[0083] I claim:

1. A calcium sulfonate grease composition comprising the following ingredients: overbased oil-soluble calcium sulfonate and calcium hydroxyapatite.

2. The calcium sulfonate grease composition according to claim 1 comprising less than 36% overbased oil-soluble calcium sulfonate.

3. The calcium sulfonate grease composition according to claim 2 wherein the grease has a worked 60 stroke penetration between 265 and 295 and a dropping point of 575 F or higher.

4. The calcium sulfonate grease composition according to claim 1 wherein the grease is a complex grease and comprises between 25% and 32% overbased oil-soluble calcium sulfonate.

5. The calcium sulfonate grease composition according to claim 1 further comprising the following ingredients: at least one converting agent and at least one complexing acid.

6. The calcium sulfonate grease composition according to claim 5 wherein the amount of calcium hydroxyapatite is stoichiometrically insufficient to neutralize all of the complexing acid.

7. The calcium sulfonate grease composition according to claim 6 further comprising one or more other basic calcium compounds selected from the group consisting of: calcium hydroxide, calcium oxide, added calcium carbonate or any combination thereof in a total amount sufficient to neutralize at least some of the complexing acid not neutralized by the calcium hydroxyapatite.

8. The calcium sulfonate grease composition according to claim 7 wherein the overbased oil-soluble calcium sulfonate comprises finely dispersed calcium carbonate and 5%-30% of that calcium carbonate is used to neutralize substantially all of the complexing acid not neutralized by the calcium hydroxyapatite and the one or more other basic calcium compounds.

9. The calcium sulfonate grease composition according to claim 5 wherein the amount of calcium hydroxyapatite is stoichiometrically sufficient to neutralize all of the complexing acid or acids.

10. The calcium sulfonate grease composition according to claim 9 further comprising one or more other basic calcium compounds selected from the group consisting of: calcium hydroxide, calcium oxide, added calcium carbonate or any combination thereof.

11. The calcium sulfonate grease composition according to claim 5 further comprising a facilitating acid.

12. The calcium sulfonate complex grease composition according to claim 9 wherein no calcium oxide or calcium hydroxide is added.

13. The calcium sulfonate complex grease composition according to claim 5 wherein the one or more converting agents are selected from the group consisting of alcohols, ethers, glycols, glycol ethers, glycol polyethers, carboxylic acids, inorganic acids, organic nitrates, compounds that contain active hydrogen or compounds that contain tautomeric hydrogen; and

wherein the one or more complexing acids are selected from the group consisting of a long chain carboxylic acid, a short chain carboxylic acid, boric acid, and phosphoric acid.

14. The calcium sulfonate complex grease composition according to claim 11 wherein the facilitating acid is dodecylbenzene sulfonic acid.

15. The calcium sulfonate grease composition according to claim 3 wherein the overbased calcium sulfonate is a poor quality overbased calcium sulfonate.

16. The calcium sulfonate grease composition according to claim 7 wherein the grease has a worked 60 stroke penetration between 265 and 295 and a dropping point of 575 F or higher.

17. The calcium sulfonate grease composition according to claim 16 wherein the overbased oil-soluble calcium sulfonate is a poor quality calcium sulfonate.

18. The calcium sulfonate grease composition according to claim 6 further comprising one or more basic calcium compounds selected from the group consisting of calcium oxide, calcium hydroxide, or a combination thereof, wherein the one or more other basic calcium compounds comprise equivalent basicity of no more than 75% of the hydroxide equivalent basicity provided by the total of the calcium hydroxyapatite and the one or more basic calcium compounds.

19. The calcium sulfonate grease composition according to claim 5 further comprising one or more basic calcium compounds selected from the group consisting of calcium oxide, calcium hydroxide, or a combination thereof, wherein the calcium hydroxyapatite and one or more basic calcium compounds are stoichiometrically insufficient to neutralize all of the complexing acid.

20. The calcium sulfonate grease composition according to claim 19 wherein the overbased oil-soluble calcium sulfonate comprises finely dispersed calcium carbonate and 5%-30% of that calcium carbonate is used to neutralize substantially all of the complexing acid not neutralized by the calcium hydroxyapatite and one or more basic calcium compounds

21. A calcium sulfonate grease composition comprising the following ingredients:

less than 36% overbased oil-soluble calcium sulfonate;

2% to 20% calcium hydroxyapatite;

2% to 10% water;

one or more other converting agents in a total amount of 0.1% to 5% and

one or more complexing acids in a total amount of 2.8% to 11%.

22. The calcium sulfonate grease composition according to claim 21 wherein the grease has a dropping point of 575 F or higher.

23. The calcium sulfonate grease composition according to claim 21 further comprising one or more other basic calcium compounds and wherein the amount of calcium hydroxyapatite is stoichiometrically insufficient to neutralize all of the complexing acid.

24. The calcium sulfonate grease composition according to claim 23 wherein the one or more other basic calcium compounds is selected from the group consisting of: calcium hydroxide, calcium oxide, added calcium carbonate or any combination thereof and wherein the total amount of the one or more other basic calcium compounds is at least stoichiometrically sufficient to neutralize all of the complexing acid not neutralized by the calcium hydroxyapatite.

25. The calcium sulfonate grease composition according to claim 24 wherein the overbased calcium sulfonate is a poor quality overbased calcium sulfonate.

26. The calcium sulfonate grease composition according to claim 21 further comprising one or more other basic calcium compounds selected from the group consisting of calcium oxide, calcium hydroxide, or a combination thereof, wherein the one or more other basic calcium compounds comprise equivalent basicity of no more than 75% of the hydroxide equivalent basicity provided by the total of the calcium hydroxyapatite and the one or more basic calcium compounds.

27. A method for making an overbased calcium sulfonate complex grease comprising the steps of:

mixing overbased oil-soluble calcium sulfonate having amorphous calcium carbonate dispersed therein with a base oil, and one or more converting agents to form a pre-conversion mixture;

converting the pre-conversion mixture to a converted mixture by heating until conversion of the amorphous calcium carbonate to crystalline calcium carbonate has occurred;

mixing calcium hydroxyapatite with the pre-conversion mixture or the converted mixture or both; and

mixing one or more complexing acids with the pre-conversion mixture or the converted mixture or both.

28. The method according to claim 27 further comprising mixing one or more other basic calcium compounds with the pre-conversion mixture or the converted mixture or both.

29. The method according to claim 28 wherein the one or more other basic calcium compounds is selected from the group consisting of: calcium hydroxide, calcium oxide, added calcium carbonate or any combination thereof.

30. The method according to claim 28 wherein the amount of calcium hydroxyapatite mixed is stoichiometrically insufficient to neutralize all of the complexing acid and the total amount of the one or more other basic calcium compounds mixed is stoichiometrically sufficient to neutralize at least some of the complexing acid not neutralized by the calcium hydroxyapatite.

31. The method according to claim 30 wherein 5-30% of the dispersed calcium carbonate originating from the overbased calcium sulfonate is used to neutralize substantially all of the complexing acid not neutralized by the calcium hydroxyapatite and the one or more other basic calcium compounds.

32. The method according to claim 27 wherein the overbased calcium sulfonate is a poor quality calcium sulfonate and the grease has a dropping point of at least 575 F.

33. The method according to claim 27 wherein the one or more complexing acids mixed with the pre-conversion mixture are different than the one or more complexing acids mixed with the converted mixture.

34. The method according to claim 27 wherein the calcium hydroxyapatite is mixed only with the converted mixture in an amount stoichiometrically sufficient to neutralize all of the complexing acid.

35. The method according to claim 34 wherein at least a portion of one or more complexing acids is mixed with the converted mixture.

36. The method of claim 28 wherein the calcium sulfonate grease has a dropping point of at least 575 F and less than 36% overbased calcium sulfonate is used.

37. The method according to claim 27 further comprising mixing added calcium carbonate and one or more other basic calcium compounds with the pre-conversion mixture or the converted mixture or both;

wherein the calcium hydroxyapatite and one or more other basic calcium compounds are stoichiometrically insufficient to neutralize all of the complexing acid;

wherein the added calcium carbonate is stoichiometrically sufficient to neutralize substantially all of the complexing acid not neutralized by the calcium hydroxyapatite and one or more other basic calcium compounds; and

wherein the one or more other basic calcium compounds are selected from the group consisting of calcium hydroxide, calcium oxide, or a combination thereof.

38. The method according to claim 28 wherein the one or more other basic calcium compounds are selected from the group consisting of calcium oxide, calcium hydroxide, or a combination thereof;

and wherein the one or more other basic calcium compounds comprise equivalent basicity of no more than 75% of the hydroxide equivalent basicity provided by the total of the calcium hydroxyapatite and the one or more basic calcium compounds.

CLAIMS

1. A calcium sulfonate grease composition comprising the following ingredients: overbased oil-soluble calcium sulfonate and calcium hydroxyapatite having a formula $Ca_5(PO_4)_3OH$ or mathematically equivalent formula with a melting point of around 1100°C .

2. A calcium sulfonate grease composition according to claim 1 comprising around 10% to 36% overbased oil-soluble calcium sulfonate.

3. A calcium sulfonate grease composition according to claim 1 wherein the grease is a complex grease and comprises between 25% and 32% overbased oil-soluble calcium sulfonate.

4. A calcium sulfonate grease composition according to claim 1 further comprising the following ingredients: at least one converting agent and at least one complexing acid.

5. A calcium sulfonate grease composition according to claim 4 wherein the amount of calcium hydroxyapatite is stoichiometrically insufficient to neutralize ail of the complexing acid.

6. A calcium sulfonate grease composition according to claim 5 further comprising one or more other basic calcium compounds selected from the group consisting of: calcium hydroxide, calcium oxide, added calcium carbonate or any combination thereof in a total amount sufficient to neutralize at least some of the complexing acid not neutralized by the calcium hydroxyapatite.

7. A calcium sulfonate grease composition according to claim 4 wherein the amount of calcium hydroxyapatite is stoichiometrically sufficient to neutralize all of the complexing acid or acids.

8. A calcium sulfonate grease composition according to claim 7 further comprising one or more other basic calcium compounds selected from the group consisting of: calcium hydroxide, calcium oxide, added calcium carbonate or any combination thereof.

9. A calcium sulfonate grease composition according to claim 4 further comprising a facilitating acid.

10. A calcium sulfonate complex grease composition according to claim 7 wherein no calcium oxide or calcium hydroxide is added.

11. A calcium sulfonate complex grease composition according to claim 4 wherein the one or more converting agents are selected from the group consisting of alcohols, ethers, glycols, glycol ethers, glycol polyethers, carboxylic acids, inorganic acids, organic nitrates, compounds that contain active hydrogen or compounds that contain tautomeric hydrogen; and

wherein the one or more complexing acids are selected from the group consisting of a long chain carboxylic acid, a short chain carboxylic acid, boric acid, and phosphoric acid.

12. A calcium sulfonate complex grease composition according to claim 9 wherein the facilitating acid is dodecylbenzene sulfonic acid.

13. A calcium sulfonate grease composition according to any one of claims 2 to 12 wherein the overbased oil-soluble calcium sulfonate is a poor quality calcium sulfonate.

14. A calcium sulfonate grease composition according to claim 4 further comprising one or more basic calcium compounds selected from the group consisting of calcium oxide, calcium hydroxide, or a combination thereof, wherein

the calcium hydroxyapatite and one or more basic calcium compounds are stoichiometrically insufficient to neutralize all of the complexing acid.

15. A calcium sulfonate grease composition according to claim 6 or 14 wherein the overbased oil-soluble calcium sulfonate comprises finely dispersed calcium carbonate and 5%-30% of that calcium carbonate is used to neutralize substantially all of the complexing acid not neutralized by the calcium hydroxyapatite and one or more basic calcium compounds

16. A calcium sulfonate grease composition according to claim 2 further comprising the following ingredients:

2% to 10% water;

one or more other converting agents in a total amount of 0.1% to 5%; one or more complexing acids in a total amount of 2.8% to 11%; and

wherein the amount of calcium hydroxyapatite is around 2% to 20%.

17. A calcium sulfonate grease composition according to claim 2, 6 or 16 wherein the grease has a dropping point of 575 F or higher.

18. A calcium sulfonate grease composition according to claim 16 further comprising one or more other basic calcium compounds and wherein the amount of calcium hydroxyapatite is stoichiometrically insufficient to neutralize all of the complexing acid.

19. The calcium sulfonate grease composition according to claim 18 wherein the one or more other basic calcium compounds is selected from the group consisting of: calcium hydroxide, calcium oxide, added calcium carbonate or any combination thereof and wherein the total amount of the one or more other basic calcium compounds is at least stoichiometrically sufficient to neutralize all of the complexing acid not neutralized by the calcium hydroxyapatite.

20. The calcium sulfonate grease composition according to claim 16 further comprising one or more other basic calcium compounds selected from the group consisting of calcium oxide, calcium hydroxide, or a combination thereof, wherein the one or more other basic calcium compounds comprise equivalent basicity of no more than 75% of the hydroxide equivalent basicity provided by the total of the calcium hydroxyapatite and the one or more basic calcium compounds.

21. A method for making an overbased calcium sulfonate complex grease comprising the steps of:

mixing overbased oil-soluble calcium sulfonate having amorphous calcium carbonate dispersed therein with a base oil, and one or more converting agents to form a pre-conversion mixture;

converting the pre-conversion mixture to a converted mixture by heating until conversion of the amorphous calcium carbonate to crystalline calcium carbonate has occurred;

mixing calcium hydroxyapatite with the pre-conversion mixture or the converted mixture or both;

mixing one or more complexing acids with the pre-conversion mixture or the converted mixture or both; and

wherein the calcium hydroxyapatite has a formula of $Ca_5(PO_4)_3OH$ or a mathematically equivalent formula with a melting point of around 1100°C.

22. A method according to claim 21 further comprising mixing one or more other basic calcium compounds with the pre-conversion mixture or the converted mixture or both.

23. A method according to claim 22 wherein the one or more other basic calcium compounds is selected from the group consisting of: calcium hydroxide, calcium oxide, added calcium carbonate or any combination thereof.

24. A method according to claim 22 wherein the amount of calcium hydroxyapatite mixed is stoichiometrically insufficient to neutralize all of the complexing acid or acids and the total amount of the one or more other basic calcium compounds mixed is stoichiometrically sufficient to neutralize at least some of the complexing acid not neutralized by the calcium hydroxyapatite.

25. A method according to claim 24 wherein 5-30% of the dispersed calcium carbonate originating from the overbased calcium sulfonate is used to neutralize substantially all of the complexing acid not neutralized by the calcium hydroxyapatite and the one or more other basic calcium compounds.

26. A method according to claim 21 wherein the overbased calcium sulfonate is a poor quality calcium sulfonate and the grease has a dropping point of at least 575 F.

27. A method according to claim 21 wherein the one or more complexing acids mixed with the pre-conversion mixture are different than the one or more complexing acids mixed with the converted mixture.

28. A method according to claim 21 wherein the calcium hydroxyapatite is mixed only with the converted mixture in an amount stoichiometrically sufficient to neutralize all of the complexing acid or acids.

29. A method according to claim 28 wherein at least a portion of one or more complexing acids is mixed with the converted mixture.

30. A method of claim 22 wherein the calcium sulfonate grease has a dropping point of at least 575 F and around 10% to 36% overbased calcium sulfonate is used.

31. A method according to claim 21 further comprising mixing added calcium carbonate and one or more other basic calcium compounds with the pre-conversion mixture or the converted mixture or both;

wherein the calcium hydroxyapatite and one or more other basic calcium compounds are stoichiometrically insufficient to neutralize all of the complexing acid;

wherein the added calcium carbonate is stoichiometrically sufficient to neutralize substantially all of the complexing acid not neutralized by the calcium hydroxyapatite and one or more other basic calcium compounds; and

wherein the one or more other basic calcium compounds are selected from the group consisting of calcium hydroxide, calcium oxide, or a combination thereof.

32. A method according to claim 22 wherein the one or more other basic calcium compounds are selected from the group consisting of calcium oxide, calcium hydroxide, or a combination thereof;

and wherein the one or more other basic calcium compounds comprise equivalent basicity of no more than 75% of the hydroxide equivalent basicity provided by the total of the calcium hydroxyapatite and the one or more basic calcium compounds.

33. A calcium sulfonate grease composition consisting of the following ingredients: overbased oil-soluble calcium sulfonate and calcium hydroxyapatite having a formula $Ca_5(PO_4)_3OH$ or mathematically equivalent formula with a melting point of around 1100°C.

34. A calcium sulfonate grease composition consisting essentially of the following ingredients: overbased oil-soluble calcium sulfonate and calcium hydroxyapatite having a formula $Ca_5(PO_4)_3OH$ or mathematically equivalent formula with a melting point of around 1100°C.