

Description

Title

REFRIGERATION CYCLE DEVICE

Field

[0001]

The present disclosure relates to a refrigeration cycle device.

Background

[0002]

The following PTL 1 discloses a refrigeration cycle device in which a portion where temperature rises when brazing is performed on a refrigerant flow path is covered by a rust preventive coating film.

Citation List

Patent Literature

[0003]

[PTL 1] JP 2008-202813 A

Summary

Technical Problem

[0004]

In a case where a refrigeration cycle device is used in an environment where sulfidizing gas such as hydrogen sulfide or sulfur dioxide is present in a rubber factory or the like, for example, sulfidation corrosion is likely to occur particularly to a brazed portion of refrigerant piping. When piping strength is lowered by corrosion, leakage of a refrigerant possibly occurs.

[0005]

An object of the present disclosure, which has been made to solve the above problem, is to provide a refrigeration cycle device which is advantageous in improving durability under an environment where sulfidizing gas is present.

Solution to Problem

[0006]

A refrigeration cycle system according to the present disclosure includes: a first refrigerant pipe; a second refrigerant pipe; a brazing filler metal joining an end portion of the first refrigerant pipe to an end portion of the second refrigerant pipe; a first film covering an exposed portion of the brazing filler metal, the first film being made of a corrosion inhibitor; and a first paint layer covering an outer surface of the first film.

Advantageous Effects of Invention

[0007]

In the present disclosure, it is possible to provide a refrigeration cycle device which is advantageous in improving durability under an environment where sulfidizing gas is present.

[0008]

Fig. 1 is a diagram illustrating a refrigeration cycle device according to a first embodiment.

Fig. 2 is a vertical cross-sectional diagram schematically illustrating a part of a refrigerant flow path of a refrigerant circuit provided to the refrigeration cycle device according to the first embodiment.

Fig. 3 shows 1,2,3-benzotriazole.

Fig. 4 shows N,N-bis(2-ethylhexyl)-4-methyl-1H-benzotriazole-1-methanamine.

Fig. 5 is a vertical cross-sectional diagram schematically illustrating a part of a refrigerant flow path of a refrigerant circuit provided to a refrigeration cycle device according to a second embodiment.

Description of Embodiments

[0009]

Embodiments will hereinafter be described with reference to drawings. The same reference characters are given to the elements common to or corresponding among the drawings, and descriptions thereof will be simplified or skipped. Note that in a case where an angle is mentioned in the present disclosure, when a major angle and a minor angle whose sum is 360 degrees are present, the angle of the minor angle is indicated in principle, and when an acute angle and an obtuse angle whose sum is 180 degrees are present, the angle of the acute angle is indicated in principle.

[0010]

First Embodiment

Fig. 1 is a diagram illustrating a refrigeration cycle device according to a first embodiment. As illustrated in Fig. 1, a refrigeration cycle device 1 of the present embodiment includes a compressor 2 which compresses a refrigerant, a condenser 3 which condenses a high-pressure refrigerant compressed by the compressor 2, an expansion valve 4 which decompresses and expands the high-pressure refrigerant passing through the condenser 3, an evaporator 5 which evaporates a low-pressure refrigerant decompressed by the expansion valve 4, and refrigerant piping 6. The compressor 2, the condenser 3, the expansion valve 4, and the evaporator 5 are connected together via the refrigerant piping 6 and thereby form an annular refrigerant circuit. Low-pressure

refrigerant gas flowing out from the evaporator 5 is drawn into the compressor 2 and again circulates in the refrigerant circuit.

[0011]

The refrigerant in the present disclosure is not particularly limited but may be any of carbon dioxide, ammonia, propane, isobutane, Freon such as HFC, HFO-1123, and HFO-1234yf, for example.

[0012]

The condenser 3 corresponds to a heat exchanger which exchanges heat between the high-pressure refrigerant discharged from the compressor 2 and a first fluid at a lower temperature than the above high-pressure refrigerant. In the condenser 3, the temperature of the first fluid rises by heating by the high-pressure refrigerant. The first fluid may be gas such as air on the outside or inside of a room or may be liquid such as water or another liquid heating medium, for example. The refrigeration cycle device 1 may include a first fluid actuator (not illustrated) such as a pump or a blower, for example, for causing the first fluid to flow to the condenser 3.

[0013]

The expansion valve 4 decompresses and expands the high-pressure refrigerant and makes that the low-pressure refrigerant. The expansion valve 4 may have a structure in which an opening degree of a refrigerant path is adjustable. The low-pressure refrigerant passing through the expansion valve 4 is turned into a gas-liquid two-phase state.

[0014]

The evaporator 5 corresponds to a heat exchanger which exchanges heat between the low-pressure refrigerant decompressed by the expansion valve 4 and a second fluid at

a higher temperature than the above low-pressure refrigerant. The refrigerant in the evaporator 5 evaporates by absorbing the heat of the second fluid. The second fluid may be gas such as air on the outside or inside of the room or may be liquid such as water or another liquid heating medium, for example. The refrigeration cycle device 1 may include a second fluid actuator (not illustrated) such as a blower or a pump, for example, for causing the second fluid to flow to the evaporator 5.

[0015]

The refrigeration cycle device 1 may be used for the purpose of heating the first fluid by the condenser 3 or may be used for the purpose of cooling the second fluid by the evaporator 5. The refrigeration cycle device 1 may be used for a indoor-cooling device, a indoor-heating device, a dehumidifying device, an air-conditioning device, a water heating device, and so forth, for example.

[0016]

Fig. 2 is a vertical cross-sectional diagram schematically illustrating a part of a refrigerant flow path of the refrigerant circuit provided to the refrigeration cycle device 1 according to the first embodiment. As illustrated in Fig. 2, the refrigeration cycle device 1 includes a first refrigerant pipe 7, a second refrigerant pipe 8, a brazing filler metal 9 joining an end portion 7a of the first refrigerant pipe 7 to an end portion 8a of the second refrigerant pipe 8, a first film 10 covering an exposed portion 9a of the brazing filler metal 9, and a first paint layer 11 covering an outer surface of the first film 10. Note that Fig. 2 corresponds to a diagram which is sectioned along a plane including a central axis of the first refrigerant pipe 7 and a central axis of the second refrigerant pipe 8.

[0017]

The first refrigerant pipe 7 and the second refrigerant pipe 8 may constitute any portion of the refrigerant circuit. For example, the first refrigerant pipe 7 and the second refrigerant pipe 8 may constitute a part of the condenser 3 or a part of the evaporator 5. For example, in a case where the heat exchanger constituting the condenser 3 or the evaporator 5 has hairpin-shaped piping and a U-shaped pipe joint, one of the first refrigerant pipe 7 and the second refrigerant pipe 8 may correspond to the hairpin-shaped piping, and the other of the first refrigerant pipe 7 and the second refrigerant pipe 8 may correspond to the U-shaped pipe joint. Alternatively, the first refrigerant pipe 7 and the second refrigerant pipe 8 may constitute a connection portion between the refrigerant piping 6 and the compressor 2, the condenser 3, the expansion valve 4, or the evaporator 5.

[0018]

Each of the first refrigerant pipe 7 and the second refrigerant pipe 8 is made of metal. Each of the first refrigerant pipe 7 and the second refrigerant pipe 8 may be made of copper or a copper alloy, for example. The end portion 7a of the first refrigerant pipe 7 is joined to the end portion 8a of the second refrigerant pipe 8 by brazing using the brazing filler metal 9.

[0019]

The brazing filler metal 9 may be a brazing filler metal which is used for hard brazing and has a melting point of 450°C or higher, for example. As the brazing filler metal 9, for example, silver brazing, gold brazing, yellow brass brazing, brass brazing, nickel brazing, aluminum brazing, and so forth may be used.

[0020]

In the illustrated example, the end portion 7a of the first refrigerant pipe 7 is positioned on the inside of the end portion 8a of the second refrigerant pipe 8. An outer diameter of the end portion 7a of the first refrigerant pipe 7 is equivalent to or smaller than an inner diameter of the end portion 8a of the second refrigerant pipe 8. A portion between an outer periphery surface of the end portion 7a of the first refrigerant pipe 7 and an inner periphery surface of the end portion 8a of the second refrigerant pipe 8 is filled with the brazing filler metal 9. In the following description, a part where the end portion 7a of the first refrigerant pipe 7 is positioned on the inside of the end portion 8a of the second refrigerant pipe 8 will be referred to as "overlapping portion 14".

[0021]

The exposed portion 9a is a portion of the brazing filler metal 9, the portion being exposed from an opening of the end portion 8a of the second refrigerant pipe 8. In the illustrated example, in a position at a distal end of the end portion 8a, the exposed portion 9a has a surface which is vertical to the central axis of the second refrigerant pipe 8. The exposed portion 9a is not limited to such an example but may be placed on the outside of the second refrigerant pipe 8 through the opening of the end portion 8a, for example. Further, the exposed portion 9a may have a surface which is inclined with respect to the central axis of the second refrigerant pipe 8.

[0022]

The first film 10 formed on the surface of the exposed portion 9a of the brazing filler metal 9 is made of a corrosion inhibitor. The first film 10 exhibits an action of protecting the surface of the exposed portion 9a of the brazing filler metal 9. In the present disclosure, the corrosion inhibitor denotes a substance inhibiting corrosion of metal which forms the first refrigerant pipe 7, the second refrigerant pipe 8, and the

brazing filler metal 9. The corrosion inhibitor in the present disclosure is also referred to as metal deactivator or rust preventive agent.

[0023]

The corrosion inhibitor in the present disclosure may be a benzotriazole-based compound. The benzotriazole-based compound is particularly highly reactive with copper. Thus, in a case where the first refrigerant pipe 7 and the second refrigerant pipe 8 are made of copper or a copper alloy, a particularly excellent corrosion inhibiting action can be obtained.

[0024]

In the present disclosure, it is particularly preferable that as the benzotriazole-based compound, for example, 1,2,3-benzotriazole illustrated in Fig. 3 or N,N-bis(2-ethylhexyl)-4-methyl-1H-benzotriazole-1-methanamine illustrated in Fig. 4 be used.

[0025]

The corrosion inhibitor in the present disclosure is not limited to the above examples but may be a tolyltriazole-based compound or may be a mercaptobenzothiazole-based compound, for example.

[0026]

The first film 10 may be a film corresponding to a molecule film which is formed of molecules resulting from chemical combination of metal and the corrosion inhibitor, the metal forming the first refrigerant pipe 7, the second refrigerant pipe 8, or the brazing filler metal 9.

[0027]

The first paint layer 11 is a layer formed by applying paint to a surface of the first film 10. The thickness of the first paint layer 11 is thicker than the film thickness of the

first film 10. The paint of the first paint layer 11 may be rust preventive paint such as epoxy-resin-based paint, tar-epoxy-resin-based paint, acrylic-resin-based paint, or alkyl-silicate-resin-based paint.

[0028]

For example, there is a case where the refrigeration cycle device 1 is used in an environment where sulfidizing gas such as hydrogen sulfide or sulfur dioxide is present in air in a rubber factory or the like. In related art, in such a case, there is a problem that sulfidation corrosion is likely to occur particularly to a brazed portion of refrigerant piping. As for this problem, in the present embodiment, the first film 10 made of the corrosion inhibitor and the first paint layer 11 covering the first film 10 are provided, and the sulfidation corrosion of the brazed portion of the brazing filler metal 9 can thereby reliably be prevented.

[0029]

The first film 10 exhibits an action of protecting the brazing filler metal 9 from the sulfidizing gas. The first film 10 obstructs contact of the brazing filler metal 9 with the sulfidizing gas, and the sulfidation corrosion of the brazing filler metal 9 can thereby reliably be prevented. The first paint layer 11 exhibits an action of protecting the first film 10. The first paint layer 11 thicker than the first film 10 covers the first film 10, and the first film 10 can thereby reliably be protected for a long period. Because the first film 10 is thin, if the first paint layer 11 is absent, there is a possibility that the first film 10 is partially damaged due to aging and a corrosion inhibiting effect is gradually lowered. However, in the present embodiment, both of the first film 10 and the first paint layer 11 are provided, and the sulfidation corrosion of the brazed portion of the brazing filler metal 9 can thereby reliably be prevented for a long period. Thus,

durability of the refrigeration cycle device 1 is improved, an occurrence of leakage of the refrigerant can reliably be prevented for a long period, and it is possible to extend the life of the refrigeration cycle device 1.

[0030]

It is preferable that the first paint layer 11 be made of paint to which the corrosion inhibitor is added. In a case where the first paint layer 11 does not contain the corrosion inhibitor, there is a possibility that the film thickness of the first film 10 is decreased and the first film 10 is partially damaged due to aging degradation. However, when the first paint layer 11 is provided, the first paint layer 11 being made of the paint to which the corrosion inhibitor is added, the corrosion inhibitor in the first paint layer 11 moves to the first film 10, and the first film 10 can thereby be reproduced before aging degradation occurs to the first film 10. Thus, the sulfidation corrosion of the brazed portion of the brazing filler metal 9 can reliably be prevented for a much longer period. Note that in a case where the corrosion inhibitor is added to the paint, its concentration is preferably 0.1 wt% to 5 wt%, for example.

[0031]

It is preferable that the corrosion inhibitor of the first paint layer 11 be the same substance as the corrosion inhibitor of the first film 10. For example, in a case where the corrosion inhibitor of the first film 10 is 1,2,3-benzotriazole, it is preferable that the corrosion inhibitor of the first paint layer 11 be also 1,2,3-benzotriazole. In a case where the corrosion inhibitor of the first film 10 is N,N-bis(2-ethylhexyl)-4-methyl-1H-benzotriazole-1-methanamine, it is preferable that the corrosion inhibitor of the first paint layer 11 be also N,N-bis(2-ethylhexyl)-4-methyl-1H-benzotriazole-1-methanamine. Accordingly, reproduction of the first film 10 can further be promoted.

[0032]

However, in the present disclosure, the corrosion inhibitor of the first paint layer 11 may be a different substance from the corrosion inhibitor of the first film 10. For example, when the corrosion inhibitor of the first film 10 is 1,2,3-benzotriazole, the corrosion inhibitor of the first paint layer 11 may be N,N-bis(2-ethylhexyl)-4-methyl-1H-benzotriazole-1-methanamine, and vice versa.

[0033]

The refrigeration cycle device 1 in the present embodiment further includes a second film 12 covering an outer surface of the first refrigerant pipe 7 and an outer surface of the second refrigerant pipe 8. The second film 12 is made of a corrosion inhibitor. By providing the second film 12, corrosion of the first refrigerant pipe 7 and the second refrigerant pipe 8 can more reliably be prevented. The second film 12 may have a similar configuration to the first film 10. The corrosion inhibitor of the second film 12 may be the same substance as the corrosion inhibitor of the first film 10. The second film 12 may be formed together with the first film 10. Because the second film 12 is thin, the second film 12 does not hinder heat exchange between the outer surface of the first refrigerant pipe 7 and the outer surface of the second refrigerant pipe 8 and the fluid. Thus, even in a case where the second film 12 is provided, lowering of heat exchange efficiency of the first refrigerant pipe 7 and the second refrigerant pipe 8 can be prevented.

[0034]

An example of a method for forming the first film 10 and the second film 12 together will be described in the following. An aqueous solution is prepared in which the corrosion inhibitor is dissolved in pure water. For example, in a case of 1,2,3-

benzotriazole, the concentration of the aqueous solution is preferably 0.25 wt%. In a case of 1,2,3-benzotriazole and N,N-bis(2-ethylhexyl)-4-methyl-1H-benzotriazole-1-methanamine, the concentration of the aqueous solution is preferably 1 wt%. The first refrigerant pipe 7 and the second refrigerant pipe 8 are brazed with the brazing filler metal 9 and are thereafter immersed in the above aqueous solution. That is, the first refrigerant pipe 7 and the second refrigerant pipe 8, which are brazed with the brazing filler metal 9, are immersed in the above aqueous solution. An immersion time period may be approximately two to three minutes, for example. Accordingly, the first film 10 and the second film 12 are formed.

[0035]

There is a possibility that when the first film 10 and the second film 12 are exposed to a high temperature in brazing, they are degraded. However, the first film 10 and the second film 12 are formed after brazing, and degradation of the first film 10 and the second film 12 due to heat can thereby reliably be prevented.

[0036]

The method for forming the first film 10 and the second film 12 is not limited to the above example. For example, a method may be used in which the first refrigerant pipe 7 and the second refrigerant pipe 8, which are brazed with the brazing filler metal 9, are immersed in a solution in which the corrosion inhibitor is dissolved in an oily solvent.

[0037]

The refrigeration cycle device 1 in the present embodiment further includes a second paint layer 13 covering a partial range of an outer surface of the second film 12. The second paint layer 13 is a layer formed by applying paint to a surface of the second film 12. The paint of the second paint layer 13 may be the same as the paint of the first

paint layer 11. One end of the second paint layer 13 is connected with one end of the first paint layer 11. The second paint layer 13 may be formed together with the first paint layer 11.

[0038]

The second paint layer 13 exhibits an action of protecting the second film 12. The second paint layer 13 thicker than the second film 12 covers the second film 12, and the second film 12 can thereby reliably be protected for a long period.

[0039]

The heat exchange efficiency of a region covered by the second paint layer 13 is lowered compared to a region which is not covered by a paint layer. The second paint layer 13 covers only the partial range of the outer surface of the second film 12. The remaining range of the outer surface of the second film 12 is not covered by the paint layer but is exposed. As described above, the second paint layer 13 is provided to only the partial range of the outer surface of the second film 12, and lowering of the heat exchange efficiency of the first refrigerant pipe 7 and the second refrigerant pipe 8 due to the second paint layer 13 can thereby reliably be reduced.

[0040]

In the example in Fig. 2, the second paint layer 13 covers the second film 12 on the outer surface of the second refrigerant pipe 8 in the overlapping portion 14. The second paint layer 13 does not cover the second film 12 on the outer surface of the first refrigerant pipe 7. That is, the second film 12 on the outer surface of the first refrigerant pipe 7 is not covered by the paint layer but is exposed. Such a configuration can reliably prevent lowering of the heat exchange efficiency of the first refrigerant pipe 7.

[0041]

In the example in Fig. 2, the second paint layer 13 does not cover the second film 12 in the range except the overlapping portion 14 in the second film 12 on the outer surface of the second refrigerant pipe 8. That is, the second film 12 in the range except the overlapping portion 14 in the second film 12 on the outer surface of the second refrigerant pipe 8 is not covered by the paint layer but is exposed. Such a configuration can reliably prevent lowering of the heat exchange efficiency of the second refrigerant pipe 8.

[0042]

It is preferable that the second paint layer 13 be made of paint to which the corrosion inhibitor is added. When the second paint layer 13 is provided, the second paint layer 13 being made of the paint to which the corrosion inhibitor is added, the corrosion inhibitor in the second paint layer 13 moves to the second film 12 covered by the second paint layer 13, and the second film 12 can thereby be reproduced before aging degradation occurs to the second film 12. Thus, the sulfidation corrosion of the brazed portion of the brazing filler metal 9 can reliably be prevented for a much longer period. It is preferable that the corrosion inhibitor of the second paint layer 13 be the same substance as the corrosion inhibitor of the second film 12.

[0043]

Second Embodiment

Next, a second embodiment will be described with reference to Fig. 5; however, a description will mainly be made about different points from the above-described first embodiment, and descriptions common to the first embodiment will be simplified or skipped. Further, the same reference characters are given to the elements common to or corresponding to the above-described elements. Fig. 5 is a vertical cross-sectional

diagram schematically illustrating a part of a refrigerant flow path of a refrigerant circuit provided to a refrigeration cycle device 1 according to the second embodiment.

[0044]

As illustrated in Fig. 5, the refrigeration cycle device 1 according to the second embodiment includes the first refrigerant pipe 7, the second refrigerant pipe 8, the brazing filler metal 9 joining the end portion 7a of the first refrigerant pipe 7 to the end portion 8a of the second refrigerant pipe 8, the first film 10 covering the exposed portion 9a of the brazing filler metal 9, and the first paint layer 11 covering the outer surface of the first film 10.

[0045]

Meanwhile, the refrigeration cycle device 1 according to the second embodiment is different from the first embodiment in a point that it does not include the second paint layer 13. That is, the second film 12 on the outer surface of the second refrigerant pipe 8 in the overlapping portion 14 is not covered by the second paint layer 13 but is exposed.

[0046]

In the refrigeration cycle device 1 according to the second embodiment, the whole second film 12 on the outer surface of the first refrigerant pipe 7 is not covered by the paint layer but is exposed, and the whole second film 12 on the outer surface of the second refrigerant pipe 8 is not covered by the paint layer but is exposed. Thus, the heat exchange efficiency of the first refrigerant pipe 7 and the second refrigerant pipe 8 is improved compared to the first embodiment. The first refrigerant pipe 7 and the second refrigerant pipe 8 are less subject to corrosion than the brazing filler metal 9. Thus, even when the paint layer is absent, only the second film 12 can reliably inhibit corrosion for a long period.

[0047]

In the present embodiment, because the range of the paint layer which may become a cause of lowering of the heat exchange efficiency of the first refrigerant pipe 7 and the second refrigerant pipe 8 is set to only the first paint layer 11 as the minimum necessary range, it is possible to make much higher the heat exchange efficiency of the first refrigerant pipe 7 and the second refrigerant pipe 8 while reliably inhibiting corrosion of the brazed portion.

Reference Signs List

[0048]

- 1 refrigeration cycle device
- 2 compressor
- 3 condenser
- 4 expansion valve
- 5 evaporator
- 6 refrigerant piping
- 7 first refrigerant pipe
- 7a end portion
- 8 second refrigerant pipe
- 8a end portion
- 9 brazing filler metal
- 9a exposed portion
- 10 first film
- 11 first paint layer
- 12 second film

13 second paint layer

14 overlapping portion

Claims

[Claim 1]

A refrigeration cycle device comprising:

a first refrigerant pipe;

a second refrigerant pipe;

a brazing filler metal joining an end portion of the first refrigerant pipe to an end portion of the second refrigerant pipe;

a first film covering an exposed portion of the brazing filler metal, the first film being made of a corrosion inhibitor; and

a first paint layer covering an outer surface of the first film.

[Claim 2]

The refrigeration cycle device according to claim 1, wherein the first paint layer is made of paint to which a corrosion inhibitor is added.

[Claim 3]

The refrigeration cycle device according to claim 2, wherein the corrosion inhibitor of the first paint layer is the same substance as the corrosion inhibitor of the first film.

[Claim 4]

The refrigeration cycle device according to any one of claims 1 to 3, further comprising a second film covering an outer surface of the first refrigerant pipe and an outer surface of the second refrigerant pipe, the second film being made of a corrosion inhibitor.

[Claim 5]

The refrigeration cycle device according to claim 4, further comprising a second paint layer covering a partial range of an outer surface of the second film.

[Claim 6]

The refrigeration cycle device according to claim 5, wherein the second paint layer is made of paint to which a corrosion inhibitor is added.

[Claim 7]

The refrigeration cycle device according to claim 5 or 6, further comprising an overlapping portion in which the end portion of the first refrigerant pipe is positioned on an inside of the end portion of the second refrigerant pipe, wherein

the second paint layer covers the second film on the outer surface of the second refrigerant pipe in the overlapping portion, and

the second film on the outer surface of the first refrigerant pipe is not covered by a paint layer.

[Claim 8]

The refrigeration cycle device according to claim 7, wherein the second film in a range except the overlapping portion in the second film on the outer surface of the second refrigerant pipe is not covered by a paint layer.

[Claim 9]

The refrigeration cycle device according to any one of claims 1 to 4, wherein an outer surface of the first refrigerant pipe and an outer surface of the second refrigerant pipe are not covered by a paint layer.