GOVERNMENT OF INDIA : THE PATENT OFFICE, 214, ACHARYA JAGADISH BOSE ROAD, CALCUTTA-17.

Complete Specification No. 110716, Application No. 110716 dated 19th May, 1967. Complete Specification left on 15th March, 1968. Application accepted 16th October, 1968.

Index at acceptance—103[XLV(1)]

PROVISIONAL SPECIFICATION

A COMPOSITION FOR ADDITION TO COOLING WATER TO INHIBIT CORROSION IN SOLDER COATED STEEL HEAT EXCHANGER EQUIPMENT

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, RAFI MARG, NEW DELHI-1, INDIA, AN INDIAN REGISTERED BODY INCORPORATED UNDER THE REGISTRATION OF SOCIETIES ACT (ACT XXI OF 1860)

The following specification describes the nature of this invention

This is an invention by Kummattithidal SANTHANAM RAJAGOPALAN, Scientist, Central Electrolchemical Research Institute, Karaikudi-3, Madras State, India and (Miss) Krishnamurthy Venu, Senior Scientific Assistant, Central Electrochemical Research Institute, Karaikudi-3, Madras State, India, both Indian citizens.

This invention relates to improvements in or relating to Corrosion Protection of Radiators.

Hitherto it has been reported that automobile radiators and other types of heat exchange equipment, e.g., condensers, are made of brass and other copper alloys. Mention is also made of radiators made of other metals e.g., aluminium, steel. Natural water (with or without corrosion inhibitors) is circulated through the systems for cooling purposes. Potassium chromate, Sodium benzoate, sodium nitrite, borax and triethanolemine phosphate in the concentration range 0.1 to 1% have been recommended as inhibitors of corrosion in such systems using natural water as cooling medium.

This is open to the objection that :

1. Metals required for the manufacture of brass and other copper alloys have to be imported into this country :

   and hence, there is considerable drain of foreign exchange in the manufacture of radiators :

2. The use of aluminium in the construction of radiators is beset with manufacturing difficulties : and

3. All-steel radiators are liable to suffer corrosion under the wide variety of user conditions to which it is subjected in spite of recommendations regarding addition of corrosion inhibitors.

The object of this invention is to formulate a more satisfactory protective scheme for radiators using steel as the material of construction instead of brass and other copper alloys.

The invention consists in the combination of two different methods of giving protection to steel from corrosion, viz., use of a protective coating of solder on steel as well as addition of a corrosion inhibitor compatible with the system. By the combination of these two methods, the steel is taken care of by solder coating when natural water is used as such to make up loss of coolant and the inhibitor system prevents the likelihood of steel (exposed in the pores of the solder coating) undergoing substantial amount of corrosion during the life of the radiator. The inhibitor system is so formulated that it can confer protection for solder coating as well. The composition of the solder coating falls in the following range :

Tin	25	to	50%
Lead	75	to	50%

Concentration ranges of the chemicals employed in the new inhibitor system are as follows :

Sodium dicromate	2	to	5%
Borax	0.5	to	2%
Sodium hydroxide	0.1	to	0.5%

The pH of the cooling media in the radiator is brought to the following range :

6.5 to 7.5

The protective scheme formulated above can ensure that under the very wide variety of user conditions, the corrosion of the automobile radiator or any other such cooling system does not take place appreciably even though natural water is employed as a coolant. Example of a suitable combination to be employed is solder coating having the composition (25% Sn and 75% Pb), inhibitor coating having the composition (Sodium dichromate-borax=2.1) and a cooling medium pH of 6.7.

The performance of the protective scheme mentioned above is given below :

Price : TWO RUPEES.

1 -11 (35) C.P.&D. (Cal)/76

TABLE 1

Protection given by solder coating to steel in natural waters under unstirred condition.

Total immersion of 2" × 1/2" specimens in duplicate for 10 days at room temperature (30 °C)

Sample No.	Corrosion-promoting constituents Cl (ppm)	SO_4 (ppm)	Weight loss in mgms for Steel	Weight loss in mgms. with Solder coated steel	Visual observations for solder coated steel
1	15	4	7.2±0.1	3.8±0.1	Brown rust on the edges and holes.
2	150	40	7.1±0.1	3.7±0.1	
3	300	80	5.9±0.1	3.6±0.3	
4	750	200	8.0±0.4	4.4±0.4	

It is seen from the table that the solder coating gives protection to steel but it cannot prevent rusting of steel at edges and pores in the coating. The rate of corrosion at the edges and pores is, in fact, accelerated while solder covered steel is protected.

The performance of the recommended system in natural water containing appreciable amounts of corrosive constituents like chloride and sulphate is compared with some inhibitors at the concentrations mentioned in the literature.

TABLE 2

Protection given by inhibitor systems to steel and solder coated steel in natural water containing 750 ppm chloride and 20 ppm sulphate.

Description of test :

Solution—unstirred and intermittently heated to 85° C for about 1/10th of the total test period. Total Immersion of 2" × 1/2" specimens in triplicate for 15 days.

System	Weight loss in mgms.		Visual observations at the end of the test	
	Steel	Solder coated steel	Steel	Solder coated steel
1% K_2CrO_4	8.2±0.8	0.7±0.2	Rust spots & violet film	Blue colouration of exposed steel (i.e., holes, edges etc.)
1% $NaNO_2$	1.4±0.4	6.2±0.9	Bright	Shiny particles on solder, Exposed Steel bright.
1% Na_2HPO_4	9.5±1.5	3.9±0.9	Uniformly dull	Exposed steel— dulled or grey
Inhibitor system proposed.	0.3*	1.1±0.3	Bright	Bright

*Weight gain.

The main advantages of the invention are :

1. Protection of steel radiators from corrosion can be obtained under the wide variety of user conditions even though natural water (which is varying in composition) is employed as coolant.
2. The attack of solder by coolant containing chlorides and sulphates is prevented.
3. Galvanic corrosion of exposed steel is prevented.
4. The inhibitor system is much cheaper than sodium benzoate—sodium nitrite mentioned in literature.
5. Conditions employed do not promote scale formation.

Dated this 17th day of May, 1967.

Sd./—
Patent Officer
COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH.

COMPLETE SPECIFICATION

A COMPOSITION FOR ADDITION TO COOLING WATER TO INHIBIT CORROSION IN SOLDER COATED STEEL HEAT EXCHANGER EQUIPMENT

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, RAFI MARG, NEW DELHI-1 INDIA, AN INDIAN REGISTERED BODY INCORPORATED UNDER THE REGISTRATION OF SOCIETIES ACT (ACT XXI OF 1860)

The following specification particularly describes and ascertains the nature of this invention and the manner in which it is to be performed :—

This is an invention by KUMMATTITHIDAL SANTHANAM RAJAGOPALAN, Scientist, and MISS KRISHNAMURTHY VENU, Senior Scientific Assistant, both of the Central Electrochemical Research Institute, Karaikudi-3, Madras State, India, both Indian citizens.

This invention deals with the protection of radiators from corrosion.

Hitherto it has been reported that automobile radiators and other types of heat exchange equipments e.g., condensers are made of copper, brass and other alloys of non-ferrous metals. Mention is also made of radiators made of other metals e.g., aluminium, steel. Natural water with or without corrosion inhibitors is circulated through the systems for cooling purposes. Potasium chromate, sodium benzoate plus sodium nitrate, borax and triethenolamine phosphate in the concentration range 0.1 to 1% have been recommended as inhibitors of corrosion in such systems which use natural water as cooling medium.

The present methods suffer from the following drawbacks :—

(1) for the manufacture of radiators from brass and other copper alloys these alloys have to be imported or the metals from which these alloys are made are to be imported resulting in drain of valuable foreign exchange,

(2) the use of aluminium in the construction of radiators is reported to present manufacturing difficulties,

(3) all steel radiators are liable to suffer corrosion under the wide variety of user conditions to which it would be subjected inspite of recommendations regarding addition of corrosion inhibitors.

The object of this invention is to formulate a more satisfactory protective scheme for radiators using steel as the material of construction instead of brass and other copper alloys.

Corrosion of all steel radiators and such other heat exchange equipment under the wide variety of user conditions can be prevented by the combined use of a protective coating of solder on steel and addition of the corrosion inhibitor mentioned in the specification to the cooling water.

A protective scheme has been evolved by means of which brass used for the manufacture of radiators can be replaced by steel without detriment to the life and performance of the radiator and such other heat exchange equipments by corrosion.

According to the present invention, the composition for addition to cooling water to inhibit corrosion in solder coated steel heat exchanger equipment such as solder coated steel radiator comprises sodium dichromate, boran and sodium hydroxide.

Thus the composition for an inhibitor system may comprise sodium dichromate, borax, sodium hydroxide which is characteristic in that it is present in the form of a non-deliquescent powder which when added to the extent of 3% in cooling water inhibits corrosion of steel as well as solder.

The invention includes within its scope a process for an inhibitor system for heat exchange equipment made of steel and coated with solder which consists in adding sodium dichromate to sodium hydroxide, grinding the two together and subsequently grinding this mixture with borax wherein the sequence of operation mentioned is followed in order to get a powdery non-deliquescent product, when kept in closed container.

Thus, in the process of the invention, natural water is used as such to make up loss of coolant, whereby protection is given to steel from corrosion by the use of a protective coating of solder on steel as well as addition of corrosion inhibitor which protects steel as well as solder, whereby the steel is taken care of by solder coating when natural water is used as such to make up loss of coolant and the inhibitor system prevents the likelihood of steel (exposed in the pores of the solder coating) undergoing substantial amount of corrosion during the life of the radiator and such other heater exchange equipments.

The inhibitor system is so formulated that it can confer protection for solder coating as well.

The composition of the solder coating falls in the following range :

Tin . . .	25 to 50%
Lead . . .	75 to 50%

The thickness to be employed is in the range of 15-25 microns.

Concentration ranges of the chemicals employed in the inhibitor system are :—

Sodium dichromate .	60 to 80%
Borax . . .	15 to 20%
Sodium hydroxide .	3 to 4%

The range of concentration in which the inhibitor system is added to cooling water is 1-4%.

The protective scheme formulated above can ensure under that the very wide variety of user conditions, the corrosion of the automobile radiator or any other such cooling system does not take place appreciably even though natural water is employed as ccolant.

Example

A suitable combination to be employed is sōlder coating having the composition 25% tin and 75% lead and 3% solution of the inhibitor mixture in natural water used as cooling medium. The performance of the protective schmeme is given below :—

TABLE 1

Protection given by solder coating to steel in natural waters under unstirred condition

Total immersion of 2" × ½" specimens in duplicate for 10 days at room temperature (30° C).

Sample No.	Corrosion-promoting constituents Cl(ppm)	SO_4 (ppm)	Weight loss in mgms for steel	Weight loss in mgms. with Solder coated Steel	Visual observations for solder coated Steel
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4	750	200	8.0±0.4	4.4±0.4	

It is seen from the table that the solder coating gives protection to steel but it cannot prevent rusting of steel at edges and pores in the coating. The rate of corrosion at the edges and pores is, in fact, accelerated while solder covered steel is protected.

The performance of the recommended inhibitor system in natural water containing appreciable amounts of corrosive constituents like chloride and sulphate is compared with some inhibitors at the concentrations mentioned in the literature.

TABLE 2

Protection given by inhibitor systems to steel and solder coated steel in natural water containing 750 ppm chloride and 20 ppm sulphate

Description of test :

Solution—unstirred and intermittently heated to 85° C. for about 1/10th of the total test period. Total immersion of 2" × ½" specimens in triplicate for 15 days.

System	Weight loss in mgms.		Visual observations at the end of the test	
	Steel	Solder coated Steel	Steel	Solder coated Steel
1% K_2CrO_4	8.2±0.8	0.7±0.2	Rust spots and violet film	Blue colouration of exposed steel (i.e. hole, edges etc.)
1% $NaNO_2$	1.4±0.4	6.2±0.9	Bright	Shiny particles on solder. Exposed Steel bright.
1% Na_2HPO_4	9.5±1.5	3.9±1.5	Uniformly dull	Exposed steel-dulled or grey.
Inhibitor system proposed	0.3*	1.1±0.3	Bright	Bright

*Weight gain.

The main advantages of the inventions are :

(1) Protection of steel radiators and such other heat exchange equipment from corrosion can be obtained under the wide variety of user conditions even though natural water (which is varying in composition) is employed as coolant.

(2) The attack of solder by coolant containing chlorides and sulphates is prevented.

(3) Galvanic corrosion of exposed steel is prevented.

(4) Conditions employed do not promote scale formation.

(5) The inhibitor system is much cheaper than sodium benzoate-sodium nitrite mentioned in literature as shown in Table 3.

TABLE 3

Cost of inhibitor for addition to 5 litres of natural water

Benzoate nitrite system.	(1.55 sodium benzaote + 0.1 sodium nitrate)	Rs. 1.10
New inhibitor mixture mentioned in the specification.		

The substitution of brass for steel for manufacture of radiators and such other heat exchange equipments can be made provided a protective scheme consisting of the application of solder coating to steel and the addition of the inhibitor system mentioned in the specification are adopted in combination in all steel radiators.

Noteworthy features :—

(1) the combination of a protective coating of solder on steel and addition of a corrosion inhibitor mixture to protect steel as well as solder from undergoing corrosion during the life of the radiator and such other heat exchanger equipments,

(2) the use of solder coating in the appropriate composition range,

(3) the use of an inhibitor system consisting of a mixture of sodium dichromate, borax and sodium hydroxide in the appropriate concentration range,

(4) the concentration of inhibitor system to be added to the cooling water.

WE CLAIM :

1. A composition for addition to cooling water to inhibit corrosion in solder coated steel heat exchanger equipment such as solder coated steel radiator which comprises sodium dichromate, borax and sodium hydroxide.

2. A composition as claimed in claim 1 for an inhibitor system which comprises sodium dichromate, borax, sodium hydroxide which is characteristic in that it is present in the form of a non-deliquescent powder which when added to the extent of 3% in cooling water inhibits corrosion of steel as well as solder.

3. A process for an inhibitor system as claimed in claim 1 or 2 for heat exchange equipment made of steel and coated with solder which consists in adding sodium dichromate to sodium hydroxide, grinding the two together and subsequently grinding this mixture with borax wherein the sequence of operation mentioned is followed in order to get a powdery non-deliquescent product, when kept in closed container.

4. A process as claimed in claim 3 wherein natural water is used as such to make up loss of coolant whereby protection is given to steel from corrosion by the use of a protective coating of solder on steel as well as addition of corrosion inhibitor which protects steel as well as solder, whereby the steel is taken care of by solder coating when natural water is used as such to make up loss of coolant and the inhibitor system prevents the likelihood of steel (exposed in the pores of the solder coating) undergoing substantial amount of corrosion during the life of the radiator and such other heater exchange equipments.

5. A composition for addition to cooling water in solder coated steel heat exchanger equipment substantially as hereinbefore described.

Dated this 24th day of February, 1968.

(Sd/-)

PATENTS OFFICER,

Council of Scientific & Industrial Research.

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