CLAIMS

1. A method of treating a recirculating cooling water system to inhibit corrosion on water system components made of aluminum and its alloys, copper and its alloys, zinc and its alloys, lead, or ferrous metals other than galvanized steel or any combination thereof and to inhibit scale over a range of LSI values of -2.5 to 3, the method comprising adding an amount of an amino-acid based polymer or its water soluble salt, hydroxyphosphonoacetic acid or its water soluble salt, and a second phosphonic acid or its water soluble salt to the water in the water system; and

wherein the adding step provides (1) an active concentration of 2 ppm – 50 ppm of the amino-acid based polymer or its water soluble salt, an active concentration of 2 ppm – 50 ppm of the hydroxyphosphonoacetic acid or its water soluble salt, and an active concentration of 1.5 ppm – 20 ppm of the second phosphonic acid or its water soluble salt in the volume of water in the water system to inhibit scale or (2) an active concentration of 3 ppm – 50 ppm of the amino-acid based polymer or its water soluble salt, an active concentration of 3 ppm – 50 ppm of the hydroxyphosphonoacetic acid or its water soluble salt, and an active concentration of 2 ppm – 20 ppm of the second phosphonic acid or its water soluble salt to inhibit corrosion; and

wherein the adding step provides an active amount of amino-acid based polymer or its water soluble salt that is (1) equal to or greater than an active amount of the hydroxyphosphonoacetic acid or its water soluble salt and (2) equal to or greater than an active amount of the second phosphonic acid or its water soluble salt; and

wherein no zinc or molybdenum or compounds containing zinc or molybdenum are added to the water in the water system.

2. The method of claim 1 wherein the second phosphonic acid is a phosphonocarboxylic acid or its water soluble salt and the water has an LSI value of 0.2 to 3.0 prior to the adding step, the method further comprising increasing the LSI of the water after the adding step by 2 or more over the LSI prior to the adding step without scale formation.

3. The method of claim 2 wherein the second phosphonic acid is HEDP or its water soluble salt.

4. The method of claim 2 wherein the phosphonocarboxylic acid is PBTC or its water soluble salt; and the amino-acid based polymer is polyaspartic acid or its water soluble salt.

5. The method of claim 4 wherein the LSI value prior to the adding step is 0.2 to 1.0 and the LSI value after the adding step is at least two times the LSI value before the adding step without any scale formation.

6. The method of claim 4 wherein the LSI value prior to the adding step is 0.2 to 1.0.

7. The method of claim 2 wherein the second phosphonic acid is PBTC or its water soluble salt.

8. The method of claim 1 wherein the second phosphonic acid is a phosphonocarboxylic acid or its water soluble salt.

9. The method of claim 8 wherein the adding step provides (1) an active concentration of 3 ppm – 30 ppm of the amino-acid based polymer or its water soluble salt, an active concentration of 2 ppm – 20 ppm of the hydroxyphosphonoacetic acid or it water soluble salt, and an active concentration of 1.5 ppm – 10 ppm of the phosphonocarboxylic acid or its water soluble salt in the volume of water in the water system to inhibit scale or (2) an active concentration of 5 ppm – 30 ppm amino-acid based polymer or its water soluble salt, an active concentration of 3 ppm – 20 ppm of the hydroxyphosphonoacetic acid or its water soluble salt, and an active concentration of 2 ppm - 10 ppm of the phosphonocarboxylic acid or its water soluble salt in the volume of water in the water system to inhibit corrosion.

10. The method of claim 1 wherein the second phosphonic acid is a phosphonocarboxylic acid or its water soluble salt;

the amino-acid based polymer or its water soluble salt, and hydroxyphosphonoacetic acid or its water soluble salt, and phosphonocarboxylic acid or its water soluble salt, and a tracer are combined in a treatment composition that does not contain tin prior to addition to the water system and wherein the method further comprises:

periodically measuring the amount of treatment composition in the water system based on a measurement of the tracer.

11. The method of claim 10 further comprising adding additional treatment composition as needed to maintain a concentration of the amino-acid based polymer or its water soluble salt of at least 2 ppm and a concentration of the hydroxyphosphonoacetic acid or its water soluble salt of at least 2 ppm, wherein these concentrations are when added to a volume of water in the water system to inhibit scale.

12. The method of claim 1 wherein the water in the water system contains a biocide.

13. The method of claim 12 wherein the biocide contains chlorine or bromine.

14. The method of claim 12 wherein the second phosphonic acid is HEDP or its water soluble salt and wherein no tin is added to the water system.

15. The method of claim 14 wherein the biocide contains chlorine or bromine.

16. The method of claim 1 wherein the water in the water system has a pH of 7-9.

17. The method of claim 1 wherein the water system is a recirculating water system having water with an LSI value of greater than 0 before the adding step and wherein the cycles of concentration are increased after the adding step.

18. The method of claim 17 wherein the second phosphonic acid is (1) PBTC or its water soluble salt or (2) HEDP or its water soluble salt; and wherein the cycles of concentration are increased to greater than 4.

19. The method of claim 17 wherein the second phosphonic acid is (1) PBTC or its water soluble salt or (2) HEDP or its water soluble salt; and wherein the cycles of concentration are increased to at least 6.

20. The method of claim 1 wherein no tin is added to the water system.

21. The method of claim 1 wherein the amino-acid based polymer is polyaspartic acid or its water soluble salt and the second phosphonic acid is PBTC or its water soluble salt.

22. The method of claim 21 wherein the water in the water system has an LSI value of greater than 0 before the adding step and wherein the cycles of concentration are increased after the adding step.

23. The method of claim 22 wherein the cycles of concentration are increased by at least 1.

24. The method of claim 21 wherein no tin is added to the water system.

25. The method of claim 1 wherein the adding step provides an active concentration of 3 ppm – 10 ppm of the amino-acid based polymer or its water soluble salt, an active concentration of 3 ppm – 7.5 ppm of the hydroxyphosphonoacetic acid or its water soluble salt, and an active concentration of 3 ppm – 4.8 ppm of the second phosphonic acid or its water soluble salt in the volume of water in the water system to inhibit corrosion.

26. A method of treating a recirculating cooling water system to inhibit corrosion on water system components made of aluminum and its alloys, copper and its alloys, zinc and its alloys, lead, or ferrous metals other than galvanized steel or any combination thereof and to inhibit scale over a range of LSI values of -2.5 to 3, the method comprising adding an amount of a polyaspartic acid or its water soluble salt, hydroxyphosphonoacetic acid or its water soluble salt, and an HEDP or its water soluble salt to the water in the water system; and

wherein the adding step provides (1) an active concentration of 2 ppm – 50 ppm of the polyaspartic acid or its water soluble salt, an active concentration of 2 ppm – 50 ppm of the hydroxyphosphonoacetic acid or its water soluble salt, and an active concentration of 1.5 ppm –

20 ppm of the HEDP or its water soluble salt in the volume of water in the water system to inhibit scale or (2) an active concentration of 3 ppm – 50 ppm, of the polyaspartic acid or its water soluble salt, an active concentration of 3 ppm – 50 ppm of the hydroxyphosphonoacetic acid or its water soluble salt, and an active concentration of 2 ppm – 20 ppm of the HEDP or its water soluble salt to inhibit corrosion; and

wherein the adding step provides an active polyaspartic acid or its water soluble salt that is (1) equal to or greater than an active amount of the hydroxyphosphonoacetic acid or its water soluble salt and (2) equal to or greater than an active amount of the HEDP or its water soluble salt; and

wherein no zinc or molybdenum or compounds containing zinc or molybdenum are added to the water in the water system.

27. The method of claim 26 wherein the water has an LSI value of greater than 0 before the adding step and wherein the cycles of concentration are increased after the adding step.

28. The method of claim 27 wherein the cycles of concentration are increased by at least 1.

29. The method of claim 26 wherein no tin is added to the water system.

30. A method of treating a recirculating water system to inhibit scale formation, the method comprising adding an amount of an amino-acid based polymer or its water soluble salt, a hydroxyphosphonoacetic acid (HPA) or its water soluble salt, and a second phosphonic acid or its water soluble salt to the water in the water system; and

increasing an LSI value of the water after the adding step compared to an LSI value of the water prior to the adding step without scale formation; and

wherein the LSI value prior to the adding step is 0.2 to 3.0;

wherein the adding step provides an active concentration of at least 2 ppm of the amino-acid based polymer or its water soluble salt, an active concentration of at least 2 ppm of the hydroxyphosphonoacetic or its water soluble salt, and an active concentration of at least 1.5 ppm of the second phosphonic acid or its water soluble salt, and a total active concentration of the amino-acid based polymer or its water soluble salt, the hydroxyphosphonoacetic acid or its water soluble salt, and the second phosphonic acid or its water soluble salt of 6.5 ppm to 18.7 ppm in the volume of water in the water system; and

wherein the adding step provides an active amount of amino-acid based polymer or its water soluble salt that is (1) equal to or greater than an active amount of the hydroxyphosphonoacetic acid or its water soluble salt and (2) equal to or greater than an active amount of the second phosphonic acid or its water soluble salt;

wherein no zinc or molybdenum or compounds containing zinc or molybdenum are added to the water in the water system; and

at least one of the following: (1) wherein the amino-acid based polymer is polyaspartic acid or its water soluble salt and the second phosphonic acid is HEDP or its water soluble salt; or (2) wherein the cycles of concentration are increased to at least 4 after the adding step.

31. The method of claim 30 wherein the second phosphonic acid is a phosphonocarboxylic acid or its water soluble salt.

32. The method of claim 30 wherein no tin is added to the water in the water system.

33. The method of claim 32 wherein the cycles of concentration are increased after the adding step.

34. The method of claim 33 wherein the cycles of concentration are increased by at least 1.

35. The method of claim 33 wherein the cycles of concentration are increased by at least 2.

36. The method of claim 30 wherein the cycles of concentration are increased by at least 1.

37. The method of claim 30 wherein the cycles of concentration are increased by at least 2.

38. The method of claim 30 wherein the second phosphonic acid is a HEDP or its water soluble salt; and wherein the adding step provides a total active concentration of the amino-acid based polymer or its water soluble salt, HPA or its water soluble salt, and HEDP or its water soluble salt of 6.5 ppm to 13.4 ppm when added to a volume of water in the water system.

39. The method of claim 30 wherein the amino-acid -based polymer is polyaspartic acid or its water soluble salt and the second phosphonic acid is PBTC or its water soluble salt.

40. The method of claim 39 wherein the cycles of concentration are increased after the adding step.

41. The method of claim 40 wherein the cycles of concentration are increased by at least 1.

42. The method of claim 40 wherein the cycles of concentration are increased by at least 2.

43. The method of claim 30 wherein the second phosphonic acid is a PBTC or its water soluble salt; and wherein the adding step provides a total active concentration of the amino-acid based polymer or its water soluble salt, PBTC or its water soluble salt, and HPA or its water soluble salt of 6.5 ppm to 13.6 ppm when added to a volume of water in the water system.

44. The method of claim 30 wherein the water system is a recirculating water system;

wherein the second phosphonic acid is (1) PBTC or its water soluble salt or (2) HEDP or its water soluble salt; and

wherein the cycles of concentration are increased to greater than 4 after the adding step.

45. The method of claim 30 wherein the water system is a recirculating water system;

wherein the second phosphonic acid is (1) PBTC or its water soluble salt or (2) HEDP or its water soluble salt; and

wherein the cycles of concentration are increased to at least 6 after the adding step.

46. A method of treating a water system to inhibit scale when the water has an LSI value of greater than 0 to 3, the method comprising adding an amount of an amino-acid based polymer or its water soluble salt, hydroxyphosphonoacetic acid or its water soluble salt, and a second phosphonic acid or its water soluble salt to the water in the water system; and

wherein the adding step provides (1) concentration of 3 ppm – 30 ppm of the amino-acid based polymer or its water soluble salt, an active concentration of 2 ppm – 20 ppm of the hydroxyphosphonoacetic acid or it water soluble salt, and an active concentration of 1.5 ppm – 10 ppm of the second phosphonic acid or its water soluble salt in the volume of water in the water system to inhibit scale;

wherein no tin or zinc or molybdenum or compounds containing zinc or molybdenum are added to the water system; and

at least one of the following: (1) wherein the second phosphonic acid is not a PBTC or its water soluble salt or (2) wherein the amino-acid based polymer is polyaspartic acid or its water soluble salt and the second phosphonic acid is HEDP or its water soluble salt.

47. The method of claim 46 wherein the adding step provides an active amount of amino-acid based polymer or its water soluble salt that is (1) equal to or greater than an active amount of the hydroxyphosphonoacetic acid or its water soluble salt and (2) equal to or greater than an active amount of the second phosphonic acid or its water soluble salt.

48. The method of claim 46 wherein the second phosphonic acid is HEDP or its water soluble salt and wherein the water in the water system contains a biocide.

49. The method of claim 48 wherein the biocide contains chlorine or bromine.

50. The method of claim 46 wherein the cycles of concentration are increased after the adding step.

51. The method of claim 50 wherein the cycles of concentration are increased by at least 1.

52. The method of claim 51 wherein the cycles of concentration are increased by at least 2.