

WHAT IS CLAIMED IS:

1. A heat transfer mixture represented by the formula:
$$1 = V_{pg}/V_{nf} + V_w/V_{nf} + V_{pw}/V_{nf} + V_{sf}/V_{nf} + V_{bs}/V_{nf}$$
wherein V_{nf} is a volume of a nanofluid,
wherein V_{pg} is a volume of propylene glycol,
wherein V_w is a volume of water,
wherein V_{pw} is a volume of a nanopowder,
wherein V_{sf} is a volume of a surfactant, and
wherein V_{bs} is a volume of a base additive.
2. The heat transfer mixture recited in claim 1, wherein $5\% < V_{pg}/V_{nf} < 75\%$.
3. The heat transfer mixture recited in claim 1, wherein $5\% < V_w/V_{nf} < 94\%$.
4. The heat transfer mixture recited in claim 1, wherein $0.1\% < V_{NP}/V_{nf} < 20\%$.
5. The heat transfer mixture recited in claim 1, wherein $0.01\% < V_{sf}/V_{nf} < 3\%$.
6. The heat transfer mixture recited in claim 1, wherein $0.1\% < V_{bs}/V_{nf} < 10\%$.

7. The heat transfer mixture recited in claim 1, wherein:

$5\% < V_{pg}/V_{nf} < 75\%$;

$5\% < V_w/V_{nf} < 94\%$;

$0.1\% < V_{NP}/V_{nf} < 20\%$;

$0.01\% < V_{sf}/V_{nf} < 3\%$; and

$0.1\% < V_{bs}/V_{nf} < 10\%$.

8. A heat transfer mixture comprising:

propylene glycol;

water;

a nanopowder comprising Al_2O_3 ;

a surfactant; and

a base additive,

wherein the nanopowder has a particle size between about 100 nanometers and about 600 nanometers,

wherein the heat transfer mixture comprises between about 1% by volume and about 20% by volume of the nanopowder,

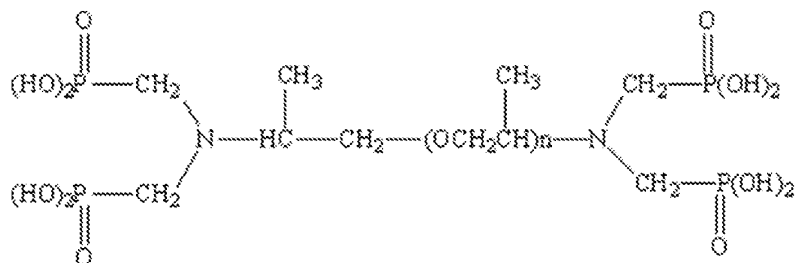
wherein the heat transfer mixture comprises between about .010% by volume and about 3% by volume of the surfactant, and

wherein the heat transfer mixture has a pH is between about 8.5.to about 12.

9. The heat transfer mixture recited in claim 8, wherein the surfactant is a sodium salt solution of polyamino polyether methylene phosphonic acid.

10. The heat transfer mixture recited in claim 8, wherein the surfactant is

represented by the formula:



11. A heat transfer mixture comprising:

between about 5% by volume and about 70% by volume of propylene glycol;

between about 5% by volume and about 94% by volume of water;

between about 1.0% by volume and about 20% by volume of a nanopowder comprising Al_2O_3 ;

between about 0.01% by volume and about 3% by volume of a surfactant; and

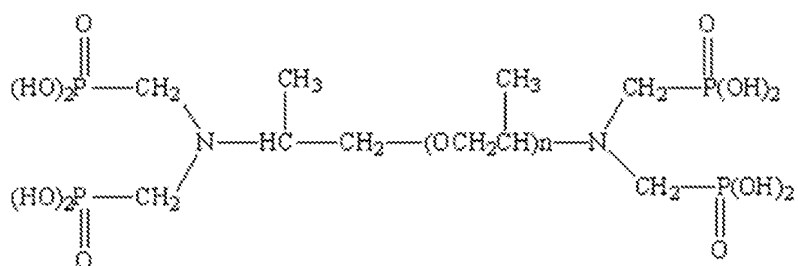
between about 1.0% by volume and about 10% by volume of a base additive,

wherein the nanopowder has a particle size between about 100 nanometers and about 600 nanometers, and

wherein the heat transfer mixture has a pH of about 10.0.

12. The heat transfer mixture recited in claim 11, wherein the surfactant is

represented by the formula:



13. A heat transfer mixture represented by the formula:

$$1 = V_{eg}/V_{nf} + V_w/V_{nf} + V_{pw}/V_{nf} + V_{sf}/V_{nf} + V_{bs}/V_{nf} + V_{ac}/V_{nf} + V_{ci}/V_{nf},$$

wherein V_{nf} is a volume of a nanofluid,

wherein V_{eg} is a volume of ethylene glycol,

wherein V_w is a volume of water,

wherein V_{pw} is a volume of a nanopowder,

wherein V_{sf} is a volume of a surfactant,

wherein V_{bs} is a volume of a base additive,

wherein V_{ac} is a volume of an acid additive, and

wherein V_{ci} is a volume of a corrosive inhibitor.

14. The heat transfer mixture recited in claim 13, wherein $30.0\% < V_{eg}/V_{nf} < 50.0\%$.

15. The heat transfer mixture recited in claim 13, wherein $50.0\% < V_w/V_{nf} < 70.0\%$.

16. The heat transfer mixture recited in claim 13, wherein $1\% < V_{NP}/V_{nf} < 3.0\%$.

17. The heat transfer mixture recited in claim 13, wherein $0.12\% < V_{sf}/V_{nf} < 0.40\%$.

18. The heat transfer mixture recited in claim 13, wherein $1.3\% < V_{bs}/V_{nf} < 2.0\%$.

19. The heat transfer mixture recited in claim 13, wherein $0.0 < V_{ac}/V_{nf} < 2.0$.

20. The heat transfer mixture recited in claim 13, wherein $0.012 < V_{ci}/V_{nf} < 0.1$.

21. The heat transfer mixture recited in claim 13, wherein:

$30\% < V_{eg}/V_{nf} < 50.0\%$;

$50.0\% < V_w/V_{nf} < 70.0\%$;

$1\% < V_{NP}/V_{nf} < 3.0\%$;

$0.12\% < V_{sf}/V_{nf} < 0.40\%$;

$1.3\% < V_{bs}/V_{nf} < 2.0\%$;

$0.0 < V_{ac}/V_{nf} < 2.08$; and

$0.02 < V_{ci}/V_{nf} < 0.1$.

22. The heat transfer mixture recited in claim 13, wherein:

$35.0\% < V_{eg}/V_{nf} < 45.0\%$;

$55.0\% < V_w/V_{nf} < 65.0\%$;

$1\% < V_{NP}/V_{nf} < 2.0\%$;

$0.12\% < V_{sf}/V_{nf} < 0.40\%$;

$1.3\% < V_{bs}/V_{nf} < 6.8\%$;

$0 < V_{ac}/V_{nf} < 2.0$; and

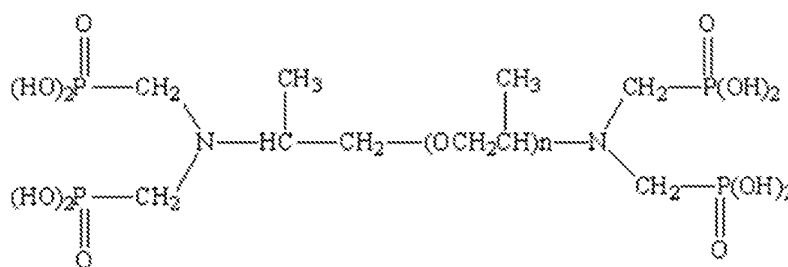
$0.02 < V_{ci}/V_{nf} < 0.1$.

23. The heat transfer mixture recited in claim 13, wherein the nanopowder is aluminum oxide.

24. The heat transfer mixture recited in claim 13, wherein the nanopowder is aluminum oxide in a range between 100 nanometers and 600 nanometers.

25. The heat transfer mixture recited in claim 13, wherein the surfactant is a sodium salt solution of polyamino polyether methylene phosphonic acid.

26. The heat transfer mixture recited in claim 13, wherein the surfactant is represented by the formula:



27. The Heat transfer mixture recited in claim 13, wherein the heat transfer mixture has a pH of between about 8.5-12.0.

28. The heat transfer mixture recited in claim 13, wherein the heat transfer mixture has a pH of 10.0.

29. A heat transfer mixture comprising:

ethylene glycol;

water;

a nanopowder comprising Al_2O_3 ;

a surfactant;

a base additive;

an acid additive; and

a corrosive inhibitor,

wherein the nanopowder has a particle size between about 100 nanometers and about 600 nanometers,

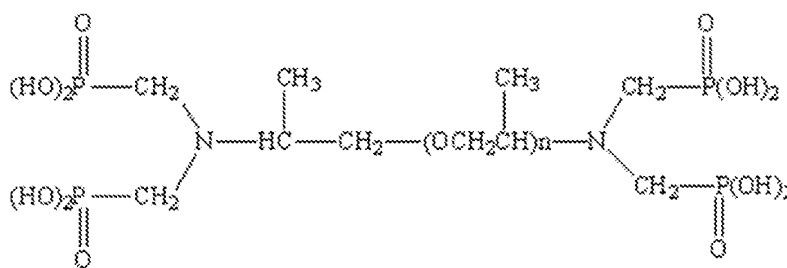
wherein the heat transfer mixture comprises between about 10% by volume and about 20% by volume of the nanopowder,

wherein the heat transfer mixture comprises between about 0.4% by volume and about 3% by volume of the surfactant, and

wherein the heat transfer mixture has a pH is between about 8.5 to about 12.0

30. The heat transfer mixture recited in claim 29, wherein the surfactant is a sodium salt solution of polyamino-polyether-methylene-phosphonic acid.

31. The heat transfer mixture recited in claim 29, wherein the surfactant is represented by the formula:



32. A heat transfer mixture comprising:

between about 5% by volume and about 70% by volume of ethylene glycol;

between about 5% by volume and about 94% by volume of water;

between about 1.0% by volume and about 20% by volume of a nanopowder comprising Al_2O_3 ;

between about 0.1% by volume and about 3% by volume of a surfactant;

between about 1.0% by volume and about 10% by volume of a base additive;

between about 0% by volume and about 6.8% by volume of an acid additive;

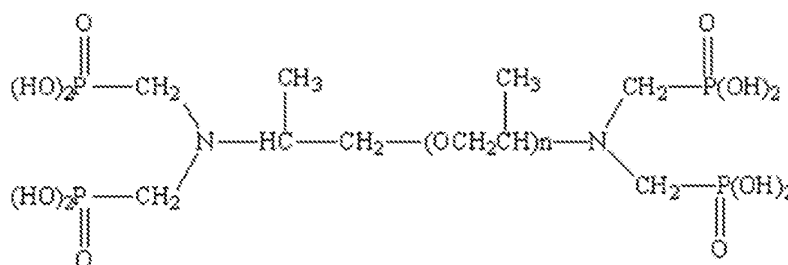
and

between about 0.12% by volume and about 0.10% by volume of a corrosive inhibitor,

wherein the nanopowder has a particle size between about 100 nanometers and about 600 nanometers, and

wherein the heat transfer mixture has a pH of about 10.0.

33. The heat transfer mixture recited in claim 32, wherein the surfactant is represented by the formula:



34. A heat transfer mixture represented by the formula:

$$1 = \text{Veg}/\text{Vnf} + \text{Vw}/\text{Vnf} + \text{Vpw}/\text{Vnf} + \text{Vsf}/\text{Vnf} + \text{Vac}/\text{Vnf}$$

wherein Vnf is a volume of a nanofluid,

wherein Veg is a volume of ethylene glycol,

wherein Vw is a volume of water,

wherein V_{pw} is a volume of a nanopowder,
wherein V_{sf} is a volume of a surfactant, and
wherein V_{ac} is a volume of an acid additive.

35. The heat transfer mixture recited in claim 34, wherein $25\% < V_{eg}/V_{nf} < 50\%$.

36. The heat transfer mixture recited in claim 34, wherein $30\% < V_w/V_{nf} < 70\%$.

37. The heat transfer mixture recited in claim 34, wherein $0.1\% < V_{NP}/V_{nf} < 20\%$.

38. The heat transfer mixture recited in claim 34, wherein $0.01\% < V_{sf}/V_{nf} < 3\%$.

39. The heat transfer mixture recited in claim 34, wherein $0\% < V_{ac}/V_{nf} < 10\%$.

40. The heat transfer mixture recited in claim 34, wherein:

$25\% < V_{eg}/V_{nf} < 50\%$;

$30\% < V_w/V_{nf} < 70\%$;

$0.1\% < V_{NP}/V_{nf} < 30\%$;

$0.01\% < V_{sf}/V_{nf} < 5\%$; and

$0\% < V_{ac}/V_{nf} < 10\%$.

41. A heat transfer mixture comprising:

ethylene glycol;

water;

a nanopowder comprising Al_2O_3 ;

a surfactant; and

an acid additive,

wherein the nanopowder has a particle size between about 100 nanometers and about 600 nanometers,

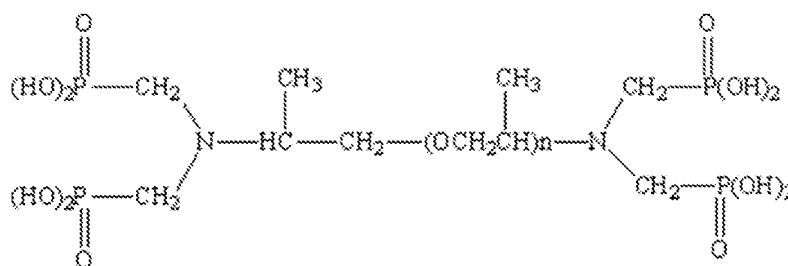
wherein the heat transfer mixture comprises between about 10% by volume and about 20% by volume of the nanopowder,

wherein the heat transfer mixture comprises between 0.1% about by volume and 3% by volume of the surfactant, and

wherein the heat transfer mixture has a pH of about 8.5 to about 12.0.

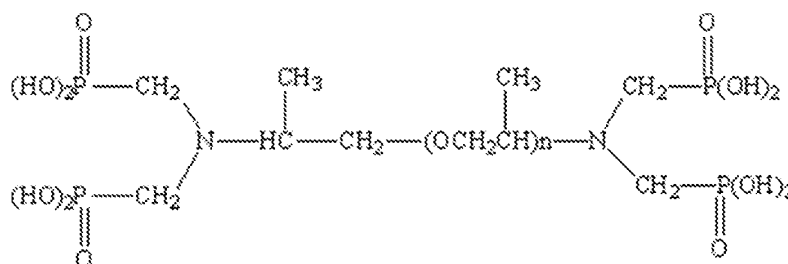
42. The heat transfer mixture recited in claim 41, wherein the surfactant is a sodium salt solution of polyamino polyether methylene phosphonic acid.

43. The heat transfer mixture recited in claim 41, wherein the surfactant is represented by the formula:



44. A heat transfer mixture comprising:
- between about 30% by volume and about 50% by volume of ethylene glycol;
 - between about 50% by volume and about 70% by volume of water;
 - between about 1.0% by volume and about 3.0% by volume of a nanopowder comprising Al_2O_3 ;
 - between about 0.1% by volume and about 0.4% by volume of a surfactant;
- and
- between about 0% by volume and about 2.0% by volume of an acid additive,
- wherein the nanopowder has a particle size between about 100 nanometers and about 600 nanometers, and
- wherein the heat transfer mixture has a pH of about 10.0.

45. The heat transfer mixture recited in claim 44, wherein the surfactant is represented by the formula:



46. A heat transfer mixture represented by the formula:

$$1 = V_w/V_{nf} + V_{pw}/V_{nf} + V_{sf}/V_{nf} + V_{bs}/V_{nf} + V_{ac}/V_{nf} + V_{ci}/V_{nf},$$

wherein V_{nf} is a volume of a nanofluid,

wherein V_w is a volume of water,

wherein V_{pw} is a volume of a nanopowder,

wherein V_{sf} is a volume of a surfactant,

wherein V_{bs} is a volume of a base additive,

wherein V_{ac} is a volume of an acid additive, and

wherein V_{ci} is a volume of a corrosive inhibitor.

47. The heat transfer mixture recited in claim 46, wherein the surfactant is HEDP / PBTC / PCA - etidronic acid / phosphonobutane-tricarboxylic acid / phosphino-carboxylic acid.