Description

The present invention relates to a process for inhibiting the corrosion of vapor/condensed water systems by adding an anticorrosive which is capable of effectively inhibiting the corrosion of piping systems by changing CO_2, which is contained in condensed water and causes the corrosion of piping systems, into an amine carbonate.

In general, soft water is used as a feed for low pressure boilers of up to about 1961 kPa (20 kg/cm^2), However, when boilers are fed with soft water, CO_2 is formed through the thermal decomposition of methyl orange alkalinity components (M alkalinity components) contained in the feed water, and the CO_2 so formed dissolves into condensed water, thus causing the corrosion of piping systems.

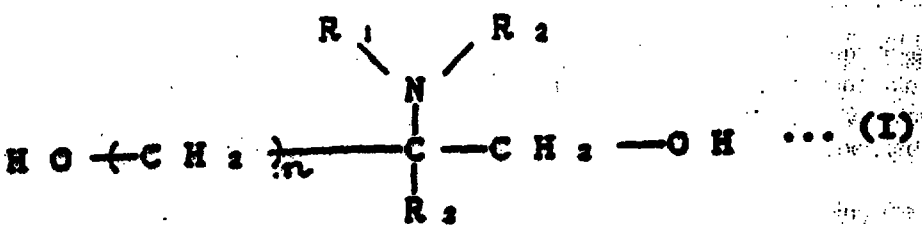
As anticorrosives for vapor/condensed water systems, there have hitherto been employed highly volatile amines, such as cyclohexylamine and morpholine. In general, such agents are injected into a water-feeding system and circulated through a boiler. Prior anticorrosives consisting of highly volatile amines are distributed more in vapor than in condensed water at the time when vapor generated by a boiler is condensed.

If the volatility of amines contained in vapor is low, a condensed water containing the amines in large quantities, is formed whereas highly volatile amines contained in vapor can dissolve into condensed water only in extremely small quantities. Accordingly, prior anticorrosives consisting of highly volatile amines suffer from the problem that they are incapable of removing CO_2 dissolved in condensed water to a sufficient degree because of their low solubility in condensed water.

US-A-3976441 discloses a substituted aminoalkylpropanediol for use as a corrosion inhibitor in liquid hydrocarbon fuel compositions.

It is the object of the present invention to provide a process capable of effectively inhibiting the corrosion of piping systems by changing CO_2, which is contained in condensed water and causes the corrosion of piping systems, into an amine carbonate by using an anticorrosive which can dissolve in feed water at a high concentration and is capable of readily raising the pH of feed water to a satisfactory high level.

This object of the invention is achieved by a process for inhibiting the corrosion of vapor/condensed water systems, which comprises adding to boiler feed water an anticorrosive comprising 1-100% by weight of at least one aminodiol represented by general formula (I)



... (I)

wherein R_1, R_2 and R_3 each represents -H, $-CH_3$, $-C_2H_5$ or $-C_3H_7$; and n represents an integer of 0 to 2, in an amount of 0,1 to 500 mg per liter of said boiler feed water.

The aminodiols represented by general formula (I) are low volatile amines the volatility of which is low enough to allow the compounds to dissolve or migrate into condensed water in large quantities to effectively change CO_2 contained in the condensed water to amine carbonates.

Since the volatility of the aminodiols used in the process of invention is low, the compounds, when added to feed water, possess only a relatively low capability of migrating from the feed water into vapor. However, the compounds can be dissolved in feed water at high concentrations and, in addition, possess a markedly high capability of migrating from vapor into condensed water. As a result, the compounds are dissolved in condensed water in quantities which are large enough to allow them to function as an anticorrosive in an extremely effective manner.

The present invention will hereinafter be explained in further detail.

Among the aminodiols of general formula (I) those having a low volatility are particularly preferred.

Specific examples of aminodiols of general formula (I) are 1-amino-1,2-ethanediol, 2-dimethylamino-1,4-butanediol, 2-amino-2-ethyl-1,3-propanediol, 2-diethylamino-2-propyl-1,3-propanediol and 2-amino-2-ethyl-1,4-butanediol.

There is no particular restriction on the content of the aminodiols to be contained in the anticorrosive.

The concentration of the compounds can be selected within the range of from 1 to 100% by weight.

The anticorrosive may contain other volatile amines in combination with aminodiols of general formula (I). Examples of such volatile amines usable in combination with the aminodiols are cyclohexylamine, ammonia, aminomethylpropanol, morpholine, and aminoalcohols of general formula (II)



(II)

wherein R_4 and R_5 each represents -H, $-CH_3$, $-C_2H_5$ or $-C_3H_7$.

Specific examples of aminoalcohols of general formula (II) are monoethanolamine, N,N-dimethylmonoethanolamine, N,N-diethylmonoethanolamine N-propylmonoethanolamine.

It is possible to attain further improved anticorrosive effects by using the aminodiols represented by general formula (I) in combination with other volatile amines, such as aminoalcohols represented by general formula (II).

There is no particular restriction on the total amount of the aminodiols and other volatile amines to be contained in the anticorrosive used in the process of the invention. It can be selected within the range of from 1 to 100% by weight.

There is no particular restriction on the ratio of the aminodiols to other volatile amines. The ratio can be selected within the following rage (based on weight): aminodiols : other volatile amines = 1:99 to 99:1.

In such a case, the aminodiols and other volatile amines can be in the form of a mixture prepared by admixing them at a predetermined ratio prior to their use, or can be separately injected into systems to be protected with them.

In addition the anticorrosive used in the process of the present invention can contain other additives, such as other anticorrosives or modifiers.

The anticorrosive used in the process of the present invention is highly effective for the inhibition of corrosion in vapor/condensed water systems having a condensation rate of 0 to 100%, for example, in boiler plant vapor/condensed water systems. The anticorrosive can inhibit the corrosion of piping systems since it possesses an extremely high solubility in condensed water and, hence, can effectively change CO_2, which is contained in condensed water and causes the corrosion of piping systems, into an amine carbonate. The anticorrosive is also highly effective with regard to the inhibition of corrosion of boilers per se since its solubility in feed water for boilers is quite high and, hence, the pH of the feed water can be readily raised.

The present invention will further be explained by way of examples.

EXAMPLE 1

A vapor-generating autoclave was operated at 180 °C, during which a test water (soft water) having the quality set forth below and (except the case of Run No. 1) containing various agents shown in Table 1 at a concentration of 15 mg, per liter of feed water, was fed at a rate of 12 to 12.8 l/h.

The vapor so generated was fed to a condenser, and a test piece of mild steel (15 x 50 x 1 mm) was immersed in the condensed water. The rate of corrosion was measured after 48 hours. The blow rate was set at 10%.

The results obtained are shown in Table 1.

Quality of Test Water

Softened water from the Atsugi City Water Supply Service
pH: 8.1
Electric conductivity: 200 µs/cm
M alkalinity: 45 mg-$CaCO_3$/l
Cl: 13 mg/l
SiO_2: 29 mg/l
SO_4^{2-}: 25 mg/l

Table 1

Run No.	Agents		Corrosion Rate (mdd)	Notes
	Kind	Content (Wt%)		
1	--	--	17.2	*1
2	Cyclohexylamine	100	7.2	*1
3	Morpholine	100	6.2	*1
4	Monoethanolamine	100	4.8	*1
5	2-Amino-2-ethyl-1,3-propanediol	100	3.2	*2
6	2-Amino-2-ethyl-1,3-propanediol Monoethanolamine	50 50	2.5	*2
7	2-Amino-2-ethyl-1,3-propanediol Cyclohexylamine	50 50	2.8	*2
8	2-Amino-2-methyl-1,3-propanediol	100	3.3	*2
9	2-Amino-2-methyl-1,3-propanediol Monoethanolamine	50 50	2.4	*2

*1: Control examples for comparison
*2: Examples according to the present invention

It is apparent from Table 1 that the anticorrosives used in the process according to the present invention exhibit excellent anticorrosive effects.

EXPERIMENTAL EXAMPLE 1

The autoclave used in Example 1 was operated under the same conditions, and the distribution of the agents shown in Table 2 was examined at a condensation rate of 10%. The results obtained are shown in Table 2.

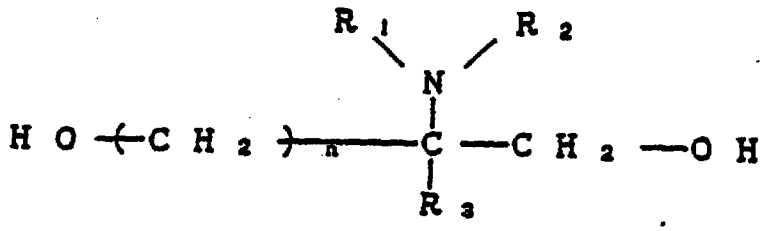
Table 2

No.	Agents	Concentration in Boiler Water (mg/l)	Concentration in Vapor (mg/l)	Concentration in Condensed Water (mg/l)
1	Cyclohexylamine	12	15	5.0
2	Morpholine	26.5	14	15.0
3	Monoethanolamine	107	7	38.9
4	2-Amino-2-ethyl-1,3-propanediol	172	5	23.4

It can be seen from the results shown in Table 2 that 2-amino-2-ethyl-1,3-propanediol is inferior in its capability of migrating into vapor but is excellent in its overall capability of migrating into condensed water.

Claims

1. A process for inhibiting the corrosion of vapor/condensed water systems, which comprises adding to boiler feed water an anticorrosive comprising 1-100% by weight of at least one aminodiol represented by general formula (I)



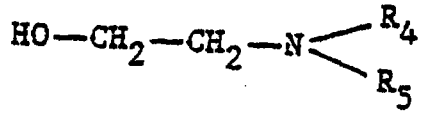
(I)

wherein R_1, R_2 and R_3 each represents -H, $-CH_3$, CH_2H_5 or $-C_3H_7$; and n represents an integer of 0 to 2,
in an amount of 0.1 to 500 mg per liter of said boiler feed water.

2. The process of claim 1, wherein at least one volatile amine is additionally added to said boiler feed water in combination with said aminodiols, wherein the ratio of said aminodiol to said other volatile amine is in the range of 1/99 to 99/1, based on the weight.

3. The process of claim 1, wherein said aminodiol is a member selected from the group consisting of 1-amino-1,2-ethanediol,
2-dimethylamino-1,4-butanediol,
2-amino-2-ethyl-1,3-propanediol,
2-diethylamino-2-propyl-1,3- propanediol and
2-amino-2-ethyl-1,4-butanediol.

4. The process of claim 2, wherein said other volatile amine is at least one aminoalcohol represented by general formula (II)



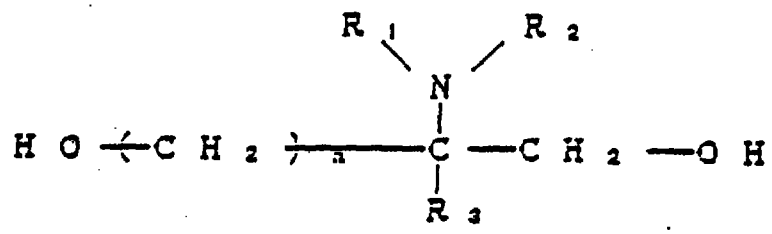
(II)

wherein R_4 and R_5 each represents -H, $-CH_3$, $-C_2H_5$ or $-C_3H_7$.

5. The process of claim 4, wherein said aminoalcohol is a member selected from the group consisting of monoethanolamine, N,N-dimethylmonoethanolamine, N,N-diethylmonoethanolamine and N-propylmonoethanolamine.

Patentansprüche

1. Verfahren zum Verhindern der Korrosion von Dampf/Kondenswasser-Systemen, welches das Zugeben eines Korrosionsschutzmittels, welches 1 - 100 Gew.-% von mindestens einem Aminodiol umfaßt, das durch die allgemeine Formel (I) dargestellt ist



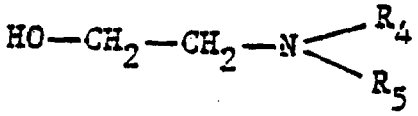
(I)

worin R_1, R_2 und R_3 jeweils -H, $-CH_3$, $-C_2H_5$ oder $-C_3H_7$ bedeuten; und n eine ganze Zahl von 0 bis 2 bedeutet,
zu Kesselspeisewasser in einer Menge von 0,1 bis 500 mg pro Liter des Kesselspeisewassers umfaßt.

2. Verfahren nach Anspruch 1, worin mindestens ein flüchtiges Amin zusätzlich zu dem Kesselspeisewasser in Kombination mit den Aminodiolen zugegeben wird, worin das Verhältnis des Aminodiols zu dem anderen flüchtigen Amin im Bereich von 1/99 bis 99/1, bezogen auf das Gewicht, liegt.

3. Verfahren nach Anspruch 1, worin das Aminodiol ein Bestandteil ist, ausgewählt aus der Gruppe bestehend aus 1-Amino-1,2-ethandiol, 2-Dimethylamino-1,4-butandiol, 2-Amino-2-ethyl-1,3-propandiol, 2-Diethylamino-2-propyl-1,3-propandiol und 2-Amino-2-ethyl-1,4-butandiol.

4. Verfahren nach Anspruch 2, worin das andere flüchtige Amin mindestens ein Aminoalkohol, dargestellt durch die allgemeine Formel (II), ist



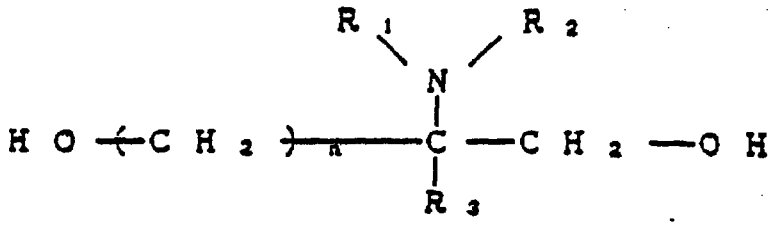
(II)

worin R_4 und R_5 jeweils -H, $-CH_3$, $-C_2H_5$ oder $-C_3H_7$ bedeuten.

5. Verfahren nach Anspruch 4, worin der Aminoalkohol ein Bestandteil ist, ausgewählt aus der Gruppe bestehend aus Monoethanolamin, N,N-Dimethylmonoethanolamin, N,N-Diethylmonoethanolamin und N-Propylmonoethanolamin.

Revendications

1. Procédé d'inhibition de la corrosion pour systèmes vapeur/eau condensée, qui comprend l'addition dans l'eau d'alimentation d'une chaudière d'un anticorrosif comprenant 1 à 100 % en poids d'au moins un aminodiol représenté par la formule générale (I)



(I)

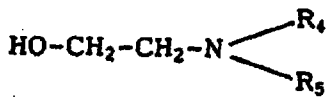
où R_1, R_2 et R_3 chacun représentent -H, $-CH_3$, $-C_2H_5$ ou $-C_3H_7$; et n représente un nombre entier de 0 à 2,
en une quantité de 0,1 à 500 mg par litre de ladite eau d'alimentation de chaudière.

* C L M S *

2. Procédé selon la revendication 1, dans lequel au moins une amine volatile est en plus ajoutée à ladite eau d'alimentation de chaudière, en combinaison avec lesdits aminodiols, dans lequel le rapport dudit aminodiol à ladite autre amine volatile est dans la gamme de 1/99 à 99/1, sur la base du poids.

3. Procédé selon la revendication 1, dans lequel ledit aminodiol est un élément choisi parmi le groupe constitué du 1-amino-1,2-éthanediol, du 2-diméthylamino-1,4-butanediol, du 2-amino-2-éthyl-1,3-propanediol, du 2-diéthylamino-2-propyl-1,3-propanediol et du 2-amino-2-éthyl-1,4-butanediol.

4. Procédé selon la revendication 2, dans lequel ladite autre amine volatile est au moins un aminoalcool représenté par la formule générale (II)



(II)

où R_4 et R_5 chacun représentent -H, $-CH_3$, $-C_2H_5$ ou $-C_3H_7$.

5. Procédé selon la revendication 4, dans lequel ledit amino-alcool est un élément choisi parmi le groupe constitué de la monoéthanolamine, de la N,N-diméthylmonoéthanolamine, de la N,N-diéthylmonoéthanolamine et de la N-propylmonoéthanolamine.