Patented July 13, 1937 2,087,103

UNITED STATES PATENT OFFICE

2,087,103

ANTIFREEZE SOLUTIONS

Frederick B. Downing, Carneys Point, and Charles J. Pedersen, Penns Grove, N. J., assignors to E. I. du Pont de Nemours & Company, Wilmington, Del., a corporation of Delaware

No Drawing. Application November 30, 1935. Serial No. 52,339

20 Claims. (Cl. 252—5)

This invention relates to liquids suitable for use in heat exchange devices and the like and more particularly to aqueous alcohol solutions for use in automobile radiators.

The cooling system of an internal combustion engine is composed of three essential parts, a metal heat exchanger, a liquid for transferring the excess heat of the engine to the atmosphere and a mechanism for circulating the liquid in the heat exchanger. The heat exchanger comprises a hot portion or the engine block made of ferrous metals and aluminum alloys where the heat generated in the engine is transferred to the liquid and a cold portion or the radiator made of copper-containing metals and solder where the heat is transferred to the atmosphere.

Water is the cooling medium most commonly employed in this type of heat exchange device but its use in cold weather is condemned by its tendency to solidify at a relatively high temperature. Accordingly, it has become common practice to replace the water with an antifreeze liquid when the heat exchange device is to be subjected to conditions where the temperatures would approach the freezing point of the water. The most common antifreeze liquid employed at the present time is an aqueous solution of a non-electrolyte such as glycerine, methyl alcohol and ethyl alcohol. However, such alcohols have the disadvantage that they tend to increase the corrosive action of the water on the metals of the heat exchanger. This corrosion causes the loss of the metals of the heat exchanger, thereby reducing its life and utility. The corrosion products are not good heat conductors and hence their accumulation upon the surfaces of the heat exchanger greatly decrease its efficiency. Further, such corrosion products accumulate in the liquid as solid particles which tend to clog the circulation ports in the device, thereby suppressing and in some cases completely preventing the necessary circulation of the cooling liquid throughout the heat exchanger.

For the above reasons, it is now common practice to add substances to such heat exchange liquids which substances inhibit or prevent the corrosive action of the alcohol and water on the metals of the heat exchange device. The usual corrosion inhibitors merely protect against corrosion of the ferrous metals with increase in the corrosion of other metals such as the copper-containing metals. Other corrosion inhibitors are objectionable in that they form upon the surfaces of the heat exchanger a film which decreases the over-all coefficient of heat transfer.

Usually the heat exchange devices contain rust or other corrosion products formed prior to the addition of such anti-freeze liquid. Also, the best inhibitors known today do not prevent all corrosion so that there is a gradual accumulation of solid corrosion products in the heat exchanger. These corrosion products can do the least amount of harm if they are finely divided and dispersed in the liquid phase. If their particle size is large enough they will clog the circulation conduits and check the flow of the cooling liquid. If they are cemented on the heat exchanger, they will decrease its overall coefficient of heat transfer and cause the engine to overheat. Large pieces of rust may be flaked off as scale or may be formed by the agglomeration of small particles. Scale can be removed only by dissolving it in a pickling solution or by a thorough mechanical cleaning. However, the coalescence of rust particles and their adherence to metallic surfaces should be prevented.

It is of economic significance to the users of a heat exchange liquid that it be as permanent as possible. Its loss from the heat exchange device necessitates the purchase of additional material. Evaporation is the principal cause of loss of the relatively volatile antifreeze solutions, such as the aqueous solutions of methyl and ethyl alcohol. The rate of evaporation is a function of the vapor pressure, which in turn is a function of the temperature and composition. The temperature of evaporation may be varied over a narrow range by the addition of boiling point elevators, but such variations are so insignificant to be of no practical value. It has been proposed to prevent such loss of volatile material by covering the surface of the liquid with a protective surface film of an oil such as the petroleum oils and particularly kerosene. However, such oils have proved to be unsatisfactory for the reason that they carry the corrosion products to the surface of the liquid as a dispersion, emulsion or scum. Under the conditions prevailing in such devices, this floating rust or other corrosion product in the oil becomes cemented upon the surfaces of the heat exchanger, thereby reducing its efficiency and, in automobile radiators, frequently causing overheating. It appears that the oil acts as a binder tending to cause the rust to become cemented upon the metal surfaces.

The handling of commercial alcohols is always attended by the possibility of their being misdirected and misappropriated for illegal uses. It is, therefore, generally desirable to add, to liquids containing ethanol for heat exchange de-

percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises a mixture of alkanes and for each 10 parts of said mixture at least one part of a mixture of higher alkanols, said mixtures of alkanes and alkanols boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

14. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein 0.05 to about 5.0% of an alkali metal nitrite, about 0.005 to about 0.1% of a mercapto benzothiazole, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hyrdoxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises a petroleum oil and for each 10 parts of said oil at least one part of a mixture of higher alkanols, said oil and mixture of alkanols boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

15. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein 0.05 to about 5.0% of an alkali metal nitrite, about 0.005 to about 0.1% of a mercapto benzothiazole, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises a petroleum oil, a mixture of cyclic terpene hydrocarbons and for each 10 parts of said oil and terpene hydrocarbons at least one part of a mixture of cyclic terpene alcohols, said oil and mixtures of hydrocarbons and alcohols boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

16. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising ethyl alcohol having incorporated therein 0.05 to about 0.5% by weight of sodium nitrite, 0.005 to about 0.1% by weight of mercaptobenzothiazole, 0.05 to about 1.0% by weight of sodium lactate, 0.1 to about 5.0% by volume of kerosene, 0.1 to about 5.0% by volume of a mixture of alcohols comprising about 70 to about 75% of alpha and beta terpineols and about 20 to about 25% of borneol and isoborneol, said mixture of alcohols boiling between about 204° and about 230° C., and 0.1 to about 5% by volume of a mixture of alpha-pinene, camphene, dipentene, terpinene and terpinoline boiling between 154° and 180° C.

17. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein a corrosion inhibitor, about 0.05 to about 1.0 percent of an alkali metal salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises at least one higher alkanol boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

18. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein a corrosion inhibitor, about 0.05 to about 1.0 percent of an alkali metal salt of lactic acid, and a small amount of an evaporation retarder which comprises at least one higher alkonal boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

19. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein 0.05 to about 5.0% of an alkali metal nitrite, about 0.005 to about 0.1% of a mercapto benzothiazole, about 0.05 to about 1.0 percent of an alkali metal salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises a petroleum oil and for each 10 parts of said oil at least one part of a mixture of higher alkanols, said oil and mixture of alkanols boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

20. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein 0.05 to about 5.0% of an alkali metal nitrite, about 0.005 to about 0.1% of a mercapto benzothiazole, about 0.05 to about 1.0 percent of an alkali metal salt of lactic acid, and a small amount of an evaporation retarder which com-

carbon atoms such as the mixtures obtained by the reduction of coconut and like oils, containing at least 10 carbon atoms and boiling between 200 and 260° C., which are sold under the trade name of "Lorol", may be employed. Further, pine oil, which comprises a mixture of terpene alcohols, and alcohols, obtained by the oxidation of petroleum hydrocarbons, may be employed. The individual alkanols or the mixtures thereof should be substantially immiscible with the dilute solution of the water-soluble alcohol and have a boiling range of between about 150° C. to about 300° C. and have a specific gravity below 0.96.

These alkanols are employed primarily for the purpose of providing a continuous oily layer upon the upper surface of the diluted aqueous alcohol solution. The terpene alcohols have the additional advantage of being slightly soluble in dilute ethanol and can be removed therefrom only with great difficulty. Accordingly, they render the recovery of potable alcohol more difficult. We have found that the alkanols do not readily "wet" rust and similar corrosion products and hence do not readily form emulsions or dispersions thereof, or carry the rust to the upper surface of the aqueous alcohol solution. The amount of the alkanols to be employed will vary with the constituents of the aqueous alcohol solution and the area of the upper surface of such solution. In any event, the amount of higher alkanol or mixture of higher alkanol and oily material must be sufficient to form a continuous layer on the upper surface of the aqueous alcohol solution.

It has been found that these higher alkanols can be employed together with the usual oily materials employed for retarding loss of alcohol from such aqueous alcoholic solutions. When such higher alkanols are employed with such oily materials, they reduce the tendency of the oily materials to form dispersions, emulsions and the like with the rust. We have found that, if a water-soluble acid containing a hydroxy aliphatic group of not more than six carbon atoms, as hereinbefore defined, or its water-soluble salt is present, such acid or its salt will help to prevent the flotation of the rust and cementation of the rust on the metal surfaces of the heat exchanger. Accordingly, the presence of such acid or its salt decreases the amount of higher alkanol necessary to give the desired result. In fact, if only one part of such higher alkanol is employed for each 10 parts of oily material, such as kerosene, in the presence of such acid or its salt, such alkanol and acid or salt will suppress substantially all tendency of the oily material to carry such rust to the surface of the aqueous alcohol solutions and to cement the rust to the surfaces of the heat exchanger. The oily materials which may be employed with the higher alkanols should have a boiling range of between about 150° C. to about 300° C. and a specific gravity below 0.96. Preferably, the oils comprise alkanes and particularly mixtures thereof. The term "alkanes" is understood to mean the a-cyclic and ali-cyclic hydrocarbons, including the terpene hydrocarbons. The preferred mixtures are those generally known as kerosene and similar petroleum distillates.

We do not here attempt to claim per se the use of the higher alkanols and the oily materials for preventing the loss of volatile alcohol, as such combination is specifically disclosed and claimed in the copending application of Spiegler and Pedersen Serial No. 52,340, filed November 30, 1935. However, we do intend to claim such combination in the specific composition herein disclosed and particularly in combination with the water-soluble acids containing a hydroxy aliphatic group of not more than six carbon atoms and their water-soluble salts, as hereinbefore defined. Reference is herewith made to such copending application of Spiegler and Pedersen for a more detailed description of the alkanols and oily materials and the various modifications and variations thereof and their advantageous characteristics.

The oily aliphatic hydrocarbons, such as kerosene, may be replaced in whole or in part by monocyclic or di-cyclic terpene hydrocarbons or mixtures thereof. Such terpene hydrocarbons are also aliphatic in nature but have the advantage over the other oily hydrocarbons of being slightly soluble in the aqueous alcohol solutions and being removed therefrom with great difficulty so that they contaminate the alcohol and render more difficult the recovery of potable alcohol. Accordingly, we preferably employ such terpene hydrocarbons in addition to the higher alkanols and the other oily materials. Some of the terpene hydrocarbons are limonenes, dipentene, terpinolenes, terpinenes, phellandrenes, sylvestrene, carvestrene, menthene, sabinene, thujenes, pinenes, fenchene, camphene, bornylene and santene. We preferably employ mixtures of such terpene hydrocarbons and particularly a mixture of alpha-pinene, camphene, dipentene, terpinene and terpinoline boiling between 154° C. and 200° C.

Accordingly, the preferred compositions of our invention consist of:

Sodium nitrite	0.05 to 0.5% by weight
Mercaptobenzothiazole	0.005 to 0.1% by weight
Sodium lactate	0.05 to 1.0% by weight
Kerosene	0.1 to 5.0% by volume
Terpene hydrocarbons (mixed)	0.1 to 5.0% by volume
Terpene alcohols (mixed)	0.1 to 5.0% by volume
Ethyl alcohol (officially denatured CD–10) to make	100%

A specific composition which has proved to be particularly satisfactory was made up as follows:

To commercial ethanol, denatured according to official formula CD–10, was added; 0.025% by weight of a trade grade of mercapto benzothiazole known as "Captax", 0.27% by weight of commercial sodium lactate as a 54% aqueous solution, 0.25% by weight of commercial sodium nitrite, 0.003% by weight of crude concentrated "du Pont Anthraquinone Rubine R", 2.7% by volume of long time burning oil with a boiling range of 190° C. to 280° C., 0.3% by volume of a mixture of terpene alcohols with a boiling range of 200° C. to 225° C. and 0.3% by volume of a mixture of terpene hydrocarbons having a boiling range of 180° C. to 200° C.

The order and the method of adding the different ingredients may be varied to suit the equipment available for blending. It has been found convenient to order the additions as follows:

1. Sodium nitrite,
2. Mercaptobenzothiazole,
3. Petroleum oil, terpene alcohols and terpene hydrocarbons, previously mixed in the correct proportions,
4. Sodium lactate, and
5. Du Pont Anthraquinone Rubine R.

The resulting composition is then diluted with water to the desired strength, preferably to contain 10 to 40% by volume of alcohol, whereupon the higher alcohols and hydrocarbons separate to form a continuous liquid layer floating on the upper surface of the aqueous alcohol solution.

Finally, a proprietary product should be distinctive and attractive in appearance. These effects are obtained by dissolving in the antifreeze solution a colored compound soluble in alcohol and water, fast to heat and unaffected chemically by the other ingredients. The dye known to the trade as "Du Pont Anthraquinone Rubine R" meets all of these requirements and is particularly satisfactory for use in the compositions of the present invention. It must be noted however, that the dye is not an essential component of the antifreeze since its contribution to the combination is esthetic rather than utilitarian. Such dye should be added in an amount of 0.001 to about 0.01% by weight of the solution. Larger amounts may be employed but are unnecessary. Any other dye; soluble in water and alcohol and stable in the presence of the other ingredients, may be employed.

While we have disclosed the preferred embodiments of our invention and the preferred modes of carrying the same into effect, it will be readily apparent to those skilled in the art that many variations and modifications may be made therein without departing from the spirit of our invention. Accordingly, the scope of our invention is to be limited solely by the appended claims, construed as broadly as is permissible in view of the prior art.

We claim:

1. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein a corrosion inhibitor, about 0.05 to about 1.0 percent of a member of the group consisting of water-soluble acids containing a hydroxy aliphatic group of not more than 6 carbon atoms in a straight chain and their water-soluble salts, and a small amount of an evaporation retarder which comprises at least one higher alkanol boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

2. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein a corrosion inhibitor, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises at least one higher alkanol boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

3. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein a corrosion inhibitor, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises a mixture of alkanols, said mixture boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

4. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein a corrosion inhibitor, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises an oily material and for each 10 parts of oily material at least one part of at least one higher alkanol, said alkanol and oily material boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

5. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein a corrosion inhibitor, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises an oily material and for each 10 parts of oily material at least one part of a mixture of higher alkanols, said oily material and mixture of higher alkanols boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

6. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein a corrosion inhibitor, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises a mixture of alkanes and for each 10 parts of said alkanes at least one part of a mixture of higher alkanols, said mixtures of alkanes and alkanols boiling between about 150°

C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

7. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein a corrosion inhibitor, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises a petroleum oil and for each 10 parts of said oil at least one part of a mixture of higher alkanols, said oil and mixture of alkanols boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

8. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein a corrosion inhibitor, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises a petroleum oil, a mixture of cyclic terpene hydrocarbons and for each 10 parts of said oil and terpene hydrocarbons at least one part of a mixture of higher alkanols, said oil and mixtures of terpene hydrocarbons and alkanols boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

9. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein a corrosion inhibitor, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises a petroleum oil and for each 10 parts of said oil at least one part of a mixture of cyclic terpene alcohols, said oil and mixture of terpene alcohols boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

10. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein 0.05 to about 5.0% of a nitrite of a metal above aluminum in the electromotive series, about 0.005 to about 0.1% of a mercaptan, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises at least one higher alkanol boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

11. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein 0.05 to about 5.0% of an alkali metal nitrite, about 0.005 to about 0.1% of a mercapto benzothiazole, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises at least one higher alkanol boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

12. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein 0.05 to about 5.0% of an alkali metal nitrite, about 0.005 to about 0.1% of a mercapto benzothiazole, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaportion retarder which comprises an oily material and for each 10 parts of oily material at least one part of at least one higher alkanol, said oily material and alkanol boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

13. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein 0.05 to about 5.0% of an alkali metal nitrite, about 0.005 to about 0.1% of a mercapto benzo thiazole, about 0.05 to about 1.0

percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises a mixture of alkanes and for each 10 parts of said mixture at least one part of a mixture of higher alkanols, said mixtures of alkanes and alkanols boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

14. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein 0.05 to about 5.0% of an alkali metal nitrite, about 0.005 to about 0.1% of a mercapto benzothiazole, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hyrdoxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises a petroleum oil and for each 10 parts of said oil at least one part of a mixture of higher alkanols, said oil and mixture of alkanols boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

15. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein 0.05 to about 5.0% of an alkali metal nitrite, about 0.005 to about 0.1% of a mercapto benzothiazole, about 0.05 to about 1.0 percent of a water-soluble salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises a petroleum oil, a mixture of cyclic terpene hydrocarbons and for each 10 parts of said oil and terpene hydrocarbons at least one part of a mixture of cyclic terpene alcohols, said oil and mixtures of hydrocarbons and alcohols boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

16. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising ethyl alcohol having incorporated therein 0.05 to about 0.5% by weight of sodium nitrite, 0.005 to about 0.1% by weight of mercaptobenzothiazole, 0.05 to about 1.0% by weight of sodium lactate, 0.1 to about 5.0% by volume of kerosene, 0.1 to about 5.0% by volume of a mixture of alcohols comprising about 70 to about 75% of alpha and beta terpineols and about 20 to about 25% of borneol and isoborneol, said mixture of alcohols boiling between about 204° and about 230° C., and 0.1 to about 5% by volume of a mixture of alpha-pinene, camphene, dipentene, terpinene and terpinoline boiling between 154° and 180° C.

17. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein a corrosion inhibitor, about 0.05 to about 1.0 percent of an alkali metal salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises at least one higher alkanol boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

18. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein a corrosion inhibitor, about 0.05 to about 1.0 percent of an alkali metal salt of lactic acid, and a small amount of an evaporation retarder which comprises at least one higher alkonal boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

19. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein 0.05 to about 5.0% of an alkali metal nitrite, about 0.005 to about 0.1% of a mercapto benzothiazole, about 0.05 to about 1.0 percent of an alkali metal salt of an aliphatic hydroxy-carboxylic acid containing not more than 6 carbon atoms in a straight chain, and a small amount of an evaporation retarder which comprises a petroleum oil and for each 10 parts of said oil at least one part of a mixture of higher alkanols, said oil and mixture of alkanols boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

20. A non-corrosive liquid suitable for use in heat exchange devices and the like containing iron and copper-containing metals comprising a volatile water-soluble alcohol having incorporated therein 0.05 to about 5.0% of an alkali metal nitrite, about 0.005 to about 0.1% of a mercapto benzothiazole, about 0.05 to about 1.0 percent of an alkali metal salt of lactic acid, and a small amount of an evaporation retarder which com-

prises a petroleum oil and for each 10 parts of said oil at least one part of a mixture of higher alkanols, said oil and mixture of alkanols boiling between about 150° C. and about 300° C. and having a specific gravity below 0.96, said evaporation retarder being present in an amount sufficient to form a continuous liquid layer upon the upper surface of an aqueous solution containing the same amount of the volatile alcohol in a concentration of less than 50% by volume and being substantially immiscible with such volatile alcohol when it is in such aqueous solution.

FREDERICK B. DOWNING.
CHARLES J. PEDERSEN.