 5 brake fluids under the provisions of the table above.

[0012] The physical properties of the present compositions as well as the presence of borate ester, or lack thereof, allow it to serve especially well as a brake fluid. Moreover, compositions lacking borate ester can meet the requirements necessary for DOT 3, DOT 4, or DOT 5 brake fluids.

[0013] Functional fluids of the present invention comprise one or any combination of the following:

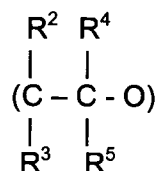
- (a) about 50 wt % to about 100 wt %, based on the total weight of the composition of a glycol component;
- (b) about 0 or about 0.01 wt % to about 10 wt %, based on the weight of the total composition, of a glycol borate ester component; and
- (c) about 0.10 or 0.30 wt % to about 10 wt %, based on the weight of the total composition, of an additives package.

[0014] The glycol component can be formed partially, substantially entirely (at least 90% or at least 95% by weight) or entirely of one, two, three or more glycols and/or polyglycols. Preferably the glycols or polyglycols of the glycol component have the formula of FORMULA I:



with repeat unit:

FORMULA II



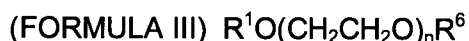
[0015] wherein each of R^1 , R^2 , R^3 , R^4 , R^5 , R^6 is either hydrogen (H) or an alkyl group containing 1 to 8 or more carbon atoms or mixtures thereof. It is typical that R^6 is hydrogen for greater than 20%, more typically for greater than 50%, and even possibly for greater than 80% of the glycol component. The glycol component which substantially entirely (at least 90% or at least 95% by weight) or entirely contains glycols having $\text{R}^6 = \text{H}$ is also possible. It is preferable that either R^1 or R^6 is an alkyl group containing 1 to 8 carbon atoms and the other is hydrogen such that the glycol or polyglycol is an alkoxy glycol ether (e.g., an alkyl end capped alkoxy glycol ether) as opposed to being simply a glycol where R^1 is (H). Typically, both R^1 and R^6 are (H) for less than 90%, more typically less than 50% and even possibly less than 30% or 20% by weight of the glycol component, the overall fluid composition or both. It is also possible for R^1 and R^6 are both alkyl group containing 1 to 8 carbon atoms such that the glycol or polyglycol is an alkoxyglycol diether (e.g., an alkyl double end capped alkoxy glycol diether). If present the concentration of the double end capped glycol is typically less than about 80%, more typically less than about 50%, and even possibly less than about 20% by weight of the glycol component. The glycol component which is substantially free (less than about 90% or less than about 5% by weight of the glycol component) or entirely free of double end capped glycols is also possible. It will be understood that, as used herein, a polyglycol of FORMULA I having n of at least 2 or greater and that the term glycol includes all polyglycols. It should also be understood that the glycol component can include glycols of FORMULA I wherein R^1 and R^6 are both alkyl group, R^1 and R^6 are both H, one of R^1 and R^6 is an alkyl group and the other is H, or a combination (for example, the glycol component may include glycols of FORMULA I wherein R^6 is hydrogen and R^1 is an alkyl group, H, or a combination).

[0016] The glycol component can include an amount of glycol where $n=1$. When included, such glycol may be at least about 0.001% by weight (e.g., is at least about 0.01% by weight) of the glycol component. Moreover such glycol is typically less than about 30%, more typically less than about 10% and even more typically less than about 5% by weight of the of the glycol component. Preferably, glycols of the glycol component comprise glycols (e.g., alkoxy glycols) where $n = 2$, glycols (e.g., alkoxy glycols) where $n = 3$, glycols (e.g., alkoxy glycols) where $n = 4$

or more, or mixtures thereof. More preferable glycol components comprise a mixture of glycols (e.g., alkoxy glycols) having $n = 2$, $n = 3$, and $n = 4$ or more. It is also preferred for the glycols wherein $n = 2$ or more to be present in the glycol component and/or the overall functional fluid in an amount that is at least about 50 wt %, more typically at least about 60 wt% and more typically at least about 75 wt% of the glycol component, the overall functional fluid or both. The glycol component and/or the overall functional fluid may even consist essentially or entirely of glycols wherein $n = 2$ or more). It is also preferred for the glycols wherein $n = 2$ or more to be present in the glycol component and/or the overall functional fluid in an amount that is less than about 99.99 wt%, typically less than about 99 wt%, more typically less than about 90 wt% and even more typically less than about 85 wt%.

[0017] The glycol component typically includes an amount of a first glycol (e.g., a first polyglycol) where R^2 , R^3 , R^4 , and R^5 are each H. R^6 is preferably H, but may be a an alkyl group containing 1 to 8 carbon atoms (e.g., R^6 may be methyl, ethyl, propyl, butyl, and the like). When included, such first glycol (e.g., a mixture of single glycol or a mixture of glycols of FORMULA 1 each having R^2 , R^3 , R^4 , R^5 , and R^6 all H) is at least about 0.2%, typically at least about 3%, more typically at least about 10% and even more typically at least about 20% by weight of the total glycol component. Moreover such first glycol is typically less than about 80%, more typically less than about 50% and even more typically less than about 30% by weight of the of the total glycol component. For such first glycol n is at least 1, but preferably n is 2 or more. The amount of the first glycol in which $n = 2$ is typically less than about 20.00 wt% (e.g., from about 0.25 wt % to about 20.00 wt %) by weight of the first glycol. The amount of the first glycol in which $n = 3$ or more is typically greater than about 25 wt.%, more typically greater than about 40 wt.% and most preferably greater than about 70 wt.% of the first glycol. The amount of the first glycol in which $n = 3$, if present, typically may be from about 0 wt.% to about 99.5 wt % (e.g., from about 25.0 wt % to about 99.5 wt % of the first glycol). The first glycol may also include or consist essentially or entirely of glycols having n at least 4. For example, the amount of the first glycol for which n is at least 4, if present, may be greater about 10 wt %, typically greater than about 30 wt%, more typically greater than 45 wt%, and most typically greater than about 50 wt% of the first glycol. The amount of the first glycol in which $n = 4$ may be less than about 50 wt%, preferably less than about 30 wt.% (e.g., is typically from about 0 or 0.1 wt % to about 15 wt %) of the first glycol. Of course, higher or lower amounts of the overall first glycol and the particular amounts of the first glycol having different n values may be employed unless otherwise specified. The glycol component may also be free of the first glycol.

Without limitation, the first glycols may include or consist essentially of a glycol according to FORMULA III:



where R^1 and R^6 are H, an alkyl group containing 1 to 8 carbon atoms, or mixtures thereof and n is at least 1.

[0018] The glycol component typically includes an amount of second glycols (e.g., second polyglycols), which may be one or a mixture of glycols, wherein at least one and typically only one, but also possibly two, three or all four of R^2 , R^3 , R^4 , and R^5 are each an alkyl group containing 1 to 8 carbon atoms. R^6 is preferably H, but may be a an alkyl group containing 1 to 8 carbon atoms (e.g., R^6 may be methyl, ethyl, propyl, butyl, and the like). Preferable second glycols include an R^2 or R^3 group and more preferably an R^4 or R^5 group comprising a methyl, an ethyl, a propyl, a butyl, or any combination thereof. Moreover, preferable second glycols include an R^2 or R^3 group and more preferably an R^4 or R^5 group comprising a methyl or an ethyl group. Still more preferable second glycols include an R^2 or R^3 group and more preferably an R^4 or R^5 group comprising a methyl group (e.g., the second glycols may include propylene glycols). When included, such second glycols are at least about 3%, more typically at least about 10% and even more typically at least about 20% by weight of the glycol component. Moreover such second glycols are typically less than about 80%, more typically less than about 50% and even more typically less than about 30% by weight of the of the glycol component. For such second glycol, n is at least 1, but preferably n is 2 or more. Any of the second glycols may include or may be free of second glycols in which $n = 2$. If present, the amount of the second glycols in which $n = 2$ is typically greater than 0.01 wt%, more typically greater than about 0.25 wt% and typically less than about 20 wt%, more typically less then about 10 wt%, and most typically less than 5 wt% of the second glycols (e.g., from about 0.25 wt % to about 10.00 wt %) by weight of the second glycols. The amount of the second glycols in which $n = 3$ or more (e.g., $n=3$) is typically from about 10.0 wt% to about 100 wt% (e.g., from about 25.0 wt % to about 99.5 wt %) of the second glycols. The amount of the second glycols in which $n=4$ or more (e.g., $n = 4$) may be from about 0 wt% to about 100 wt% of the second glycols. For example, the amount of the second glycol in which $n=4$ may range from about 0 or 0.01 wt % to about 15 wt % of the second glycols. Of course, higher or lower amounts of the overall second glycol and the particular amounts of the second glycols having different n values may be employed unless otherwise specified. For example, the second glycols may have primarily (e.g., greater than about 50 wt% of the second glycols), substantially entirely (e.g., greater than about

90 wt% or about 95 wt% of the second glycols) or even entirely of glycols having $n=3$, of glycols having n of at least 3, or of glycols having n of at least 4.

[0019] The glycol component typically includes an amount of one or more third glycol (e.g., a third polyglycol) that is a copolymer, which can be a block copolymer, random copolymer or the like. Thus, any of the third glycols (which may be a one glycol or a mixture of glycols) will typically include one or more first repeat units of FORMULA I having a first configuration and one or more second repeat units having a second configuration. In particular, the third glycol typically includes at least one of a first repeat unit of FORMULA I wherein R^2 , R^3 , R^4 , and R^5 are each H. The third glycol also typically includes at least one second repeat unit wherein at least one and typically only one, but also possibly two, three or all four of R^2 , R^3 , R^4 , and R^5 are each an alkyl group containing 1 to 8 carbon atoms. For example, the second repeat unit may have one, two, three or all four of R^2 , R^3 , R^4 , and R^5 are each an alkyl group containing 1 to 8 carbon atoms and the others are H. Preferable second repeat units of the third glycols include an R^2 or R^3 group and more preferably an R^4 or R^5 group comprising a methyl, an ethyl, a propyl, a butyl, or any combination thereof. More preferable second repeat units of the third glycols include an R^2 or R^3 group and more preferably an R^4 or R^5 group comprising a methyl or an ethyl group. Still more preferable second repeat units of the third glycols include an R^2 or R^3 group and more preferably an R^4 or R^5 group comprising a methyl group. For example the second repeat unit may have one of include one of R^2 , R^3 , R^4 , and R^5 is a methyl group and the remaining are H. As such the third glycols may contain at least one, but preferably both ethylene glycol (e.g., -CH₂-CH₂-O-), and propylene glycol, (e.g., CH(CH₃)-CH₂-O or CH₂-CH(CH₃)-O) units. In any third glycol, R^6 is preferably H, but may be a an alkyl group containing 1 to 8 carbon atoms (e.g., R^6 may be methyl, ethyl, propyl, butyl, and the like). When included, such third glycols are at least about 3%, more typically at least about 10% and even more typically at least about 20% by weight of the glycol component. The glycol component may have primarily (e.g., greater than about 50 wt%), substantially entirely (e.g., greater than about 90 wt%, or even greater than about 95 wt%) or entirely the third glycols. Moreover, such third glycols are typically less than about 80%, more typically less than about 50% and even more typically less than about 30% by weight of the of the glycol component. For such third glycols, n is at least 2 or more. The amount of the third glycol in which $n = 2$, if present, is typically greater than 0.01 wt%, more typically greater than about 0.25 wt% and typically less than about 20 wt%, more typically less then about 10 wt%, and most typically less than 5 wt% of the third glycols (e.g., from about 0.25 wt % to about 10.00 wt %) by weight of the third glycols. The amount of the third glycols in which $n = 3$ or more (e.g., $n=3$) is typically from about 10.0 wt% to about 100 wt% (e.g., from

about 25.0 wt % to about 99.5 wt %) of the third glycols. The amount of the third glycol in which $n = 4$ or more (e.g., $n = 4$) may be from about 0 wt% to about 100 wt% of the third glycols. For example, the amount of the third glycol in which $n=4$ may range from about 0 or 0.01 wt % to about 15 wt % of the third glycols. Of course, higher or lower amounts of the overall third glycols and the particular amounts of the third glycols having different n values may be employed unless otherwise specified. For example, the third glycols may consist primarily (e.g., greater than 50 wt% of the third glycols), substantially (e.g., greater than 90 wt% or 95 wt% of the third glycols) or even entirely of glycols having $n=3$, of glycols having n of at least 3, or of glycols having n of at least 4.

[0020] The glycol component may contain one or more of a first glycol, second glycol, third glycol, or any combination thereof. Preferably the glycol component includes at least one or more second glycol, third glycol or a combination thereof. The total concentration of all second glycols (e.g., second glycols wherein R^1 is H, second glycols wherein R^1 is an alkyl having from 1 to 8 carbon atoms, or both) and all third glycols (e.g., third glycols wherein R^1 is H, third glycols wherein R^1 is an alkyl having from 1 to 8 carbon atoms, or both) may be at least about 0.5 wt%, preferably at least about 5 wt%, more preferably at least about 15 wt%, and most preferably at least about 20 wt% (e.g., about 22 wt%, about 45 wt%, or even about 100 wt%) based on the total weight of the glycol component. The glycol component may include one or more second glycol and third glycol, it may be free of second glycols, or it may be free of third glycols.

[0021] Any of the second glycol, third glycol or both may include, or consist essentially, or even consist of one or more glycols of FORMULA IV:



where n is at least one and R^7 is all propyl groups, or n is at least 2 and R^7 is a mixture of ethyl and propyl groups.

[0022] The glycol component may include alkoxyated glycols of FORMULA I, FORMULA III, or both, where at least one (e.g., exactly one) of R^1 and R^6 is an alkyl having from 1 to 8 carbon atoms (e.g., a methyl, an ethyl, a propyl, or a butyl). Such alkoxyated glycols (i.e., alkoxy glycols) may represent at least 30 wt%, preferably at least 50 wt%, and more preferably at least about 60 wt.% of the glycol component or even of the functional fluid.

[0023] Advantageously, use of glycols of each of the types mentioned, but particularly the second and third glycols, can assist the fluid in achieving various properties. Such properties can include, without limitation, higher boiling points, lower viscosities, greater lubricity, any combination thereof or the like.

[0024] Suitable R¹ groups of the glycol component include alkyl groups containing from 1 to 8 carbon atoms. Preferable glycol components include an R¹ group comprising a methyl, an ethyl, a propyl, a butyl, or any combination thereof.

[0025] Without limitation, examples of useful glycols (e.g., alkoxy glycols or otherwise) include methoxy triglycol, methoxy diglycol, methoxy polyglycol, ethoxy triglycol, ethoxy diglycol, ethoxy tetraglycol, propoxy triglycol, butoxy triglycol (e.g., triethylene glycol monobutyl ether), butoxy diglycol (e.g., diethylene glycol monobutyl ether), butoxy tetraglycol, pentoxy diglycol, pentoxy triglycol, 2-ethylhexyl diglycol or any combination thereof.

[0026] Preferable glycols (e.g., alkoxy glycols) of the glycol component include, without limitation, methoxy triglycol, methoxy diglycol, methoxy polyglycol (e.g., n = 4 or more), methoxy tetraglycol, ethoxy polyglycol (e.g., n = 4 or more), ethoxy triglycol, ethoxy diglycol, ethoxy tetraglycol, butoxy polyglycol (e.g., n = 4 or more), butoxy triglycol, butoxy diglycol, butoxy tetraglycol, triethylene glycol monohexyl ether, diethylene glycol monopropyl ether, triethylene glycol monopropyl ether, dipropylene glycol monomethyl ether, dipropylene glycol monopropyl ether, tripropylene glycol monopropyl ether, dipropylene glycol monobutyl ether, tripropylene glycol monobutyl ether, polypropylene glycol monobutyl ether, polypropylene glycol monopropyl ether, or any combination thereof. More preferable alkoxy glycol components comprise methoxy triglycol, methoxy diglycol, methoxy polyglycol (e.g., n = 4 or more), butoxy triglycol, butoxy diglycol, butoxy polyglycol (e.g., n = 4 or more), triethylene glycol monohexyl ether, diethylene glycol monopropyl ether, triethylene glycol monopropyl ether, dipropylene glycol monomethyl ether, dipropylene glycol monopropyl ether, tripropylene glycol monopropyl ether, dipropylene glycol monobutyl ether, tripropylene glycol monobutyl ether, polypropylene glycol monopropyl ether, polypropylene glycol monobutyl ether or any combination thereof. Most preferable alkoxy glycol components comprise a combination (e.g., a mixture) of methoxy polyglycol (e.g., n = 4 or more), butoxy diglycol, butoxy triglycol, butoxy polyglycol (e.g., n = 4 or more), triethylene glycol monopropyl ether, tripropylene glycol monopropyl ether, tripropylene glycol monobutyl ether, polypropylene glycol monopropyl ether, or polypropylene glycol monobutyl ether.

[0027] Further examples of useful glycols (e.g., alkoxy glycols or the like) include, without limitation, diethylene glycol monopropyl ether, triethylene glycol monopropyl ether, dipropylene glycol monomethyl ether, dipropylene glycol monopropyl ether, tripropylene glycol monopropyl ether, dipropylene glycol monobutyl ether, dipropylene glycol monomethyl ether, tripropylene glycol monoethyl ether, tripropylene glycol monopropyl ether, tripropylene glycol monobutyl ether, polypropylene glycol monopropyl ether, polypropylene glycol monobutyl ether,

polybutylene glycol monopropyl ether, polybutylene glycol monobutyl ether, or any combination thereof.

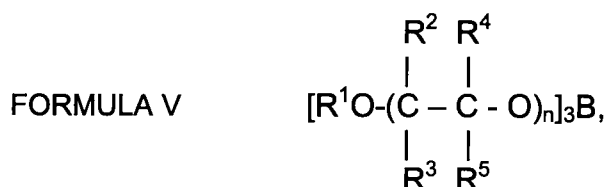
[0028] Additional suitable glycols for the glycol component may include glycols of FORMULA I (e.g., first glycols, second glycols, third glycols, or a mixture thereof) wherein R^1 and R^6 are both H. Such glycols (e.g., diols) may act as a diluent or a lubricant. For example, the functional fluids of the present invention may include less than about 50 wt%, preferably less than about 40 wt%, and more preferably less than about 30 wt% (e.g., from about 0 wt % to about 30 wt %), based on the total weight of the composition, of a diluent or a lubricant.

[0029] The glycol component may also include glycols of FORMULA I (e.g., first glycols, second glycols, third glycols, or a mixture thereof) wherein R^1 and R^6 are both alkyls having from 1 to 8 carbons. Such glycols may be characterized as having two terminal ether groups and are free of alcohol groups.

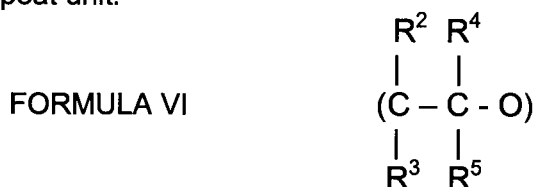
[0030] Without limitation, methods of preparing useful alkoxy glycols include an alkoxilation reaction that reacts an alkylene oxide with an alcohol to produce an alkyl glycol.

[0031] In one aspect, use of high purity alkoxy glycols in the glycol component is preferable. For example, by using high purity alkoxy glycol, a suitable low temperature viscosity is achievable. In particular, high purity butoxy triglycol and butoxy diglycol may individually or in combination be used to help maintain the desired low temperature viscosity. In one aspect, high purity alkoxy glycol is at least about 90% pure; at least about 97% pure, or at least about 98% pure. In one preferred embodiment, high purity butoxy triglycol and high purity butoxy diglycol is utilized in the fluid composition and is preferably at least 50% and more preferably at least 75% by weight of the glycol component.

[0032] When utilized, preferably the glycol borate ester component has the formula:



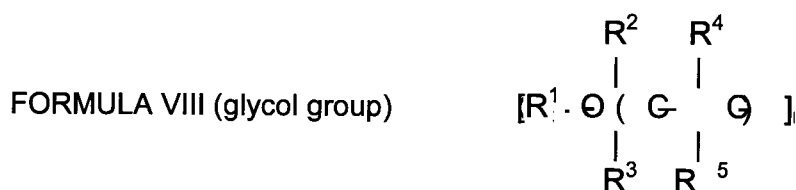
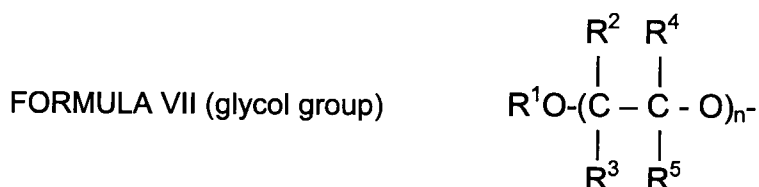
with repeat unit:



where R^1 , R^2 , R^3 , R^4 , and R^5 can be any of groups as specified with respect to FORMULA I and n can be as specified with respect to FORMULA I. As such, the glycol borate ester component can have any of the repeat units of the first glycol of the glycol component, the second glycol of the glycol component, the third glycol of the glycol component or any combination thereof as discussed with respect to FORMULA I herein. It is also understood that the glycol borate ester component and any borate containing compound is not considered as part of the glycol component, but rather is separate.

[0033] Examples of optional glycol borate ester components include alkoxy glycol borate ester components such as methoxy triethylene glycol borate ester, ethoxy triethylene glycol borate ester, butoxy triethylene glycol borate ester, or any combination thereof, such as is disclosed in U.S. Patent No. 6,558,569, filed November 10, 2000 (see e.g., column 3, lines 13 - 40), hereby incorporated by reference. If a borate ester component is present in the composition, it is preferably present in an amount greater than 0.01 or greater than 1 wt% of the functional fluid, but it is also preferably present in an amount less than about 10 wt % of the functional fluid. More preferably, the borate ester component is present in the composition in an amount less than about 4 wt % of the functional fluid. In one embodiment, the functional fluid compositions of the present invention are substantially free (e.g., present in an amount less than about 0.5% by weight of the functional fluid) or entirely free of any borate ester component.

[0034] When a glycol borate component is in the composition, it is typically the case that the glycol groups represent a substantial portion of the composition. Such glycol groups, as defined herein, are the portions of FORMULAs I and FORMULA V attached to the R^6 group (which may be a hydrogen atom) or the (B) Boron atom of those formulas. Thus, such glycol groups may be depicted as follows:



These glycol groups can represent at least about 50%, more typically at least about 60%, still more typically at least about 80% and even possibly at least about 90% by weight of the overall composition.

[0035] Fluid compositions may also include an additives package; that is one or a combination of additives employed to tune performance of the compositions in one or more aspects. The additives package, when present, is typically at least about 0.3 wt%, more typically at least about 1.0 wt% and even more typically at least about 3 wt% of the functional fluid. The additives package, when present, is typically less than about 8.0 wt%, more typically less than about 5.0, and even possibly less than about 4 or 3.5 wt% of the functional fluid.

[0036] Suitable additives packages may include, without limitation, corrosion inhibitors, stabilizers such as pH stabilizers, lubricants, anti-wear agents, anti-foaming agents, antioxidants, or any combination thereof.

[0037] Many known corrosion inhibitors such as the alkanol amines or alkyl amines and other organic amines increase low temperature viscosity of functional fluids containing borate esters, which in turn leads to the use of more complex and expensive additives such as those disclosed in EP0750033, filed June 20, 1996, incorporated by reference (see, e.g. page 2, lines 55 to page 3, line 56) and EP0617116, filed on March 9, 1994, incorporated by reference (see e.g., page 2, lines 14 to page 3, line 7 and page 4, lines 1 - 16). By using small amounts of borate esters, the fluid compositions may use known corrosion inhibitors and still achieve the desired low temperature viscosity. In addition, increased amounts of corrosion inhibitors and additives may be used to achieve improved stability or corrosion resistance without sacrificing low viscosity.

[0038] Examples of classes of corrosion inhibitors that may be used in the functional fluid compositions of the present invention include fatty acids such as lauric, palmitic, stearic or oleic acids, esters of phosphorus or phosphoric acid with aliphatic alcohols phosphites such as ethyl phosphate, dimethyl phosphate, isopropyl phosphate, butyl phosphite, triphenyl phosphite and diisopropyl phosphite, heterocyclic nitrogen containing compounds such as benzotriazole or its derivatives or any combination, such compounds, optionally with 1,2,4 triazole and/or its derivatives (see U.S. Patent No. 6,074,992, filed February 2, 1999 by Pierre Levesque, see e.g., column 2, line 65 to column 3, line 12, hereby incorporated by reference and British Patent No. 1,111,680, Filed Dec. 1, 1965 by McPhail et. al., see e.g., page 1, line 10 to page 2, line 8,

hereby incorporated by reference). Other amine compounds useful as corrosion inhibitors include alkyl amines such as di-n-butylamine and di-n-amylamine, cyclohexylamine and salts thereof. Amine compounds which are particularly useful as corrosion inhibitors in the functional fluid compositions of the present invention include the alkanol amines, preferably those containing one to three alkanol groups with each alkanol group containing from one to six carbon atoms. Examples of useful alkanol amines include mono-, di- and trimethanolamine, mono-, di- and triethanolamine, mono-, di- and tripropanolamine and mono-, di- and triisopropanolamine. In one aspect diisopropanolamine is utilized, which is readily available and inexpensive.

[0039] The additives packages may also advantageously contain, in addition to one or more corrosion inhibitors, other additive compounds such as antifoaming agents, pH stabilizers, antioxidants and the like, all well known to the skilled formulator for enhancing the performance of the functional fluid composition. Such other additives in combination with the corrosion inhibitors are normally present in an amount of from about 0.3 to about 10.0 wt %, based on the total weight of the functional fluid composition.

[0040] One preferred additives package includes a corrosion inhibitor (e.g., diisopropanolamine CAS # 110-97-4), a pH stabilizer (e.g., sodium nitrate CAS # 23-721-3), an anti-foaming agent (e.g., SAG Antifoam CAS # 63148-62-9 available from the Union Carbide Corporation), and an antioxidant (e.g., 2,4-dimethyl-6-t-butyl phenol CAS # 1879-09-0).

[0041] It is contemplated that other materials may be formulated into the functional fluids of the present invention so long as care is taken not to lower the ERBP or WERBP temperatures below acceptable levels or to increase the low temperature viscosity above an acceptable level. For example, the functional fluids of the present invention may include from about 0 or 0.10 wt % to about 30 wt %, based on the total weight of the composition, of a diluent or a lubricant such as, for example, polyethylene oxides, polypropylene oxides, polyglycols (e.g., mixtures of monoethylene glycol, diethylene glycol, triethylene glycol tetraethylene glycol, and higher mol adducts of ethylene glycol), poly(alkylene oxides) dialkoxglycols, borate co-esters, or any combination thereof. One preferred embodiment includes a lubricant, a diluent, polyglycol other than alkoxy or alkoxy ester glycols or any combination thereof, such as in an amount from about 5 wt % to about 25 wt %; more preferably, in an amount between about 15 wt % and about 22 wt %; and most preferably, in an amount between about 18.5 wt % and about 19.5 wt %.

[0042] It is also contemplated that the teachings of the present invention could be applied to other fluids formulated to achieve lower viscosities such as those disclosed in U.S. Patent No.

4,371,448, EP0 750033 and EP0617116 (hereby incorporated by reference for all purposes) to further lower viscosity while maintaining acceptable minimum ERBP and WERBP temperatures. [0043] Fluid compositions of the present invention have an ERBP of at least about 205°C, preferably at least about 240°C, more preferably at least about 250°C, and most preferably at least about 260°C or 270°C or more (e.g., more than 290°C, or even 300°C). Fluid compositions of the present invention have a WERBP of at least about 140°C, preferably at least about 144°C, and more preferably at least about 146°C or at least about 150°C or more (e.g., 160°C). The low temperature viscosity at -40°C of the fluid composition is preferably less than 1500 centistokes (cSt), preferably less than about 1450 or about 1400 centistokes (cSt), more preferably less than about 1300 cSt, more preferably less than about 1250 or 1000 cSt, and possibly less than about 880 cSt.

[0044] EXAMPLE FORMULATIONS

[0045] The following examples are not intended to be limiting and illustrate certain preferred embodiments of the present invention.

EXAMPLES 1-3

[0046] EXAMPLES 1-3 (EX. 1-3), as shown in TABLE 2, illustrate functional fluid compositions comprising first glycols which includes alkoxyated ethylene glycols (e.g., ethoxy triglycol, butoxy triglycol, and butoxy diglycol) and second glycols which includes an alkoxyated propylene glycol. The polyglycols (i.e., the polyethylene glycol monoethyl ether, the polypropyleneglycol monopropyl ether, and the polypropyleneglycol monobutyl ether) contain 90 – 99.8 wt% of molecules with $n \geq 4$, 0.1 – 10 wt% of molecules with $n=3$, and 0.1 – 10 wt% of molecules with $n=2$. The tripropylene glycol monopropyl ether mixture contains > 90 wt.% of molecules with $n=3$, >0.1% of molecules with $n=2$, and > 0.1% of molecules with $n \geq 4$. The composition also includes a lubricant of ethylene glycols (i.e., first glycols which are not alkoxyated). The lubricant in EX. 1-3 includes about 15 – 35 wt% diethylene glycol, about 35 – 55 wt.% triethylene glycol, and about 25 – 45 wt% polyethylene glycol (having n of at least 4).

EXAMPLE 4

[0047] EXAMPLE 4 (EX. 4), as shown in TABLE 2, illustrates a functional fluid composition comprising (e.g., consisting essentially of) a third glycols (e.g., a polyethylene-propylene glycol monomethyl ether and a polyethylene-propylene glycol monobutyl ether). The polyethylene-propylene glycol monoethyl ether has a molecular weight of about 200-300 daltons and the polyethylene-propylene glycol monobutyl ether has a molecular weight of about 200-400

daltons. The polyethylene-propylene glycol monoethyl ether, the polyethylene-propylene glycol monobutyl ether, or both may contain less than about 10 wt% (e.g., less than about 5 wt%) of first glycols (e.g., alkoxylated polyethylene glycol), second glycols (e.g., alkoxylated polypropylene glycol), or both.

TABLE 2. EXAMPLE FORMULATIONS

Component	Chemical Name	EX. 1 Wt. % in Fluid	EX. 2 Wt. % in Fluid	EX. 3 Wt. % in Fluid	EX. 4 Wt. % in Fluid
Alkoxylated ethylene glycol component	Ethoxy triglycol	6.00	6.00	6.00	
Alkoxylated ethylene glycol component	Butoxy triglycol	8.49	7.49	9.49	
Alkoxylated ethylene glycol component	Butoxy diglycol	3.08	3.08	3.08	
Alkoxylated ethylene glycol component	Polyethyleneglycol monoethyl ether	36	34	36	
Alkoxylated propylene glycol component	Tripropyleneglycol monopropyl ether mixture	22.00			
Alkoxylated propylene glycol component	Polypropyleneglycol monopropyl ether		22.00		
Alkoxylated propylene glycol component	Polypropyleneglycol monobutyl ether			22.0	
Alkoxylated polyethylene-propylene glycol component	Polyethylene-polypropylene glycol monomethyl ether, MW 200-300				72.35
Alkoxylated polyethylene-propylene glycol component	Polyethylene-polypropylene glycol monobutyl ether, MW 200-400				27.13
Lubricant	Diethylene glycol, triethylene glycol, and polyethylene glycol	23.00	26.00	22.00	
Additives package: Corrosion Inhibitor pH Stabilizer Antifoam Agent Antioxidant	Amines Sodium Nitrate SAG Antifoam 2,4-dimethyl-6-t-butyl phenol	1.43	1.43	1.43	0.52

[0048] These formulation for functional fluids are analyzed to measure their physical properties relating to DOT 3 brake fluid requirements. The physical properties, as shown in TABLE 3, are

measured using the test procedures set forth the Federal Motor Vehicle Standard 116 found at §571.116 et seq.)

TABLE 3. PROPERTIES OF EXAMPLES 1-4.

	EX. 1	EX. 2	EX. 3	EX. 4
ERBP	258°C	253°C	263°C	297
WERBP	146°C	147°C	145°C	147
Kinematic Viscosity at -40°C	1379 cSt	1408 cSt	1396 cSt	1276 cSt

[0049] Functional fluids of the present invention are well suited for use as a hydraulic fluid for numerous mechanical systems (e.g., hydraulic lifts, cranes, forklifts, bulldozers, hydraulic jacks, brake systems, combinations thereof, or the like). The high ERBP, WERBP, and low temperature viscosity of these fluid compositions are well-suited for brake systems in transportation vehicles (e.g., fixed and rotary wing aircraft, trains, automobiles in classes 1 to 8, or the like). These braking systems include anti-lock braking systems (ABS), stability control systems, or combinations thereof. Thus, the present invention includes any of these systems which include the fluid compositions disclosed herein.

[0050] Traditional automotive brake systems include a depression mechanism operably connected to a master cylinder, a pneumatic or hydraulic booster, brake lines, and a braking mechanism. To operate the brakes, an operator presses the depression mechanism and the master cylinder applies a pressure to the brake fluid that is transmitted through the brake lines to the braking mechanism that at least partially resists the motion of the wheel or wheels. Traditional brake systems require a booster pump to increase the pressure applied to the brake fluid to adequately operate the braking mechanism (e.g., to avoid a collision, when one or more wheels is slipping on a road surface, or combinations thereof) due to the high viscosity of traditional brake fluids.

[0051] Brake systems of the present invention may include low viscosity functional fluids described above, traditional higher viscosity brake fluids, or any combination thereof. Preferred brake systems include brake fluids that consist essentially of the low viscosity functional fluids described above. Furthermore, brake systems of the present invention may optionally include a booster pump (e.g., a pre-charge booster pump); however, the booster pump is preferably not included in the brake system as the use of the presently disclosed brake fluid may make the booster pump extraneous. Exclusion of the booster pump would represent a cost savings over systems where a booster pump was required.

[0052] It will be further appreciated that functions or structures of a plurality of components or steps may be combined into a single component or step, or the functions or structures of one-step or component may be split among plural steps or components. The present invention contemplates all of these combinations. Unless stated otherwise, dimensions and geometries of the various structures depicted herein are not intended to be restrictive of the invention, and other dimensions or geometries are possible. Plural structural components or steps can be provided by a single integrated structure or step. Alternatively, a single integrated structure or step might be divided into separate plural components or steps. In addition, while a feature of the present invention may have been described in the context of only one of the illustrated embodiments, such feature may be combined with one or more other features of other embodiments, for any given application. It will also be appreciated from the above that the fabrication of the unique structures herein and the operation thereof also constitute methods in accordance with the present invention. The present invention also encompasses intermediate and end products resulting from the practice of the methods herein. The use of "comprising" or "including" also contemplates embodiments that "consist essentially of" or "consist of" the recited feature.

[0053] The explanations and illustrations presented herein are intended to acquaint others skilled in the art with the invention, its principles, and its practical application. Those skilled in the art may adapt and apply the invention in its numerous forms, as may be best suited to the requirements of a particular use. Accordingly, the specific embodiments of the present invention as set forth are not intended as being exhaustive or limiting of the invention. The scope of the invention should, therefore, be determined not with reference to the above description, but should instead be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. The disclosures of all articles and references, including patent applications and publications, are incorporated by reference for all purposes.

What is claimed is:

1. A functional fluid composition comprising:

about 50 wt % to about 100 wt % of a glycol component wherein the glycol component includes one or more glycols of FORMULA I:



wherein R¹ and R⁶ are H or an alkyl group containing 1 to 8 carbon atoms or mixtures thereof and n is at least 1, the glycol having n repeat units which may be the same or different, including at least one repeat unit wherein at least one of R², R³, R⁴, and R⁵ is an alkyl group containing 1 to 8 carbon atoms.

2. A fluid composition of claim 1 wherein the one or more glycols of FORMULA I is present at a concentration of at least 5 wt. %, based on the total weight of the glycol component.
3. A fluid composition of claim 1 wherein the one or more glycols of FORMULA I is present at a concentration of at least 15 wt. %, based on the total weight of the glycol component.
4. A fluid composition of any of claims 1 thru 3 wherein R⁶ is H.
5. A fluid composition of any of claims 1 thru 4 wherein exactly one of R², R³, R⁴, and R⁵ is an alkyl group containing 1 to 8 carbon atoms and the rest are H.
6. A fluid composition of any of claims 1 thru 4 wherein at least two of R², R³, R⁴, and R⁵ are alkyl groups containing 1 to 8 carbon atoms and the rest are H.
7. A fluid composition of any of claims 1 thru 6 wherein the glycol component further comprises at least one glycol of FORMULA III:
(FORMULA III) R¹O(CH₂CH₂O)_nR⁶
wherein R¹ and R⁶ are H or an alkyl group containing 1 to 8 carbon atoms or mixtures thereof and n is at least 1 (e.g., n is at least 3).

8. A fluid composition of any of claims 1 thru 7 wherein the glycol of FORMULA I includes at least one first repeat unit wherein R^2 , R^3 , R^4 , and R^5 are each H and at least one second repeat unit wherein at least one (e.g., one, two, three or four) of R^2 , R^3 , R^4 , and R^5 are each an alkyl group containing 1 to 8 carbon atoms.

9. A fluid composition of any of claims 1 thru 8 wherein the one or more glycols of FORMULA I includes a glycol of FORMULA IV:



where either (i) n is at least 1 and R^7 is all propyl groups, or (ii) n is at least 2 and R^7 is a mixture of ethyl and propyl groups.

10. A fluid composition of any of claims 1 thru 9 wherein the one or more glycols of FORMULA I comprises a propylene glycol ether, an ethylene-propylene glycol ether, or both.

11. A fluid composition of any of claims 1 thru 10 wherein the glycol component includes an alkoxyated polypropylene glycol, an alkoxyated polyethylene-propylene glycol, or both.

12. A fluid composition of any of claims 1 thru 11 wherein the glycol component includes alkoxyated glycols of FORMULA I and FORMULA III



where at least one of R^1 and R^6 is an alkyl having from 1 to 8 carbon atoms, wherein the concentration of the alkoxyated glycols is greater than about 30 wt% based on the total weight of the glycol component.

13. A fluid composition of any of claims 1 thru 12 wherein the composition is substantially free of glycol borate esters.

14. A fluid composition of any of claims 1 thru 12 further comprising about 0.1 wt % to about 10 wt % of a glycol borate ester comprising the FORMULA V:



wherein each of R^1 , R^2 , R^3 , R^4 , and R^5 is H or an alkyl group containing 1 to 8 carbon atoms or mixtures thereof, n is 1 to 4; and about 0.3 wt % to about 10 wt % of an additive package including a corrosion inhibitor.

15. A fluid composition of claim 14 wherein an amount of the borate ester with $n = 3$ is greater than about 90 wt % of the borate ester, an amount of the borate ester with $n = 2$ is from about 0.5 wt % to about 5.0 wt % of the borate ester, and an amount of the borate ester with $n = 4$ is from about 0 or 0.1 wt % to about 15 wt % of the borate ester.

16. A fluid composition of any of claims 1 thru 15 wherein an amount of glycol component with $n = 3$ is greater than about 90 wt % of the glycol component, an amount of glycol component with $n = 2$ is from about 0.5 wt % to about 5.0 wt % of the glycol component, and the glycol component with $n = 4$ is from about 0 or 0.1 wt % to about 15 wt % of the glycol component.

17. A fluid composition of any of claims 1 thru 16 wherein the composition has a dry equilibrium reflux boiling point of about 205°C or more, a wet equilibrium reflux boiling point of about 140°C or more, and a viscosity of about 1500 cSt or less at a temperature of about -40°C.

18. A fluid composition of any of claims 1 thru 17 wherein the composition has a dry equilibrium reflux boiling point of about 250°C or more, a wet equilibrium reflux boiling point of 145°C or more, a viscosity of about 1400 cSt or less at a temperature of about -40°C.

19. A fluid composition of any of claims 1 thru 18 wherein the glycol component comprises one or more high purity glycol components.

20. A fluid composition of any of claims 1 thru 19 wherein the composition includes an additives package which comprises an antioxidant, an anti-foaming agent, a corrosion inhibitor, a pH stabilizer, or any combination thereof.

21. A fluid composition of any of claims 1 thru 20 wherein the glycol component comprises at least 50 wt% of alkoxyated glycols of FORMULA I and FORMULA III, wherein one of R^1 and

R⁶ is H and the other is selected from the group consisting of methyl, ethyl, propyl, butyl, or any combination thereof.

22. A fluid composition of any of claims 1 thru 20 wherein the glycol component comprises at least 70 wt% of alkoxyated glycols of FORMULA I and FORMULA III, wherein one of R¹ and R⁶ is H and the other is selected from the group consisting of methyl, ethyl, propyl, butyl, or any combination thereof.

23. A fluid composition of any of claims 1 thru 22 wherein the glycol component is present at a concentration of at least 70 wt% based on the total weight of the fluid composition.

24. A fluid composition of any of claims 1 thru 23 wherein the glycol component is present at a concentration of at least 85 wt% based on the total weight of the fluid composition.

25. A braking system including a fluid composition of any of claims 1 thru 24.

26. A braking system of claim 25 wherein the braking system is free of a booster.

27. Use of a fluid composition of any of claims 1 thru 24 as a fluid in a braking system.

28. Use of a fluid composition of any of claims 1 thru 24 as a fluid in a braking system that is free of a booster.