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COMPOUND AND METHOD FOR CONDITIONING BOILER, STEAM AND CONDENSATE SYSTEMS

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This invention relates to a compound and method for treating water, steam and condensate and entrapped gas in boiler, steam and condensate systems for the arrest, prevention, and inhibition of rust, corrosion, pitting and similar deteriorative effects.

It is well known that such deteriorative effects take place most rapidly in acid environment and consequently it has been common practice to inject into the boilers, alkaline or basic substances, for example, caustic soda to maintain an alkaline condition therein. Such substances remaining within the water do not accompany the steam distilled and do not condense with, nor do they dissolve in the condensate, consequently, only the metal which is in actual contact with the boiler water is protected by the alkaline condition. Therefore, the vapor space in the boiler, as well as all other parts of the systems in contact with the steam and condensate are exposed to any acid or corrosive agent that may be present and subject to rapid deterioration.

To partly overcome this condition, alkaline substances have been added to the condensate, but the benefit is very limited due to the fact that many points at which the condensate begins to occur are inaccessible for treatment and, besides, such treatment must be continuous for the reason that the treated condensate is continually being replaced by fresh condensate.

It is, therefore, a principal object of the present invention to maintain all of the parts of such systems under the protection of an alkaline environment.

In accomplishing this object, I provide a water treating compound which may be dissolved in the boiler water, volatilize with the steam, condense with the condensate, to form a solution therein for return to the boiler, so that all parts of the system are retained in the protecting environment of the compound in one or the other of its phases and so that the compound does not tend to collect or remain in any one of its phases.

The acid or corrosive agent usually found in steam systems is carbonic acid formed by the combination of carbon dioxide and water, the carbon dioxide having found its way into the system as a constituent of the air admitted, as a product in solution in the boiler feed water, as a product of decomposition of acid carbonates or bicarbonates, or as a product of decomposition of the normal or basic carbonates in the boiler water.

It is, therefore, another object of the invention

to provide a compound capable of neutralizing or absorbing any carbon dioxide, carbonic acid or other acid corrosive agent which may be present.

In carrying out my invention, I have found substances which are capable of neutralizing or absorbing the carbon dioxide, carbonic acid or other acid corrosive agent and at the same time are also capable of following the respective phases of the boiler feed water so that all parts of the system including the condensate portions are subjected to treatment.

I have found that best practical results are attained through use of water soluble, alkaline and volatile nitrogenous substances having a boiling point at atmospheric pressure no higher than 171° C. and no lower than 0° C. Substances with normal boiling points higher than this range have a vapor pressure so low that their volatility with steam is reduced to a point where satisfactory results are not attained. Substances with boiling points lower than this range have a vapor pressure so high that they will not condense with the steam to dissolve readily in the condensate. My invention, therefore, contemplates substances having boiling points at atmospheric pressure from 0° C. to 171° C.

Substances which meet these requirements are from the following chemical types including: substituted ammonia compounds; amines and amino compounds; primary amines, in which one hydrogen atom of the ammonia molecule has been replaced by a chemical group; secondary amines, in which two hydrogen atoms of the ammonium molecule have been replaced by chemical groups; tertiary amines, in which the three hydrogen atoms of ammonia have been replaced by chemical groups; and quaternary ammonium bases in which four hydrogen atoms attached to the nitrogen of ammonium hydroxide have been replaced by chemical groups.

Since aromatic compounds of the character noted have boiling points above the specified operative range, it is to be understood that the present invention contemplates only non-aromatic substances, namely aliphatic and heterocyclic compounds having water soluble, alkaline and volatile characteristics.

Any one of the water-soluble alkaline and volatile substances from the above classes having a boiling point as above specified is introduced into the system for treating the boiler water, steam, and condensate, or the substances may be introduced into the boiler feed water prior to admis-

sion to the boiler. Upon introduction into the system, the substances volatilize with the steam, condense with the condensate, form a solution with the condensate and remain continually in intimate contact with all of these phases, thereby maintaining an alkaline, caustic, or basic condition in all of the several phases, neutralizing and absorbing carbon dioxide, carbonic acid and all other acids which may be present throughout the entire system, to inhibit corrosion, and similar deteriorative effects. It is thus obvious that while the substances need be introduced at only one point in the system, their volatile and water-soluble characteristics make them available for treating all parts of the system.

When the salt formed by the combination of these chemical compounds with an acid is brought into contact with a stronger base such as caustic soda, a salt of the stronger base is produced releasing the chemical compound in its alkaline and uncombined form.

Consequently, in systems wherein all or part of the condensate is returned to the boiler, I take advantage of this action in reestablishing the alkaline and volatile properties of the compound after its cycle through the vapor and condensate parts of the systems. In these types of systems, it is desirable to maintain a strong alkaline condition in the boiler water, for example, by the addition to the water of a stronger base than the chemical to be employed, such as caustic soda, which substance does not volatilize, but remains in solution in the boiler water.

The chemical compound upon admission to the boiler volatilizes and passes off into the steaming space of the boiler with the steam and into all parts of the system. The compound is carried with the steam to the condensate part of the system to intimately contact all metal parts, for maintaining an alkaline condition which effectively inhibits the formation of rust, corrosion and similar deteriorative effects, the vapors condensing with the steam and forming a solution in the condensate absorb or neutralize carbonic acid and any acidity that may be present in the condensate part of the system. The compound then returns to the boiler in the form of a salt of the acid absorbed together with any excess of uncombined chemical. Upon contacting the stronger base in the boiler, the salt will react with the stronger base to again free the volatile base element in its alkaline and uncombined form to continue the cycle. The rate at which the compound is converted in the respective phases is substantially uniform so that the compound does not excessively collect in any one part of the system.

In selecting the specific chemical from any one of the types as above enumerated, it should be noted that the boiling point of that compound at the pressure in the system may be considerably higher than the temperature in the boiler without interfering with its use. This is due to the well known principle of distillation with steam which depends upon the vapor pressure of the chemical compound at the temperature of the steam. For example, the primary amine, mono-ethanol amine, has a boiling point of 171° C. at atmospheric pressure, but at the temperature of 100° C., prevailing in steam boilers at atmospheric pressure, the vapor pressure of the mono-ethanol amine allows it to evaporate steadily and continuously into the changing atmosphere of the current of steam.

Among the specific substances (together with

their boiling points at atmospheric pressure) which I have found best suited to my process are mono-amyl-amine, 102° C.; di-ethylene-diamine, 146° C.; di-ethyl-amine, 55° C.; mono-ethylene-diamine, 117° C.; iso-amyl-amine, 95° C.; di-propyl-amine, 110° C.; pyridine, 116° C.; propylamine, 49° C.; iso-propylamine, 33° C.; and the above mentioned mono-ethanol-amine, 171° C.

While I have specifically described introduction of the volatile chemical into the boiler, it is obvious that it may be introduced into any part of the system. It is also obvious that the chemical may be used in any type steam plants whether used for heating, power, or industrial processes and that all parts of such systems are subjected to treatment including the boiler or heaters, evaporators, radiators, tanks, piping, pumps, engines or turbines, condensers, valves, traps, or other equipment that may be connected into the system.

What I claim and desire to secure by Letters Patent is:

1. The process including introducing into a steam system an alkaline, water-soluble, volatile, non-aromatic amine having a boiling point no higher than 171° C. at atmospheric pressure and no lower than 0° C. at atmospheric pressure and capable of volatilizing with the steam and condensing with the steam and dissolving in the condensed steam.

2. The process including introducing into a steam system an alkaline, water-soluble, volatile, aliphatic amine having a boiling point no higher than 171° C. at atmospheric pressure and no lower than 0° C. at atmospheric pressure and capable of volatilizing with the steam and condensing with the steam and dissolving in the condensed steam.

3. The process including introducing into a steam system an alkaline, water-soluble, volatile, heterocyclic amine having a boiling point no higher than 171° C. at atmospheric pressure and no lower 0° at atmospheric pressure and capable of volatilizing with the steam and condensing with the steam and dissolving in the condensed steam.

4. The process including introducing into a steam system an alkaline, water-soluble, volatile, aliphatic amine having a boiling point no higher than 150° C. at atmospheric pressure and no lower than 30° C. at atmospheric pressure and capable of volatilizing with the steam and condensing with the steam and dissolving in the condensed steam.

5. The process including introducing into a steam system an alkaline, water-soluble, volatile, non-aromatic amine having a boiling point no higher than 125° C. at atmospheric pressure and no lower than 45° C. at atmospheric pressure and capable of volatilizing with the steam and condensing with the steam and dissolving in the condensed steam.

6. The process including introducing into a steam system an alkaline, water-soluble, volatile, heterocyclic amine having a boiling point no higher than 120° C. at atmospheric pressure and no lower than 75° at atmospheric pressure and capable of volatilizing with the steam and condensing with the steam and dissolving in the condensed steam.

7. The process including introducing into a steam system an alkaline, water-soluble, volatile, aliphatic amine having a boiling point no higher than 115° C. at atmospheric pressure and

no lower than 85° C. at atmospheric pressure and capable of volatilizing with the steam and condensing with the steam and dissolving in the condensed steam.

8. The method of conditioning steam systems of the character described to prevent corrosion of the metal parts of the system including maintaining a strong base substance in solution in a part of the system, circulating through the system an alkaline, water-soluble, volatile, non-aromatic amine having a boiling point no higher than 171° C. at atmospheric pressure and no lower than 0° C. at atmospheric pressure, for maintaining an alkaline condition in other parts of the system, and returning said amine through the strong base solution for converting said amine to its uncombined state for recirculation through the system.

9. The method of conditioning steam systems of the character described to prevent corrosion of the metal parts of the system in contact with the condensate, including maintaining a strong base substance in solution in the evaporating zone of the system, circulating through the system an alkaline, water-soluble, volatile, aliphatic amine having a boiling point no higher than 171° C. at atmospheric pressure and no lower than 0° C. at atmospheric pressure, for maintaining an alkaline condition in the condensate part of the system, and returning said amine through the strong base solution for converting said amine to its uncombined state for recirculation through the system.

10. The method of conditioning steam systems of the character described to prevent deteriorative effects of acidity on metal parts of the system in contact with the condensate, including maintaining a strong base solution in the water of the evaporating zone of the system, introducing into said solution an alkaline, water-soluble, volatile, aliphatic amine having a boiling point no higher than 171° C. at atmospheric pressure and no lower than 0° C. at atmospheric pressure whereby said amine volatilizes with formation of the steam, circulating the volatilized amine with the steam forming a solution of said amine with the condensate, returning the condensate solution to the evaporating zone wherein acid picked up by said amine combines to form a salt of the acid with the strong base and said amine is converted to uncombined form for repeating the cycle of circulation.

11. The process including introduction of a monoethanol amine into a steam system for maintaining an alkaline condition in all parts of the system to neutralize acidity in the system.

12. The process including introduction of amylamine into a steam system for maintaining an alkaline condition in all parts of the system to neutralize acidity in the system.

13. The process including introduction of di-propyl-amine into a steam system for maintaining an alkaline condition in all parts of the system to neutralize acidity in the system.

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