SUMMARY OF THE ~~INVENTION~~DISCLOSURE

[0005] In accordance with one embodiment of the present ~~invention~~disclosure, there is provided a process for preparing a salt of a sulfurized alkylhydroxyaromatic compound, the process comprising the steps of:

[0006] (a) sulfurizing an alkylhydroxyaromatic compound derived from alkylation of a hydroxyaromatic compound with one or more olefins comprising C_9 to C_{18} oligomers of monomers selected from propylene, butylene or mixtures thereof to provide a sulfurized alkylhydroxyaromatic reaction product; and subsequently

[0007] (b) removing any unsulfurized alkylhydroxyaromatic compound from the sulfurized alkylhydroxyaromatic reaction product of step (a) to provide a sulfurized alkylhydroxyaromatic compound substantially free of the unsulfurized alkylhydroxyaromatic compound; and subsequently

[0008] (c) neutralizing the sulfurized alkylhydroxyaromatic compound of step (b) to provide a salt of the sulfurized alkylhydroxyaromatic compound, wherein the salt of the sulfurized alkylhydroxyaromatic compound contains less than ~~about~~ 2% by combined mass of the unsulfurized alkylhydroxyaromatic compound and its unsulfurized metal salt.

[0009] In accordance with a second embodiment of the present ~~invention~~disclosure, there is provided a salt of a sulfurized alkylhydroxyaromatic compound containing less than ~~about~~ 2% by combined mass of an unsulfurized alkylhydroxyaromatic compound and its unsulfurized metal salt, the salt of a sulfurized alkylhydroxyaromatic compound being produced by a process comprising:

[0010] (a) sulfurizing an alkylhydroxyaromatic compound derived from alkylation of a hydroxyaromatic compound with one or more olefins comprising C_9 to C_{18} oligomers of monomers selected from propylene, butylene or mixtures thereof to provide a sulfurized

alkylhydroxyaromatic compound to provide a sulfurized alkylhydroxyaromatic reaction product;

[0011] (b) removing any unsulfurized alkylhydroxyaromatic compound from the sulfurized alkylhydroxyaromatic reaction product of step (a) to provide a sulfurized alkylhydroxyaromatic compound substantially free of the unsulfurized alkylhydroxyaromatic compound; and

[0012] (c) neutralizing the sulfurized alkylhydroxyaromatic compound of step (b) to provide the salt of the sulfurized alkylhydroxyaromatic compound containing less than ~~about~~ 2% by combined mass of the unsulfurized alkylhydroxyaromatic compound and its unsulfurized metal salt.

[0013] In accordance with a third embodiment of the present ~~invention~~disclosure, there is provided a lubricating oil composition comprising (a) a major amount of an oil of lubricating viscosity; and (b) at least one salt of a sulfurized alkylhydroxyaromatic compound containing less ~~about~~ 2% by combined mass of an unsulfurized alkylhydroxyaromatic compound and its unsulfurized metal salt, the salt of the sulfurized alkylhydroxyaromatic compound being produced by a process comprising: (i) sulfurizing an alkylhydroxyaromatic compound derived from alkylation of a hydroxyaromatic compound with one or more olefins comprising C_9 to C_{18} oligomers of monomers selected from propylene, butylene or mixtures thereof to provide a sulfurized alkylhydroxyaromatic reaction product; (ii) removing any unsulfurized alkylhydroxyaromatic compound from the sulfurized alkylhydroxyaromatic reaction product of step (i) to provide a sulfurized alkylhydroxyaromatic compound substantially free of the unsulfurized alkylhydroxyaromatic compound; and (iii) neutralizing the sulfurized alkylhydroxyaromatic compound of step (ii) to provide the salt of the sulfurized alkylhydroxyaromatic compound.

[0014] The process of the present ~~invention~~ disclosure advantageously provides a salt of a sulfurized alkylhydroxyaromatic compound containing relatively low levels of unsulfurized alkylhydroxyaromatic compound and its unsulfurized metal salt, i.e., less than about 2% by combined mass, as compared to the process disclosed in the '818 publication. Although the '818 publication discloses a sulfurized overbased metal phenate detergent containing less than 6.0% by combined mass of unsulfurized C_9-C_{15} alkyl phenol and unsulfurized metal salts thereof, Examples A and B disclosed therein only obtains an overbased detergent having 5.58 and 3.84 mass %, respectively, of unsulfurized alkyl phenol and its unsulfurized calcium salt. As such, the process of the present ~~invention~~ disclosure obtains a salt of a sulfurized alkylhydroxyaromatic compound containing levels of unsulfurized alkylhydroxyaromatic compound and its unsulfurized metal salt significantly lower than those obtained in the '818 application. This is an unexpected improvement in that the presence of the unsulfurized alkylhydroxyaromatic compound and its unsulfured metal salt in the resulting salt of a sulfurized alkylhydroxyaromatic compound is undesirable because of their deleterious estrogenic behavior and there is a growing concern of their potential release in the environment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] Prior to discussing the invention in further detail, the following terms will be defined:

[0016] DEFINITIONS

[0017] As used herein, the following terms have the following meanings, unless expressly stated to the contrary:

[0018] The term "TPP" as used herein refers to tetrapropenyl phenol and its salt.

[0019] The term "lime" as used herein refers to calcium hydroxide, also known as slaked lime or hydrated lime.

WHAT IS CLAIMED IS:

1. A process for preparing a salt of a sulfurized alkylhydroxyaromatic compound, the process comprising the steps of:

(a) sulfurizing an alkylhydroxyaromatic compound derived from alkylation of a hydroxyaromatic compound with one or more olefins comprising C_9 to C_{18} oligomers of monomers selected from propylene, butylene or mixtures thereof to provide a sulfurized alkylhydroxyaromatic reaction product; and subsequently

(b) removing any unsulfurized alkylhydroxyaromatic compound from the sulfurized alkylhydroxyaromatic reaction product of step (a) to provide a sulfurized alkylhydroxyaromatic compound substantially free of the unsulfurized alkylhydroxyaromatic compound; and subsequently

(c) neutralizing the sulfurized alkylhydroxyaromatic compound of step (b) to provide a salt of the sulfurized alkylhydroxyaromatic compound, wherein the salt of the sulfurized alkylhydroxyaromatic compound contains less than ~~about~~ 2% by combined mass of the unsulfurized alkylhydroxyaromatic compound and its unsulfurized metal salt.

2. The process according to Claim 1, wherein the hydroxyaromatic compound is a phenol and the one or more olefins comprising C_9 to C_{18} oligomers are one or more olefins comprising C_9 to C_{18} propylene oligomers.

3. The process according to Claims 1 or 2, wherein the sulfurization is carried out in the presence of a basic catalyst.

4. The process according to Claims 1-3, wherein the step of removing the unsulfurized alkylhydroxyaromatic compound comprises distilling the sulfurized alkylhydroxyaromatic reaction product of step (a).

5. The process according to Claims 1-4, wherein the neutralizing step (c) comprises contacting the sulfurized alkylhydroxyaromatic compound of step (b) with a source of an alkali or alkaline earth metal salt.

6. The process according to Claims 1-5, wherein the neutralizing step (c) comprises neutralizing and overbasing the salt of the sulfurized alkylhydroxyaromatic compound to provide an overbased salt of the sulfurized alkylhydroxyaromatic compound.

7. The process according to Claims 1-6, wherein the salt of the sulfurized alkylhydroxyaromatic compound contains from ~~about~~ 1 to ~~about~~ 1.9% % by combined mass of the unsulfurized alkylhydroxyaromatic compound and its unsulfurized metal salt.

8. The process according to Claims 1-7, wherein the salt of the sulfurized alkylhydroxyaromatic compound contains from ~~about~~ 0.2 to ~~about~~ 0.5% % by combined mass of the unsulfurized alkylhydroxyaromatic compound and its unsulfurized metal salt.

9. A salt of a sulfurized alkylhydroxyaromatic compound containing less than ~~about~~ 2% by combined mass of an unsulfurized alkylhydroxyaromatic compound and its unsulfurized metal salt, the salt of a sulfurized alkylhydroxyaromatic compound being produced by the process according to Claims 1-8.

10. The salt of a sulfurized alkylhydroxyaromatic compound according to Claim 9, containing from ~~about~~ 1 to ~~about~~ 1.9% % by combined mass of the unsulfurized alkylhydroxyaromatic compound and its unsulfurized metal salt.

11. The salt of a sulfurized alkylhydroxyaromatic compound according to Claim 9, containing from ~~about~~ 0.2 to ~~about~~ 0.5% % by combined mass of the unsulfurized alkylhydroxyaromatic compound and its unsulfurized metal salt.

12. A lubricating oil composition comprising (a) a major amount of an oil of lubricating viscosity and (b) at least one salt of a sulfurized alkylhydroxyaromatic compound according to Claims 9-11.

13. The lubricating oil composition according to Claim 12, wherein the at least one salt of a sulfurized alkylhydroxyaromatic compound is present in an amount of ~~about~~ 0.01 wt. % to ~~about~~ 40 wt. %, based on the total weight of the lubricating oil composition.

14. The lubricating oil composition according to Claims 12 or 13, further comprising at least one additive selected from the group consisting of an antioxidant, anti-wear agent, detergent, rust inhibitor, dehazing agent, demulsifying agent, metal deactivating agent, friction modifier, pour point depressant, antifoaming agent, co-solvent, package compatibiliser, corrosion-inhibitor, ashless dispersant, dye, extreme pressure agent and mixtures thereof.

15. A method for lubricating an engine comprising operating the engine with the lubricating oil composition according to Claims 12-14.