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CORROSION INHIBITING AQUEOUS AMINE DISPERSION EMULSIFIED WITH AN ETHOXYLATED AMIDE

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ABSTRACT OF THE DISCLOSURE

The present invention concerns methods and materials for inhibiting the corrosion of metal surfaces contacted by steam or steam condensate in which an aqueous dispersion of a straight chain aliphatic hydrocarbon primary amine emulsified with an ethoxylated amide is dispersed in the steam or steam condensate. Typical of the amines and amides employed are octadecylamine and ethoxylated octadecylamide.

The present invention relates to methods for dispersing fatty amines in aqeuous systems, and particularly to methods for dispersing fatty amines in the steam and/or steam condensate contained by a boiler system.

It has previously been found that the corrosion which is incurred by the contact of steam and/or steam condensate with the metal components of a boiler system may be inhibited or eliminated by incorporating small quantities of a fatty amine in the corrosive fluid. It is believed that despite the small quantities of amine employed, a protective film resistant to penetration by corrosive elements is formed upon the metal surfaces. Such methods are disclosed by U.S. Patent 2,460,259, to Kahler. However, the fact that the amines which provide the desired corrosion inhibition are solids possessing limited solubility and dispersibility has rendered their use difficult. To overcome these difficulties a variety of techniques for converting the amine to an aqueous dispersion prior to its introduction to the boiler system have been devised. For example, as disclosed by U.S. Patent 2,712,531 to Maguire, the amines have been employed in the form of their salts, e.g., octadecylamine acetate, which are generally more soluble and dispersible. However, the use of these amine salts has also caused problems in that the release of the acid often causes the degradation of the amines with a consequent reduction in their corrosion inhibiting properties, and an increase in the accumulation of fouling deposits within the system. Furthermore, at those points of localized high temperature which are common in a boiler system, the amine salt is decomposed to form free amine and free acetic acid with a consequent increase in the corrosive properties of the system. In addition, the salt component of the amine salt does not contribute directly to corrosion inhibition.

The use of emulsifiers in aiding the dispersing of the amines in a pre-emulsion has also been employed by the prior art. For example, the use of polyalkoxylated amines, polyamines, glycols and quaternary amines, is disclosed by U.S. Patent 3,088,796 to Kahler, and U.S. Patents 2,882,171 and 2,956,889, to Denman. However, in the use of such emulsifiers, the quantity of emulsifiers required is undesirably high and generally results in high costs. Furthermore, their use results in the corporation of relatively large quantities of foreign material which do not directly contribute to corrosion inhibition within the boiler system. In turn, the volatility of many of these emulsifiers is inadequate for their complete distribution within the steam.

A purpose of the present invention is the provision of improved methods for dispersing fatty amines within the steam and/or condensate of boiler systems.

A further object is the provision of aqueous dispersions of fatty amines which may be readily dispersed within the steam and/or condensate of a boiler system.

Another object is the provision of readily dispersible, stable aqueous emulsions of fatty amines which are further characterized by a desirably high concentration of the fatty amine.

An additional object is the provision of ready dispersible, stable aqueous emulsions of fatty amines which are characterized by melting points which are equal to, or higher than, the melting point of the fatty amine.

Another object is the provision of readily dispersible, stable aqueous emulsions of fatty amines, in which the cost of emulsification is reduced through the use of low cost additives.

Still another object is the provision of a method for the emulsification of fatty amines.

Yet another object is the provision of boiler systems protected against corrosion by means of the distribution of a fatty amine-emulsifier system within the steam and/or condensate of the boiler system.

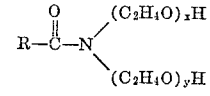
Further purposes appear in the specification and claims.

The invention generally comprises stable aqueous emulsions of a fatty amine which may be readily dispersed within the steam and/or condensate of a boiler system to yield substantial improvements in respect to the reduction of the corrosion which normally occurs in such a system. Further improvements in the nature of favorable ratios of corrosion inhibitor:emulsifier, desirable melting points, prevention of the degradation of the corrosion inhibitor, avoidance of fouling deposits of foreign matter within the boiler system, and reduced costs, are also provided.

The objects of the invention are achieved by means of the emulsification of a primary amine corrosion inhibitor by means of an alkoxylated amide emulsifier, and the dispersion of the resultant aqueous emulsion within the steam and/or condensate of a boiler system.

The primary amines employed in the invention are water insoluble, straight chain aliphatic primary monoamines having a carbon chain length of between 10 to 24 carbon atoms. Typical examples are octadecylamine, laurylamine, stearylamine, myristylamine, cetylamine, eicosylamine, behenylamine, and the like.

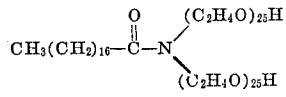
The polalkoxylated compounds employed as emulsifiers are alkoxylated amides containing between 70–98 percent by weight of ethylene oxide and possessing a long chain aliphatic radical containing between 10 to 24 carbon atoms. Such amides have the general formula:



In which R is an aliphatic hydrocarbon radical having between 10 to 24 carbon atoms, and x and y are integers having a value such that the ethyleneoxy content of the compound is between 70 and 98 percent by weight.

Typical examples of such compounds are ethoxylated tallow, lauryl, coco, or oleyl amide. However, a preferred

emulsifier is ethoxylated octadecyl amide having the formula:



It should also be noted that admixtures of the above described ethoxylated amides are suitable for the purposes of the present invention.

The emulsions of the invention may be prepared by admixing the fatty amine and the ethoxylated amide in the desired proportions and heating the mixture with agitation at a temperature of between 130°–300° F. until completely melted, and blending the molten admixtures with hot water, e.g., 130°–180° F. The blending is preferably accompanied by agitation until the temperature of the blend has fallen below 130° F. The resultant emulsion, or dilutions thereof, may be directly fed to the steam and/or condensate of a boiler.

While highly concentrated or very dilute emulsions may be prepared, for ease of feeding emulsions containing less than 50 percent by weight of solids are preferred.

It should also be noted that in most cases satisfactory emulsions may be prepared by separately adding the fatty amine and the amide emulsifier to water heated to 160°–180° F. with agitation.

The fatty amine:emulsifier system preferably contains between 40 to 90 parts by weight of the amine, and between 1 to 60 parts by weight of the emulsifier. While higher concentrations of the emulsifier yield satisfactory emulsions, the emulsifier is maintained at a low level in order to avoid the introduction of unnecessary quantities of foreign material, which do not contribute directly to corrosion inhibition, to the boiler system.

The preparation of a preferred emulsion is disclosed by the following example.

Example 1

An emulsion was prepared from 95 parts by weight of tap water and 5 parts by weight of an admixture of 85 percent by weight of octadecylamine and 15 percent by weight of an ethoxylated octadecyl amide containing 84 percent by weight of ethylene oxide. The amine and amide, both of which are solids, were heated to 215° F. with agitation and the heat and agitation were maintained until a smooth molten blend was obtained. One half of the specified quantity of tap water heated to 170° F. was then added with agitation, and the remaining heated water

was slowly added thereafter. Agitation was maintained until the temperature of the emulsion had dropped to 130° F.

The resultant emulsion (5 percent solids) was fed to the steam header of a boiler and yielded a highly satisfactory degree of corrosion inhibition. In the feeding of this emulsion, the steam header was tapped and the emulsion was introduced under a pressure in excess of the internal pressure of the system by means of a piston pump. Similar treatments in which the same emulsion was injected into condensate return lines also yielded a high degree of corrosion inhibition.

It should also be noted that in many instances the practice of the present invention may embody the feeding of the emulsions of the invention to plural segments of the boiler system. For example, while the corrosion inhibitors are preferably fed to the steam header for optimal distribution throughout the system, some systems may also require supplemental feeding to the condensate return sections, or feeding exclusively to the condensate return sections. At any rate, the feeding of corrosion inhibitors to boiler systems is generally and specifically known to those skilled in the art, and obviously susceptible to various feeding techniques.

Similarly, the effective levels of amine corrosion inhibitors are known to those skilled in the art. The quantity of amine introduced within the boiler system is preferably 0.5 to 30 parts for each one million parts of steam and condensate to be treated. However, in some instances as little as 0.01 part and as much as 200 parts per million parts may be effectively used.

To demonstrate the quality of the emulsions which are achieved by the invention despite the relatively small quantity of emulsifier employed, the following studies of such emulsions are provided. In the preparation of each of the emulsions discussed below, the amine emulsifier mixture was heated to 175° F. and the resulting molten liquid was agitated as it was allowed to cool. The admixtures were then dispersed in water heated to 180° F. and the resultant emulsions were permitted to stand for 24 hours at room temperature. At the end of the 24 hour period evaluations were conducted in which an emulsion which was visibly homogeneous was rated at "Good," those exhibiting very slight non-uniformity were considered "Fair," and those which demonstrated appreciable non-uniformity or complete separation of the solids were deemed "Poor."

The data provided by Table 1 demonstrates the stability of emulsions prepared in accordance with the invention, in which as little as 3 percent by weight of the emulsifier is employed in emulsions containing as little as 0.5 percent by weight of the amine-emulsifier combination.

TABLE 1

Nature of Amine and Quantity (Percent by weight)	Nature of Amide and Quantity (Percent by weight)	Ethylene Oxide Content of Emulsifier (Percent by weight)	Solids Present in Emulsion (Percent by weight)	Quality of Emulsion
Mixed Amines,[1] 70	Ethoxylated Laurylamide, 30	91.7	0.5	Good.
Do	do	91.7	8.0	Do.
Mixed Amines,[1] 90	Ethoxylated Laurylamide, 10	91.7	0.5	Do.
Do	do	91.7	8.0	Do.
Mixed Amines,[1] 97	Ethoxylated Laurylamide, 3	91.7	0.5	Do.
Do	do	91.7	8.0	Fair.
Mixed Amines,[1] 70	Ethoxylated Tallow Amide, 30	88.5	0.5	Good.
Do	do	88.5	8.0	Do.
Mixed Amines,[1] 90	Ethoxylated Tallow Amide, 10	88.5	0.5	Do.
Do	do	88.5	8.0	Do.
Mixed Amines,[1] 97	Ethoxylated Tallow Amide, 3	88.5	0.5	Do.
Do	do	88.5	8.0	Do.
Laurylamine, 90	Ethoxylated Stearylamide, 10	88.5	0.5	Do.
Do	do	88.5	8.0	Do.
Octadecylamine, 90	Ethoxylated Tallow Amide, 10	88.5	0.5	Do.
Do	do	88.5	8.0	Fair.

[1] The mixed amine employed in Tables 1 and 2 comprised 25% docosylamine (C_{22}), 30% eicosylamine (C_{20}), 30% octadecylamine (C_{18}), 13% hexadecylamine (C_{16}), and 2% tetradecylamine (C_{14}).

Table 2 below, demonstrates the effect of the ethylene oxide content of the emulsifier:

TABLE 2[1]

Emulsifier	Ethylene Oxide Content	Amine: Emulsifier Ratio	Quality of the Emulsion	
			8% Solids	0.5% Solids
Ethoxylated Laurylamide	52.6	70:30	Poor	Poor.
Do	52.6	90:10	do	Do.
Do	52.6	97:3	do	Do.
Do	76.9	70:30	Good	Fair.
Do	76.9	90:10	Poor	Poor.
Do	76.9	97:3	do	Do.
Do	91.7	70:30	Good	Good.
Do	91.7	90:10	do	Do.
Do	91.7	97:3	do	Fair.
Ethoxylated Tallow Amide	43.8	70:30	Fair	Good.
Do	43.8	90:10	Poor	Do.
Do	43.8	97:3	do	Poor.
Do	70.0	70:30	Good	Good.
Do	70.0	90:10	do	Do.
Do	70.0	97:3	Poor	Poor.
Do	88.5	70:30	Good	Good.
Do	88.5	90:10	do	Do.
Do	88.5	97:3	do	Do.

[1] The mixed amine employed in Table 1 was used throughout the determinations of Table 2.

It is believed that Table 2 indicates the necessity for an emulsifier having a relatively high ethylene oxide content, whereas additional studies have indicated the necessity for an ethylene oxide content of between 70 to 98 percent.

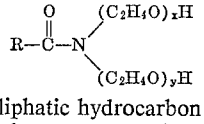
It should also be noted that poor emulsions were achieved with emulsifiers having a carbon chain length of less than 10 carbon atoms.

It will be evident that by the present invention fatty monoamines can be easily and readily introduced into the steam and/or steam condensate of boiler systems at a relatively low cost, without experiencing the difficulties and defects realized with amines alone, soluble amine salts, or amines emulsified with compositions other than those of the invention. For example, aqueous dispersions having a high amine content and a low emulsifier content, may be obtained. Furthermore, aqueous emulsions of solid amines, which are readily dispersible in boiler systems, and which do not melt at temperatures significantly below the melting point of the amine, can be prepared. Conseqeuntly, these corrosion inhibitors may be distributed within the system to be protected in the form of solids, to provide an excellent protective film upon metal surfaces. This aspect presents obvious packaging benefits.

It is also apparent that various alternatives, substitutions and modifications may be made in the present invention without departing from the reasonable spirit and scope of the inventions as defined by the following claims:

I claim:

1. A method for inhibiting the corrosion of the surfaces of metal components of a boiler system which are contacted by the steam and condensate contained by the system, comprising dispersing within said steam and condensate an aqueous dispersion of a straight chain aliphatic hydrocarbon primary amine in which said straight chain has a length of between 10 to 24 carbon atoms, and an ethoxylated amide having the formula



in which R is an aliphatic hydrocarbon radical having between 10 to 24 carbon atoms, and x and y are integers having a total value such that the ethyleneoxy content of said amide is between 70 to 98 percent by weight in which said aqueous dispersion contains at least 1 part by weight of said amide for each 99 parts by weight of said amine, and contacting said surfaces with said steam and condensate containing said amine and said amide in a quantity adequate to inhibit said corrosion.

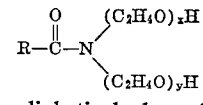
2. A method as claimed by claim 1 in which said amine is octadecylamine.

3. A method as claimed in claim 1 in which said amide is ethoxylated octadecylamide.

4. A method as claimed by claim 1 in which said amine is present in a quantity of between 40 to 99 parts by weight and said amide is present in a quantity of between 1 to 60 parts by weight.

5. A method as claimed in claim 1 in which said aqueous dispersion contains no more than 50 percent by weight of said amine and said amide.

6. A corrosion inhibiting composition for boiler systems, consisting essentially of an aqueous dispersion of a straight chain aliphatic hydrocarbon primary amine in which said straight chain has a length of between 10 to 24 carbon atoms, and an ethoxylated amide having the formula



in which R is an aliphatic hydrocarbon radical having between 10 to 24 carbon atoms, and x and y are integers having a total value such that the ethyleneoxy content of said amide is between 70 to 98 percent by weight, in which said aqeuous dispersion contains at least 1 part by weight of said amide for each 99 parts by weight of said amine.

7. A composition as claimed in claim 6 in which said amide is octadecylamide.

8. A composition as claimed in claim 6 in which said amine is present in a quantity of between 40 to 99 parts by weight and said amide is present in a quantity of between 1 to 60 parts by weight.

9. A composition as claimed in claim 6 in which said aqueous dispersion contains no more than 50 percent by weight of said amine and said amide.

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