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METHOD OF AND COMPOSITION FOR PREVENTING CORROSION OF METAL PARTS IN COOLING OR HEATING SYSTEMS

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This invention relates to a method of and means for preventing corrosion of metal parts in cooling or heating systems in which water is used as the cooling or heating medium and in which no substantial evaporation of the water takes place.

In order to counteract corrosion of metal parts in cooling and heating systems of the foregoing kind, it has inter alia, been proposed to add to the water salts of chromic acid, and more especially chromates or dichromates of the alkali metals, it being claimed that such addition also prevents the formation of scale on the walls of the metal parts. Experience has, however, shown that corrosion of the metallic parts of such systems is not completely suppressed by this measure, and that moreover in the course of time, and particularly after repeated additions of the water to make up for loss by evaporation, deposits are formed which collect on the walls of the metal parts in the form of crusts, and thus interfere with the water circulation and impede the heat exchange.

It has however, been observed that the extent to which the individual phenomena occur varies with the nature of the chromic acid salt used. Thus, when using solutions containing only monochromate, it has been found that the corrosion is at a minimum, but that at the same time the tendency to form deposits is at a maximum and that when using dichromate—and even more, when using chromic acid alone—the tendency to form deposits is reduced but the corrosive action of the solutions on the metallic tubes and on the metal parts of the system is correspondingly increased.

Thus for example, when using water of a 5 to 7 sulphate hardness and 5 to 7 carbonate hardness, it was observed after ten times the quantity of water contained in the vessel had been evaporated in the vessel, that when using an addition of alkali metal monochromate alone the total amount of deposit was about 500 to 600 mgs. per litre and it was ascertained that the pH value of this solution which initially was 8.5 had, after termination of the test, fallen to between 6 and 7. Under similar conditions, when using dichromate alone, the total amount of deposit formed was about 100 to 150 mgs. per litre and the pH value of the liquid which was initially 4 to 4.5 had increased up to about 6 at the end of the test.

As a result of exhaustive experiments, it has now been ascertained that both the attack of said solutions on the metallic parts as well as the formation of deposits from such solutions is a function of the pH value of the solutions and it has been found that both the aforesaid formation of deposits and the corrosion of the metal parts is prevented when using solutions having such a content of chromic acid salts of the alkali metals that the pH value thereof is maintained between 5 and 7 and preferably approximately 6.

In order to obtain such solutions it is necessary to ensure the presence in the water of both alkali monochromate and alkali dichromate.

A pH value of 7 can for example be obtained by using a mixture consisting of 75 parts by weight of alkali metal monochromate and 25 parts by weight of alkali metal dichromate and a pH value of 5 can be obtained when using a mixture consisting of 9 parts by weight of alkali metal monochromate and 91 parts by weight of alkali metal dichromate. The most advantageous pH value of 6 is obtained when the water contains about 1% of a mixture consisting of approximately 22 parts by weight of alkali metal monochromate and 78 parts by weight of alkali metal dichromate.

Further researches have shown that the formation of deposits from such solutions can be practically completely prevented by adding to the solutions containing alkali metal mono- and alkali metal dichromate and having a pH value of between 5 and 7, small amounts of chlorates and/or perchlorates of the alkali metals preferably in the proportion of about 1 to 2% of the total of the salt mixture.

These further additions serve a double purpose: They have a buffer effect on the pH value of the solution and moreover prevent the formation of deposits by forming readily soluble chlorates and/or perchlorates of the alkaline earth metal salts contained in the water. Thus for example, by adding 1% of a mixture consisting of 86 parts by weight of potassium dichromate, 12 parts by weight of potassium monochromate, 1 part by weight of sodium chlorate and 1 part by weight of sodium perchlorate to the water in a company's water system, the formation of deposits and the corrosion of the supply system, which may include conduits, fittings and the like of metals of the most diverse electrical potentials, is practically completely obviated.

The foregoing salt mixtures may be added to the water system in the form of powder but it has been found especially advantageous to employ them in the form of tablets, pastilles or the like moulded bodies. When using such tablets, which are generally formed by pressing under high pressure, the substantially longer time of solution

required in comparison with the loose powder has however been found to be a drawback.

It has now been ascertained that the speed of solution of the salt mixture when used in the form of moulded bodies can be increased by a multiple, by adding to the salt mixture to be formed into tablets or the like, substances such as carbonates or bicarbonates which in contact with water, liberate carbon dioxide as a result of their reaction with the alkali metal dichromate. The pressure of the liberated gaseous carbon dioxide breaks up the moulded bodies into a large number of small particles, whereby an increased speed of solution is obtained which practically equals the speed of solution of the salt mixture added in a loose form.

As can be seen from the equation:

$$K_2Cr_2O_7+2KHCO_3=2K_2CrO_4+2CO_2+H_2O$$
$$K_2Cr_2O_7+K_2CO_3=2K_2CrO_4+CO_2$$

the reaction of the alkali metal carbonate or bicarbonate with the alkali metal dichromate yields monochromate in addition to carbon dioxide. In compounding the salt mixture it is thus necessary to take into consideration the amount of monochromate formed by reaction with the carbonate and/or bicarbonate when calculating the proportion of monochromate and dichromate to be used as such. A simple stoichiometrical calculation will however furnish the amount of carbonate or bicarbonate which it is necessary to add to the salt mixture in order to obtain a solution in which a pH value lying between 5 and 7 is maintained by virtue of the additional monochromate formed.

A suitable preparation for the purposes of the present invention is in the form of a tablet consisting of 86 parts by weight of potassium dichromate, 8 parts by weight of potassium monochromate, 1 part by weight of sodium chlorate, 1 part by weight of sodium perchlorate and 2 parts by weight of sodium bicarbonate.

Instead of using monochromate as such, in the mixture or the moulded bodies made therefrom it is also possible to produce the monochromate in the solution obtained by dissolving such moulded bodies in the water to be heated from part of the dissolved dichromate by replacing the monochromate in the moulded bodies by the cheaper caustic alkali or alkali metal oxide, in which case on solution of same the reaction proceeds in accordance with the equation:

$$K_2Cr_2O_7+2KOH=2K_2CrO_4+H_2O.$$

The replacement of the monochromate by caustic alkali has the further advantage of increasing the speed of solution of the moulded body since as is well known, the solubility of caustic alkali is much greater than that of alkali metal monochromate and of alkali metal dichromate. Moreover, tablets or other moulded bodies comprising alkali metal dichromate and caustic alkali do not deteriorate on storage.

Example

A mixture of 92 parts by weight of potassium dichromate and 8 parts by weight of caustic alkali are pressed in known manner under a pressure of about 2000 kgs. per sq. cm. into the form of tablets. If such tablets be dissolved in water in the proportion of 1 grm. to 100 grms. of water a potassium dichromate potassium monochromate solution is obtained which has a pH value of 6.2.

I claim:

1. A method of preventing corrosion of metal parts in heat interchange systems, in which there is a circulation of water containing no intentional additions other than those hereinafter specified, and in which there occurs only a gradual and progressive evaporation of such water with replenishment of the latter as occasion arises, which methood comprises establishing in the water of the heat interchange system a solution of alkali metal hydroxide ions and chromic acid ions in such proportion that the aqueous solution has a pH value lying between about 5 and about 7 the concentration of chromate being at least about 1 per cent. of the total water content of the system.

2. A method of preventing corrosion of metal parts in heat interchange systems, in which there is a circulation of water containing no intentional additions other than those hereinafter specified, and in which there occurs only a gradual and progressive evaporation of such water with replenishment of the latter as occasion arises, which method comprises establishing in the water of the heat interchange system a solution of an alkali metal monochromate and an alkali metal dichromate in such proportion that the aqueous solution has a pH value lying between about 5 and about 7 the concentration of chromate being at least about 1 per cent. of the total water content of the system.

3. A method of preventing corrosion of metal parts in heat interchange systems, in which there is a circulation of water containing no intentional additions other than those hereinafter specified, and in which there occurs only a gradual and progressive evaporation of such water with replenishment of the latter as occasion arises, which method comprises incorporating in the water of the heat interchange system an alkali metal monochromate and an alkali metal dichromate in such proportion that the aqueous solution has a pH value lying between about 5 and about 7 the concentration of chromate being at least about 1 per cent. of the total water content of the system.

4. A method of preventing corrosion of metal parts in heat interchange systems, in which there is a circulation of water containing no intentional additions other than those hereinafter specified, and in which there occurs only a gradual and progressive evaporation of such water with replenishment of the latter as occasion arises, which method comprises establishing in the water of the heat interchange system a solution of alkali metal hydroxide ions and chromic acid ions in such proportion that the aqueous solutions has a pH value of about 6 the concentration of chromate being at least about 1 per cent. of the total water content of the system.

5. A method of preventing corrosion of metal parts in heat interchange systems, in which there is a circulation of water containing no intentional additions other than those hereinafter specified, and in which there occurs only a gradual and progressive evaporation of such water with replenishment of the latter as occasion arises, which method comprises establishing in the water of the heat interchange system a solution of an alkali metal monochromate and an alkali metal dichromate in such proportion that the aqueous solution has a pH value of about 6 the concentration of chromate being at

least about 1 per cent. of the total water content of the system.

6. A method of preventing corrosion of metal parts in heat interchange systems, in which there is a circulation of water containing no intentional additions other than those hereinafter specified, and in which there occurs only a gradual and progressive evaporation of such water with replenishment of the latter as occasion arises, which method comprises incorporating in the water of the heat interchange system an alkali metal monochromate and an alkali metal dichromate in such proportion that the aqueous solution has a pH value of about 6 the concentration of chromate being at least about 1 per cent. of the total water content of the system.

7. A method of preventing corrosion of metal parts in heat interchange systems, in which there is a circulation of water containing no intentional additions other than those hereinafter specified, and in which there occurs only a gradual and progressive evaporation of such water with replenishment of the latter as occasion arises, which method comprises incorporating in the water of the heat interchange system about 1% of a mixture consisting of about 22 parts by weight of alkali metal monochromate and about 78 parts by weight of alkali metal dichromate the concentration of chromate being at least about 1 per cent. of the total water content of the system.

8. A method of preventing corrosion of metal parts in heat interchange systems, in which there is a circulation of water containing no intentional additions other than those hereinafter specified, and in which there occurs only a gradual and progressive evaporation of such water with replenishment of the latter as occasion arises, which method comprises incorporating in the water of the heat interchange system an alkali metal monochromate and an alkali metal dichromate in such proportion that the aqueous solution has a pH value lying between about 5 and about 7, and further between about 1 and about 2 per cent. referred to the total amount of chromic acid salts added, of at least one substance of the group consisting of the alkali metal chlorates and perchlorates the concentration of chromate being at least about 1 per cent. of the total water content of the system.

9. A method of preventing corrosion of metal parts in heat interchange systems, in which there is a circulation of water containing no intentional additions other than those hereinafter specified, and in which there occurs only a gradual and progressive evaporation of such water with replenishment of the latter as occasion arises, which method comprises incorporating in the water of the heat interchange system at least one alkali metal dichromate and at least one substance of the group consisting of caustic alkali and alkali metal oxides, so as to convert part of said dichromate into monochromate, the proportion in which such caustic alkali and/or alkali metal oxide is added being such as to ensure in the solution produced a pH value ranging between about 5 and about 7 the concentration of chromate being at least about 1 per cent. of the total water content of the system.

10. A moulded body consisting of a mixture of alkali metal monochromate and alkali metal dichromate in such proportion that, when dissolved in water, the solution has a pH value lying between about 5 and about 7.

11. A moulded body consisting of a mixture of about 22 parts by weight of alkali metal monochromate and about 78 parts by weight of alkali metal dichromate.

12. A moulded body consisting of a mixture of about 86 parts by weight of potassium dichromate, 12 parts by weight of potassium monochromate, 1 part by weight of sodium chlorate, and 1 part by weight of sodium perchlorate.

13. A moulded body consisting of a mixture of at least one alkali metal dichromate and a substance adapted, upon being dissolved in water, to convert alkali metal dichromate into alkali metal monochromate, such latter substance being present in the mixture in such proportion that the pH value of the resulting solution ranges between about 5 and about 7.

14. A moulded body consisting of a mixture of at least one alkali metal dichromate and at least one substance of the group consisting of alkali metal carbonates and alkali metal bicarbonates, such latter substance being present in the mixture in such proportion that the pH value of the resulting solution ranges between about 5 and about 7.

15. A moulded body consisting of a mixture of about 92 parts by weight of alkali metal dichromate and 8 parts by weight of caustic alkali.

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