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Closed cooling system corrosion inhibitors.

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Novel closed cooling system corrosion preventatives are disclosed. The ingredients include sorbitol, an alkali metal gluconate, and borax. Optionally, yellow metal corrosion inhibitors such as tolyltriazole may be incorporated into the formulation. The mixture is particularly effective in high heat flux and low conductivity closed cooling systems.

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BACKGROUND OF THE INVENTION**Introduction:**

5 Closed recirculating water systems are used for a variety of heating and cooling systems. These systems range from those used in automobile and truck cooling systems, heating and cooling of buildings, the cooling of molten steel in continuous casting units, the cooling of industrial process equipment, and many other applications. In all of these systems, the prevention of scaling and the minimization of corrosion of metal parts in contact with the heating or cooling liquid are of paramount importance. While the liquids
 10 used in the heating or cooling systems are primarily aqueous, these fluids may contain in certain instances high levels of anti-freeze compounds such as ethylene glycol. In other instances, the cooling systems may be required to be relatively pure aqueous fluids such as in high heat flux, or low conductivity systems which are employed in the steel industry.

Many corrosion and scale inhibitors have been used in the past. Many of the most successful materials
 15 have contained nitrites, molybdates, chromates, soluble oils, amines or phosphates. Each of these components have some environmental or safety consideration involving their use. For example, nitrites are suspected carcinogens, molybdates and chromates are heavy metals, amines are reactive, and phosphates provide a nutrient source for algae when discharged.

In addition, many of these additives, and other additives of the prior art do not exhibit properties which
 20 modern systems now require. While prior art references teach the separate use of gluconate and sorbitol in coolant systems, there is no disclosure of utilizing these ingredients in combination with each other.

In my copending application serial 08/079,702 filed June 17, 1992, the disclosure of which is hereinafter incorporated by reference, I have disclosed the use of certain sorbitol, and gluconate mixtures which may optionally contain borates as effective corrosion and scale inhibitors for brine based refrigeration systems.
 25 Surprisingly, when the additives of my earlier filed application were tested as corrosion and scale inhibitors for non-brine systems, they performed well, at lower dosages than those required in my earlier filed application.

Objects of the Invention:

30 It is an object of this invention to provide to the art a practical scale and corrosion inhibitor formulation for use in closed system cooling and heating systems.

It is a further object of this invention to provide to the art an effective scale and corrosion control formulation for use in closed cooling and heating systems where nitrites, phosphonates, phosphates, metal
 35 inhibitors and soluble oils must be avoided.

It is a still a further object of this invention to provide to the art a scale and corrosion control formulation that would perform in normal closed system cooling systems, but which would also offer protection to mild steel in contact with closed cooling system liquids in high heat flux and low conductivity systems.

It is an additional object of this invention to provide a closed cooling system corrosion and scale inhibitor
 40 that would be satisfactory for use in critical systems including high heat flux and low conductivity systems. Further objects will appear hereinafter.

The Invention:**The Cooling Systems**

The closed cooling systems to which the corrosion and scale inhibitors of this invention are applicable are those normally encountered in the heating and cooling systems of large buildings, machinery, metals processing and the like.

50 These systems differ from open recirculating systems in that they are not exposed to the ambient air, and cooling is not achieved through evaporation as in the case of open recirculating systems. Typical closed cooling systems operate by picking up heat at a heat rich point, and releasing the heat at a heat deficient point, generally a heat exchanger. While the term cooling system is used herein, the invention is equally applicable to closed hot water heating systems such as those found in large buildings, and the term cooling
 55 system is meant to encompass heating systems as well.

As stated before, this invention finds particular utility in the treatment of high heat flux cooling systems. These systems are often designed to handle high temperature gradients and are often prone to scaling due to the great amount of heat being dissipated into the cooling system at any one time. Among the various

types of systems of this type that the corrosion and scale inhibitor of this invention find utility are those in: blast furnace tuyeres, electromagnetic stirrers, mold coolants, electric arc furnace cooling roofs, blast furnace hearth staves, electrode cooling, and basic oxygen furnace hood cooling systems.

Likewise, the corrosion and scale inhibitors of this invention are also find utility in low conductivity water systems which without treatment are highly corrosive to mild steel as naturally occurring waters but do not accomodate conventional inhibitors because their conductivity contributions are too significant. Systems of this type include but are not limited to: hot water boiler coolant systems, chilled water systems, air compressors, heating and ventilating equipment systems (comfort systems), thermal storage, and ice systems and other systems where the presence of foreign materials in the event of leakage could cause severe contamination or scaling problems.

The coolant fluid in the closed system is generally pumped from point to point, although gravity may be used to move the fluid from an upper point to a lower point without the use of supplementary mechanical pumps. Coolant fluids are generally aqueous, and depending upon their ultimate use, may be simple well water containing high levels of dissolved hardness ions (Calcium and Magnesium), treated municipal drinking water, or ion-exchanged, low conductivity water. The fluids may on occasion be winterized in those locations requiring such treatment through the use of ethylene glycol or methanol anti-freeze additives. It is desirable in certain instances to use aqueous coolant fluids having low levels of alkali or alkaline earth metals contained therein. In these cases, it may be desirable to use a distilled or deionized water as the basis for the aqueous coolant fluid.

Typical coolants to which this invention finds applicability are water based and contain from 0.1-1000 ppm of hardness expressed as $\text{Ca}(\text{CO}_3)$. Preferably, the coolants to which this invention finds applicability are water based and contain from 1.0-750 ppm of hardness expressed as $\text{Ca}(\text{CO}_3)$. Most preferably, the coolants to which this invention finds applicability are water containing as little as 0.5-500 ppm of hardness expressed as $\text{Ca}(\text{CO}_3)$.

The metals used in closed cooling systems are generally categorized as mild steel or galvanized steel, although special steel alloys may be used in certain high heat flux or low conductivity applications. Occasionally, so called yellow metals, copper, and brass may be present in the system and the selection of corrosion and scale inhibitors must be weighed with these metals in mind. Typically, most coolant systems which are the intended beneficiaries of the corrosion and scale protection agents of this invention are made of mixtures of various steel alloys including mild steel. When used with yellow metals, it is optional to add from 1-100ppm of known copper corrosion inhibitors such as tolyltriazole, benzotriazole and mercaptobenzothiazole.

Typically, the pH values of the aqueous coolant fluids contained in the closed cooling systems of this invention are maintained in the range of 6.5 to 11.5 and preferably from 7.5 to 9.5.

The Corrosion and Scale Inhibitors of this Invention

The corrosion and scale inhibitor of this invention is a blend of sorbitol and alkali metal gluconate. Optionally, alkali metal borate may be added. If yellow metals are present in the system, typical copper corrosion inhibitors such as tolyltriazole may also be added.

Generally, the corrosion and scale inhibitors of this invention are added in enough quantity to provide from 5 ppm to 4000 ppm of gluconate and from 5 ppm to 4000 ppm of sorbitol in the coolant contained in the system. Preferably, from 40 ppm to 2000 ppm of gluconate is present and most preferably from 80 ppm to 200 ppm of gluconate is added. Preferably, from 40 ppm to 2000 ppm of sorbitol is present in the coolant liquid. Most preferably, from 80 ppm to 200 ppm of sorbitol is added to the coolant liquid. Optionally, from 0 to 700 ppm of borate as sodium tetraborate pentahydrate may be added to the system and preferably from 5 ppm to 200 ppm of borate is added. In the most preferred embodiment of this invention, from 10 ppm to 60 ppm of borate as sodium tetraborate is added to the coolant liquid.

While the dosages to the coolant fluids given above are typical, they may vary depending upon the hardness present in the coolant. Dosages of active ingredients are typically lowered in the case of low conductivity systems containing little hardness, and increased for coolants containing hardness causing constituents.

While the dosages listed above are expressed as an amount to be added to the closed cooling system to which they are added, typical formulations may be manufactured which contain the corrosion and scale inhibitor ingredients of this invention so that the mixture may be preformulated and fed into the coolant system. Since all of the components of this invention are water soluble, they may be readily mixed together to form suitable inhibitor packages. A typical formulation for use in this invention may broadly comprise in percentages by weight:

Water	95-10
Sodium Gluconate	2-25
Sorbitol	2-25
Sodium Tetraborate	0-9

More preferably a formulation for use in this invention will comprise:

Water	90-15
Sodium Gluconate	3-20
Sorbitol	3-20
Sodium Tetraborate	0.5-7

Most preferably a formulation for use in this invention will comprise:

Water	85-25
Sodium Gluconate	5-15
Sorbitol	5-15
Sodium Tetraborate	1-5

A preferred corrosion inhibitory package used for the practice of this invention comprises in percentages by weight:

Compound A

26.5% of 50 wt. % Gluconic Acid
 19.0% of 70% wt. % Sorbitol
 8.4% 50% NaOH
 1% of 50 wt. % Sodium Tolyltriazole
 3.13% Sodium Tetraborate 5H₂O
 balance ----- water

The gluconate used in this invention is an alkali metal gluconate salt. Preferably, sodium gluconate is employed although other alkali metal salts of gluconate may be utilized. Sodium gluconate is available commercially from the American International Chemical Inc as sodium gluconate. Additionally, gluconic acid may also be used in the preparation of the corrosion inhibitors of this invention, although, if the acid form is utilized, it is preferred to neutralize it with an alkali metal hydroxide either prior to addition to the formula, or after the other ingredients have been mixed so as to avoid the possibility of having a low pH in the coolant system that is being treated.

The sorbitol utilized as an ingredient in this invention is generally of a technical grade, although food grades may also be employed. A preferred sorbitol for use in this invention is available from ICI Americas Inc. under the tradename SORBO. The borate material utilized in this invention is generally categorized as borax, Na₂B₄O₇. While the sodium salt is preferred, other alkali metal tetraborate salts can be used.

In the formulations of the corrosion and scale inhibitors of this invention, it will be readily apparent that other ingredients may also be added. Other ingredients which may find utility in the subject invention include anti-foam materials such as silicon oils, hydrophobized silica, and the like. While the formulations of this invention when used properly do not promote foaming, process leaks may occur into the coolant system which may necessitate the inclusion of anti-foam type materials. Tracer type materials such as those described in U.S. Patents 5,006,311, 5,132,096, 4,966,711 and 5,200,106 may also be included in the formulations. These typically inert tracer type materials may be added to help monitor or control the amount of active sorbitol, gluconate and borate in the coolant system. In the practice of this invention it is preferred to utilize an inert fluorescent indicator described and claimed in U.S. 5,006,311 and U. S. 5,132,096 rather than the transition metal tracers described in U.S. 4,966,711 and U. S. 5,200,106 above. In a most preferred application of this invention, an inert fluorescent tracer dye is added to the system in known concentration to the sorbitol, gluconate or borax, and is used to monitor the dosage of active treatment chemicals in the coolant system through the use of fluorescence spectroscopy.

While the gluconate/sorbitol blends of this invention have been shown to not foster the growth of bacteria, mold, slime or algae in coolant systems, process leaks into the system may necessitate the inclusion of a microbiocide into the system. While prior art systems employing nitrite based corrosion inhibitors could not utilize the so called oxidizing biocides, oxidizing biocides may be used in the processes of the instant invention. Typical oxidizing biocides which are compatible with the gluconate/sorbitol blends of this invention include chlorine, calcium hypochlorite, stabilized chlorine, sodium hypochlorite, and mixtures of sodium bromide with chlorine or hypochlorite. Non-oxidizing biocides may also be employed in conjunction with the formulations of this invention. Typical non-oxidizing biocides that may find utility in the corrosion and scale control formulations of this invention include: 2,2-dibromo-3-nitrilopropionamide, polyox-
 yethylene (dimethyliminio)ethylene (dimethyliminio)ethylene; 5-chloro-2-methyl-4-isothiazolin-3-one; 2-methyl-4-isothiazolin-3-one; glutaraldehyde, kathon[™], tetrabutylazine^{*}, methylenebis thiocyanate, and the like. The examples of biocides given herein are meant to be representative and are no in way inclusive of the current commercially available oxidizing and non-oxidizing biocides which may find utility in the coolant system treatments of this invention.

Other additives that may be considered for addition to the coolant formulations of this invention include visible dyes for the purpose of visible leak detection and coolant source identification. Dyes of this type should be stable at the maximum temperatures to be encountered in the coolant system.

In order to show the efficacy of the corrosion inhibitors of this invention the following experiments were performed.

EXAMPLE 1

The corrosion inhibitors of this invention were evaluated against several commonly available commercial closed system cooling inhibitor formulations. The experiments were conducted in the following manner:

A liter of water containing the ingredients to be tested is placed into a one liter container. The container is then placed in a constant temperature bath. The corrosive water is agitated to 1 foot/second using a magnetic stirrer. The constant temperature bath is heated to maintain 110°F inside the container. The corrosion coupons are suspended in the container using an ordinary Teflon tape. the tape needs to be rolled into a string before it can be inserted into the small hole at one end of the corrosion coupon. The coupon is suspended in the corrosion cell by pinching the ends of the rolled Teflon tape against the outside wall of the corrosion cell with a rubber band. Excessive evaporation of the corrosive water is eliminated by covering the top of the corrosion cell with a plastic wrap, Saran brand wrap being preferred.

Coupons were prepared by polishing with sand paper to 600 grit finish.

Each coupon is weighed individually to 0.1 mg and, its dimensions measured by a caliper to the nearest 0.1mm. The surface areas measured averaged 21.82 cm² with a standard deviation of ± 0.5 cm². Coupon surface is calculated by:

$$\text{Area (cm}^2\text{)} = 2(A)(B) + 2(A)(C) + 2(B)(C) - 2(2\pi r^2)$$

where A = length (cm)

B = width (cm)

C = thickness(cm)

π = pi = 3.142

r = Radius of the coupon hole

Procedure

The test duration is 14 days, and the temperature of the corrosive water as well as the stirring action of the magnetic stirrer are checked daily. At the end of each test, the coupon is removed from the cell and cleaned of its corrosion products by an abrasive Nylon pad. After rinsing with deionized water, the coupon is dried and weighed. The corrosion rate is calculated using the following formula:

^{**} a combination of 5-chloro-2-methyl-4-isothiazolin-3-one and 2-methyl-4-isothiazolin-3-one.

^{*} 2-(tert-butylamino)-4-chloro-6-(ethylamino)-s-triazine

$$\text{MPY} = \frac{\{[(A')-(B')] \frac{365 \text{ days}}{\text{yr.}} \times \frac{1000 \text{ mils}}{\text{inch}} \times \frac{1 \text{ inch}}{2.54 \text{ cm}}\}}{[(C')(D)(E)]}$$

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where A' is the initial weight of the coupon in grams

B' is the final weight of the coupon in grams

C' is the test duration in days measured to the nearest hour

D is the density of the coupon (value used is 7.87g/cc)

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E is the area of the coupon (cm²)

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The following Examples reported in Table I were run using the procedure described above. All tests were run in water containing 0.24% CaCl₂ to simulate a corrosive environment. An additional test, not reported in the table was performed using a commercial formulation containing nitrite. The formulation precipitated in the high hardness water and the test was discontinued. Based on the results shown, a mixture of sorbitol and gluconate provided superior corrosion protection to mild steel over a blank containing no corrosion inhibitors or sorbitol by itself. Localized pitting corrosion obtained using gluconate alone was lowered using the sorbitol/gluconate blend. Borax helped to further lower localized pitting corrosion.

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TABLE I

EX.	pH	ppm <u>Sorbitol</u>	ppm Na <u>Gluconate</u>	ppm NaNO ₂	ppm T _T	ppm Borax	Length of Test (days)	pH Final	Pitting mpy	Pitting Site#	mpy
1		1005	1005		38	238	10	7.3	130	50	19.3
2	10.7	1870	1870		70	440	12.1	7	50	30	12
3	9.3	743	1003		38	478	12.07	7.6	50	300	11.9
4	10.0		1670				7.6	7.23	94	100	12.3
5	10						7.6	7			36
6	10	1550					7.6	5.25			17.8
7	10	1550	1670				7.6	7.26	64	100	12.7
8	10			395			7.6	7.78			0.74

EXAMPLE 2

The corrosion inhibitors of this invention were evaluated in a pilot high heat flux recirculating cooling unit. This unit consisted of a 250 gallon tank equipped with a heat exchanger to allow regulation of the temperature in the tank, a bottom outlet leading to an adjustable recirculating pump. After the pump, water

passed through a 240 volt copper clad electrical heater having a high output and back to the top opening of the tank. Sufficient electrical energy could be added to the heater. Temperature and flow could be monitored at several points. Corraters were installed to measure corrosion rates, and corrosion coupons could be added to the system.

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Compound A

26.5% - 50 wt. % Gluconic Acid

19.0% of 70% wt. % Sorbitol

10 8.4% 50% NaOH

1% of 50 wt. % Sodium Tolyltriazole

3.13% Sodium Tetraborate 5H₂O

balance-----water

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Low Conductivity Applications

The first two experiments were performed on low conductivity systems and the conditions were as follows:

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Water	Deionized water
Conductivity	≤ 100 μmhos
Heat Flux	150,000 Btu/hr-ft ²
Heater voltage	132 Volts
Velocity	5 ft/sec
Flowrate	12 gpm
Bulk Water Temperature	135° F
Skin Temperature	231° F - of heater
Heater Material	Mild Steel
Corraters	Mild Steel, Copper
Coupon	Mild Steel

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Initially, to the water was added 55 ppm of Compound A, the preferred material as described on page 9 of the specification, and stabilized chlorine to provide 5 ppm of total residual chlorine. Upon the initial addition of stabilized chlorine, the conductivity of the water increased by about 30 μmhos. 55 ppm of Compound A did not provide enough corrosion protection on mild steel when 5 ppm of total chlorine were maintained in the system. Over a period of 44 hours, the corrosion rate on mild steel increased to 4.80 mpy. During this time, the conductivity of the water was 55-70 μmhos. Since the maximum allowed conductivity for the test had not been reached, the dosage of Compound A was increased during the experiment so that the conductivity was 90-100 μmhos.

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The final dosage of Compound A was approximately 300 ppm and total chlorine was 3.04 ppm. It was apparent that as the product dosage was increased, mild steel corrosion decreased over time. Over the next 120 hrs., the corrosion rate on mild steel decreased from 4.80 to 1.80 mpy and still appeared to be decreasing over time as the test was ended. Copper corrosion remained at approximately 0.10 mpy. The corrosion rate on the mild steel coupon was determined to be 3.12 mpy, which was approximately the average corrosion rate for mild steel during the period. The heat transfer surface (mild steel) had a yellowish color with some raised, brownish spots and the unheated surface had more of the raised deposits, which left pits on the heater material. The deposit on the heated and unheated areas were analyzed and the analytical results showed that the material was approximately 99% iron as Fe₂O₃ and less than 1% carbonate as CO₂. There was less than 1% dichloromethane extractables.

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A second test was run under the same operating conditions with the treatment program slightly different. Initially, 157 ppm of Compound A and 34 ppm of a commercially available non-oxidizing biocidal product (45% gluteraldehyde) was added to the system. The conductivity of the water was added to the system. The conductivity of the water was approximately 23 μmhos which was all from Compound A. There was no apparent increase in the conductivity of the water upon the addition of the biocide. During the test, an increase in mild steel corrosion was not observed. After 52 hours, mild steel and copper corrosion rates remained at 0.10 mpy.

The corrosion rate on the mild steel coupon was 0.0 mpy. The heat transfer surface felt smooth, had a

shiny appearance, and no major discoloration was observed.

The next three tests were performed on a simulated continuous caster cooling system. Conditions were as follows:

5	Water (as CaCO ₃)	13 ppm Calcium 6 ppm Magnesium 18 ppm Alkalinity 13 ppm Chloride 6 ppm Sulfate
10	Heat Flux	300,000 Btu/hr-ft ²
	Heater Voltage	187 Volts
	Velocity	21 ft/sec
	Flowrate	52 gpm
15	Bulk Water Temperature	120 ° F
	Skin Temperature	185 ° F
	Heater Material	Copper
	Corraters	Mild Steel, Copper
20	Coupon	Mild Steel

The initial dosage of Compound A was 183 ppm with stabilized chlorine added to provide chlorine present at 5 ppm. During the first 35 hrs. the product dosage did not provide enough protection against corrosion when maintaining this dosage of chlorine. Mild steel corrosion increased from 0.6 to 1.20 mpy during that period. As a result, dosage of Compound A was increased to 300 ppm over the next 60 hours. As Compound A was added, corrosion rate on mild steel increased for a short period of time and then continued to again increase.

Copper corrosion remained at .10 mpy for the duration of the test, while mild corrosion was increasing over time. The copper surface of the heater was smooth and no deposition or discoloration was observed. The corrosion rate that was obtained on the mild steel coupon was about 20 mpy.

The next test was run under the same conditions as the previous, however the initial dosage of Compound A was 800 ppm. At this dosage, mild steel corrosion was 0.35 mpy.

Stabilized chlorine to provide 5 ppm of total chlorine was initially added to the system in the form of a sodium salt of sulfamic acid + chlorine containing 7.9% as available chlorine = stabilized chlorine. However, it was observed that at the dosage of Compound A in the system, a rapid degradation of total chlorine occurred. During the first seventeen hours, total chlorine decreased to 0.52 ppm. Subsequently, stabilized chlorine to provide about 4.5 ppm total chlorine was added to the system. Several hours following the addition of biocide, total chlorine was measured at 3.42 ppm. Mild steel corrosion remained at about 0.33 mpy for the duration of the test, while copper was maintained at 0.07 mpy. The corrosion rate on the mild steel coupon was 0.30 mpy which was in better agreement with corrater readings. The final total chlorine content was measured at about 0.1 ppm. Corrosion rate on copper and mild steel remained the same. At the end of the test, the copper heater was smooth and no deposition nor discoloration was observed.

The next test ran under the same operating conditions with the treatment program slightly varied. Initially, 300 ppm of Compound A and 60 ppm of a 1.5% by weight aqueous solution of 2-methyl-4-isothiazolin-3-one was added to the system. The corrosion rate on mild steel using this treatment program was about 0.35 mpy. Throughout the test, the dosage of Compound A was incrementally increased to determine the reduction in mild steel corrosion. At 450 ppm, Compound A corrosion rate decreased slightly to about 0.30 mpy. At 600 ppm, the change was minimal, and at 800 ppm, mild steel corrosion decreased to about 0.25 mpy.

With the addition of 53 additional ppm of the biocide, corrosion rates remained the same. Copper corrosion remained at 0.05 mpy for the duration of the test. The copper heater surface remained smooth and there was no deposition or discoloration on the heat transfer surface. Corrosion rate on the mild steel coupon was 1.41 mpy which did not agree with the corrater readings due to the short length of time that the coupon remained in the water.

According to the above results, 300 ppm of Compound A provided satisfactory corrosion protection to mild steel in the presence of 5 ppm total chlorine. At this level, the conductivity of water is about 100 μ mhos which leaves little room for dosage increase in systems requiring low conductivity. With 45 ppm of glutaraldehyde as a biocidal treatment, 150 ppm of Compound A is recommended. This dosage maintained

the conductivity of water at about 25 μ mhos which allows room for dosage increase if needed.

In the high heat flux test described above, higher levels of treatment chemical are required when biocide is added. However, the treatment program provided satisfactory results by lowering corrosion rates.

5 Claims

1. A method for the prevention of corrosion on the metal surfaces in contact with a coolant fluid in a closed cooling system which comprises maintaining in the coolant fluid from 5 ppm to 4000 ppm of sorbitol and from 5 ppm to 4000 ppm of an alkali metal gluconate.
2. The method of claim 1 wherein the coolant fluid is water.
3. The method of claim 1 or 2 wherein the closed cooling system is a low conductivity cooling system.
4. The method of claim 1 or 2 wherein the closed cooling system is a high heat flux cooling system.
5. The method of claim 1 wherein up to 700 ppm of borax as sodium tetraborate pentahydrate is added to the cooling system.
6. A method for the prevention of corrosion on metal surfaces in contact with an aqueous coolant fluid in a closed cooling system which comprises maintaining in the coolant fluid from 40 ppm to 2000 ppm of an alkali metal gluconate, from 40 ppm to 2000 ppm of sorbitol and from 5 ppm to 200 ppm of borax.
7. The method of claim 6 wherein the closed cooling system is a high heat flux cooling system.
8. The method of claim 6 wherein the closed cooling system is a low conductivity cooling system.
9. The method of any of claims 6 - 8 wherein the coolant fluid contains at least one additional ingredient selected from the group consisting of: inert fluorescent tracers, anti-foam compounds, biocide control agents.
10. The method of any of claims 6 - 9 wherein an effective amount of yellow metal corrosion inhibitor from the group consisting of tolyltriazole, mercaptobenzotriazole, and benzotriazole is added to the closed cooling system.
11. The method of any of claims 6 - 10 wherein the coolant fluid contains from .1 ppm to 1000 ppm of hardness expressed as CaCO_3 .
12. The method of any of claims 6 - 11 wherein the coolant fluid is maintained at a pH of from 6.5 to 11.5.
13. A method for the prevention of corrosion on metal surfaces in contact with an aqueous coolant fluid present in a closed cooling system which comprises maintaining in the aqueous coolant fluid from 40 to 2000 ppm of an alkali metal gluconate, from 40 ppm to 2000 ppm sorbitol, from 5 ppm to 200 ppm of borax (as sodium tetraborate pentahydrate) and maintaining such coolant fluid at a pH of 7.5 to 9.5.
14. The method of claim 13 wherein an inert fluorescent tracer is added to the aqueous coolant fluid in proportion to the amount of sorbitol present.
15. The method of claim 13 or 14 wherein the aqueous coolant fluid is deionized water.
16. The method of any of claims 13 -15 wherein an effective amount of an oxidizing biocide is added to the coolant fluid to prevent microbiological growth.
17. The method of any of claims 13 -16 wherein an effective amount of an antifoam agent is added to the coolant fluid to prevent foaming.
18. A composition for controlling scale and corrosion on the surfaces of metal in contact with aqueous coolant fluids in closed cooling systems which comprises adding to such system an effective amount of

a composition comprising:

- a. to 2-25% sorbitol;
- b. to 2-25% alkali metal gluconate; and,
- c. to 0-9% borax.
- d. balance water.

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- 19.** A method for the prevention of scale and corrosion on the surfaces of metal in contact with aqueous coolant fluids in closed cooling systems which comprises adding to the aqueous coolant fluid present in such cooling system an effective amount of the composition of claim 18.

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European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 11 7381

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
D,P, X	US-A-5 330 683 (SUFFRIN B.W.) * column 3; claims 1-19 * ---	1,5,6, 10-13,19	C23F11/12 C23F11/08
Y	DE-A-39 04 733 (KURITA WATER INDUSTRIES) * table 2, comparative examples * ---	1-4, 7-12, 14-19	
Y		5,6,13	
Y	GB-A-2 027 002 (CHEMED CORP.) * page 1, line 3 - line 12; claim 1 * ---	1-4, 7-12, 14-19	
Y	GB-A-910 138 (IMPERIAL CHEMICAL INDUSTRIES) * claims 1,9 * ---	5,6,13	
A	WERKSTOFFE UND KORROSION, vol. 40, no. 2, February 1989, page R46, abstract no. 89-0560, Weinheim, DE; ---	6,13	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	EP-A-0 451 434 (DENAC N.V.) * claim 1 * ---	1-9	C23F
A	FR-A-2 054 945 (ESSO RESEARCH AND ENGINEERING CO.) ---		
A	GB-A-2 162 507 (MISAWA HOME K.K.) ---		
A	PATENT ABSTRACTS OF JAPAN vol. 7, no. 185 (C-181) (1330) 17 August 1983 & JP-A-58 091 174 (SEIWA KOGYO K.K.) 31 May 1983 * abstract * --- -/--		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 22 December 1994	Examiner Torfs, F
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			



European Patent
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EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP-A-0 112 756 (BP CHEMIE S.A.) ---		
A	EP-A-0 470 553 (BASF CORP.) -----		
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 22 December 1994	Examiner Torfs, F
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			