Case 4079-01

What is claimed is:

1. A process for preparing a bridged alkaline earth metal alkylphenate, comprising reacting:

(a) a 4-alkylphenol, unsubstituted at the *ortho* positions,

(b) an alkaline earth metal oxide or hydroxide,

(c) a bridging agent comprising sulfur or a carbonyl compound of 1 to about 6, or to 4 or to 2, carbon atoms, and

(d) a 2,6-dialkylphenol;

wherein amount of the 2,6-dialkylphenol is about 0.05 to about 3 moles (or about 0.1 to about 1.3 or about 0.25 to about 1.25 moles) per 1 mole of the 4-alkylphenol; provided that if there is a molar excess of the 2,6-dialkylphenol, then such excess is added after initial reaction of the 4-alkylphenol with alkaline earth oxide or hydroxide, the bridging agent, and no more than 1 mole of the 2,6-dialkylphenol per mole of the 4-alkylphenol.

2. The process of claim 1 wherein the 4-alkylphenol comprises 4-dodecylphenol.

3. The process of claim 1 or claim 2 wherein the 4-alkylphenol comprises tetrapropenylphenol.

4. The process of any of claims 1 through 3 wherein the alkaline earth metal oxide or hydroxide comprises calcium hydroxide.

5. The process of any of claims 1 through 4 wherein the bridging agent comprises sulfur.

6. The process of any of claims 1 through 5 wherein the bridging agent comprises formaldehyde.

7. The process of any of claims 1 through 6 wherein the bridging agent comprises both sulfur and formaldehyde.

8. The process of claim 7 wherein sulfur is supplied to the reaction mixture initially and thereafter formaldehyde is supplied.

9. The process of claim 8 wherein dialkylphenol is supplied to the reaction mixture along with the formaldehyde.

10. The process of any of claims 1 through 9 wherein the 2,6-dialkylphenol comprises 2,6-di-t-butylphenol.

11. The process of any of claims 1 through 10 wherein amount of the 2,6-dialkylphenol is about 0.15 to about 0.5 moles per 1 mole of the 4-alkylphenol.

12. The process of any of claims 1 through 11 wherein the amount of the bridging compound is about 0.8 to about 4 moles per 1 mole of the 4-alkylphenol and wherein the amount of the alkaline earth metal oxide or hydroxide is about 0.1 to about 4 moles per 1 mole of the 4-alkylphenol.

13. The process of any of claims 1 through 12 wherein the components (a) through (d) are reacted at about 150 °C to about 230 °C for about 2 to about 10 hours.

14. The process of any of claims 1 through 13 wherein the 4-alkylphenol is reacted with at least a portion of the alkaline earth metal oxide or hydroxide and at least a portion of the bridging agent prior to addition of the 2,6-dialkylphenol.

15. The process of claim 14 wherein, in a first step, about 0.1 to about 0.4 moles of calcium hydroxide and about 1 to about 3 moles of sulfur (as S_1), per mole of the 4-alkylphenol, are reacted with the 4-alkylphenol at about 170 to about 230 °C for about 3 to about 7 hours, and thereafter about 0.05 to about 0.5 moles of additional calcium hydroxide, about 0.25 to about 0.8 moles of additional sulfur, and about 0.15 to about 0.5 moles of the 2,6-dialkylphenol, per mole of the 4-alkylphenol, are added and reacted at about 150 to about 230 °C for about 1 to about 5 hours.

16. The process of any of claims 1 through 15 wherein the reaction is conducted in the presence of a solvent.

17. The process of claim 16 wherein the solvent comprises ethylene glycol.

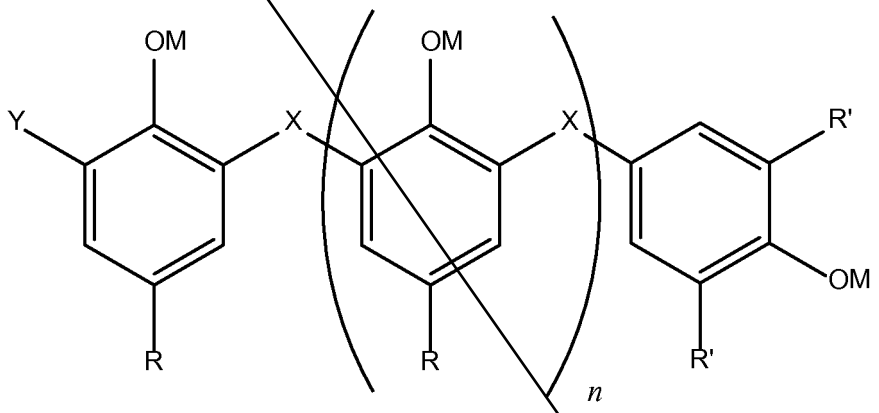
18. The process of any of claims 1 through 17 wherein the product of the reaction is subsequently treated with a molar excess of alkaline earth metal oxide or hydroxide.

19. The process of claim 18 wherein the product of the reaction is further treated with carbon dioxide, thereby providing an overbased detergent.

The process of any of claims 1 through 19 wherein the product of the reaction is subjected to vacuum stripping.

20. The product of the process of any of claims 1 through 20.

21. A bridged alkaline earth metal alkylphenate represented by the formula



where n is 0 to about 9;

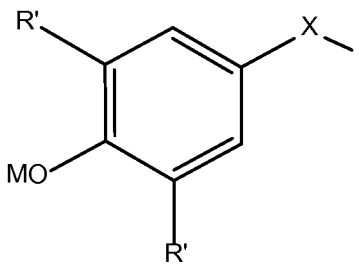
each M is independently hydrogen or a bond to a metal ion, provided that at least one M represents a bond to an alkaline earth metal ion;

each R is independently an alkyl group of about 10 to about 30 carbon atoms;

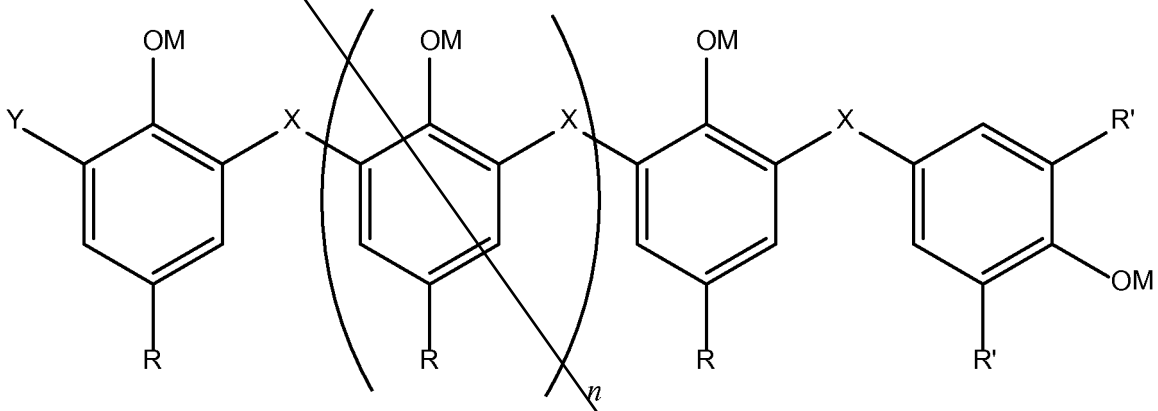
each R' is independently an alkyl group;

X is S_x or an alkylene group of 1 to about 4 carbon atoms, where x is 1 to about 4, or 1 to 2, or 1; and

Y is H or -SH or a group represented by the formula



22. The bridged alkaline earth metal alkylphenate of claim 22 being represented by the structure



where n is 0 to about 8.

23. A lubricant composition comprising an oil of lubricating viscosity and the product of any of claims 21 to 23.

24. The lubricant composition of claim 24 wherein the product of claim 21 to claim 23 is present in an amount of 0.1 to 8 percent by weight.

25. The lubricant composition of any of claim 24 or claim to 25 further comprising at least one of dispersants, detergents other than a bridged alkaline earth metal alkylphenate, antioxidants, antiwear agents, zinc dialkyldithiophosphates, and friction modifiers.

26. A method of lubricating a mechanical device, comprising supplying thereto the lubricant composition of any of claims 24 through 26.

27. The method of claim 27 wherein the mechanical device comprises an internal combustion engine.

28. The process of any of claims 1 through 20 wherein the resulting product contains a reduced amount of monomeric 4-alkylphenol, compared to the same process conducted in the absence of the 2,6-dialkylphenol.

What is claimed is:

1. A process for preparing a bridged alkaline earth metal alkylphenate, comprising reacting:

(a) a 4-alkylphenol, unsubstituted at the *ortho* positions,

(b) an alkaline earth metal oxide or hydroxide,

(c) a bridging agent comprising sulfur or a carbonyl compound of 1 to 6, or to 4 or to 2, carbon atoms, and

(d) a 2,6-dialkylphenol;

wherein amount of the 2,6-dialkylphenol is 0.05 to 3 moles, or 0.1 to 1.3, or 0.25 to 1.25 moles per 1 mole of the 4-alkylphenol; provided that if there is a molar excess of the 2,6-dialkylphenol, then such excess is added after initial reaction of the 4-alkylphenol with alkaline earth oxide or hydroxide, the bridging agent, and no more than 1 mole of the 2,6-dialkylphenol per mole of the 4-alkylphenol.

2. The process of claim 1 wherein the 4-alkylphenol comprises 4-dodecylphenol.

3. The process of claim 1 or claim 2 wherein the alkaline earth metal oxide or hydroxide comprises calcium hydroxide.

4. The process of any one of claims 1 to 3 wherein the bridging agent comprises sulfur or formaldehyde or both sulfur and formaldehyde.

5. The process of claim 4 wherein the bridging agent comprises both sulfur and formaldehyde, wherein, sulfur is supplied to the reaction mixture initially and thereafter formaldehyde is supplied.

6. The process of claim 5 wherein dialkylphenol is supplied to the reaction mixture along with the formaldehyde.

7. The process of any one of claims 1 to 6 wherein the 2,6-dialkylphenol comprises 2,6-di-t-butylphenol.

8. The process of any one of claims 1 to 7 wherein amount of the 2,6-dialkylphenol is 0.15 to 0.5 moles per 1 mole of the 4-alkylphenol.

9. The process of any one of claims 1 to 8 wherein the amount of the bridging compound is 0.8 to 4 moles per 1 mole of the 4-alkylphenol and wherein the

amount of the alkaline earth metal oxide or hydroxide is 0.1 to 4 moles per 1 mole of the 4-alkylphenol.

10. The process of any one of claims 1 to 9 wherein the components (a) through (d) are reacted at 150 °C to 230 °C for 2 to 10 hours.

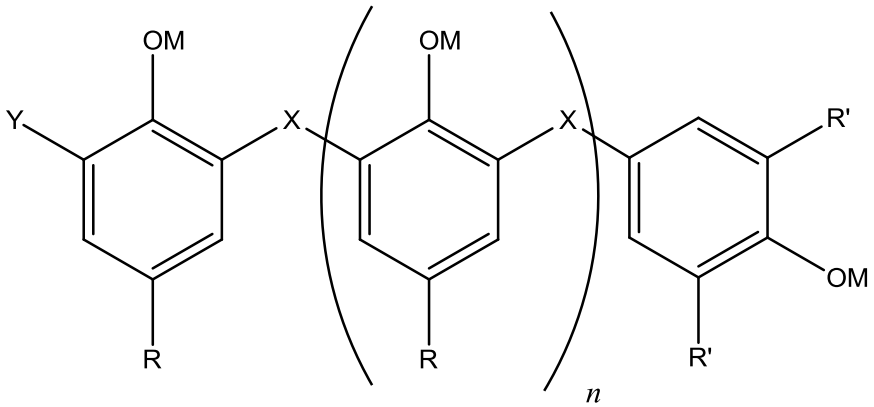
11. The process of any one of claims 1 to 10 wherein the 4-alkylphenol is reacted with at least a portion of the alkaline earth metal oxide or hydroxide and at least a portion of the bridging agent prior to addition of the 2,6-dialkylphenol.

12. The process of claim 11 wherein, in a first step, 0.1 to 0.4 moles of calcium hydroxide and 1 to 3 moles of sulfur (as S_1), per mole of the 4-alkylphenol, are reacted with the 4-alkylphenol at 170 to 230 °C for 3 to 7 hours, and thereafter 0.05 to 0.5 moles of additional calcium hydroxide, 0.25 to 0.8 moles of additional sulfur, and 0.15 to 0.5 moles of the 2,6-dialkylphenol, per mole of the 4-alkylphenol, are added and reacted at 150 to 230 °C for 1 to 5 hours.

13. The process of any one of claims 1 to 12 wherein the reaction is conducted in the presence of a solvent which optionally comprises ethylene glycol.

14. The process of any one of claims 1 to 13 wherein the product of the reaction is subsequently treated with a molar excess of alkaline earth metal oxide or hydroxide and optionally further treated with carbon dioxide, thereby providing an overbased detergent.

15. A bridged alkaline earth metal alkylphenate represented by the formula



where n is 0 to 9;

each M is independently hydrogen or a bond to a metal ion, provided that at least one M represents a bond to an alkaline earth metal ion;

each R is independently an alkyl group of 10 to 30 carbon atoms;

each R' is independently an alkyl group;

X is S_x or an alkylene group of 1 to 4 carbon atoms, where *x* is 1 to 4, or 1 to 2, or 1; and

Y is H or -SH or a group represented by the formula

