

DESCRIPTION

Title of Invention

PROCESS FOR REPAIRING PIT AND
PROCESS FOR REPAIRING METAL MEMBER

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Technical Field

The present invention relates to a process for repairing a pit comprising a heat transfer salt therein, and to a process for repairing a metal member in which a blowhole comprising a heat transfer salt therein is formed.

Background Art

A heat transfer salt as a heating medium for an application at a high temperature has been widely used in various chemical reactions. Since the heat transfer salt is able to attain uniform heat transfer to reactants for a chemical reaction, it is an industrially important heating medium. The heat transfer salt is heated in a reactor to be used for various chemical reactions. If the heat transfer salt leaks out of the reactor, there is a potential danger since it may cause, for example, vapor explosion by contacting with moisture. Thus, use of the heat transfer salt shall be under strict control.

The heat transfer salt, which is a mixture of NaNO_2 , NaNO_3 , KNO_3 , and so on, may be decomposed on heating and

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generate gas such as nitric oxides and nitrogen. Such gas may react with a metal of the reactor at a high temperature to form a pit or a blowhole. A blowhole is a hole in the metal, and a pit is an opening to outside of the metal.

5 When such pit or blowhole is formed, there is a potential risk that the heat transfer salt in a liquid state at a high temperature may leak out of the reactor through the pit or the blowhole.

Thus, with respect to a pit and a blowhole which
10 comprise a heat transfer salt therein, in order to avoid the heat transfer salt from leaking, it is required to block up the pit or repair the metal member including the blowhole therein. However, an effective measure has not been found hitherto.

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Summary of Invention

Technical Problem

Regarding hitherto unfound measure, the inventor of the present application has studied to prevent a heat
20 transfer salt from leaking. The study is directed to weld a pit itself or a metal member with a metal and thereby block up the pit or reinforce the metal member; wherein the pit comprises the heat transfer salt, and the metal member include a blowhole comprising the heat transfer salt.

25 However, in a case of the reactor in which the heat

transfer salt has been used, the heat transfer salt exists in the pit and the blowhole. Therefore, the heat transfer salt becomes liquid by heat from the welding and leaks out of the reactor. Thus, it is not easy to attain effective repair.

The present invention has been made considering the above described problem, and the purpose thereof is to provide a process for repairing a pit which has formed on or through a metal member and comprises a heat transfer salt therein, or a process for repairing a metal member in which a blowhole comprising a heat transfer salt therein is formed, the pit and the blowhole may be those generated in a reactor to which the heat transfer salt has been introduced.

Solution to Problem

A pit repairing process of the present invention is, in order to solve the above problem, a process for repairing (by welding) a pit which has formed on or through a metal member and comprises a heat transfer salt therein, which process comprises a first welding step for forming a plurality of metal layers over (or on) the pit by a micro-TIG method in which welding is conducted by arc discharge to a welding material, a compression step for compressing the formed metal layers by applying impact on the metal

layers so that a thickness of the metal layers is compressed at a compression ratio of 50% or less, and thereafter a second welding step for forming a plurality of additional metal layers on the compressed metal layers by the micro-TIG method.

According to the above process of the present invention, in the first welding step, since the metal layers are formed in a short time by the micro-TIG method, its heat is hard to be transferred to the pit. Therefore, the metal layers can be formed while preventing the pit from deforming and preventing the heat transfer salt from leaking. Further, in the compression step, because the compression of the metal layers can make a part of the metal layers move into the pit, the pit can be blocked up, strongly. Finally, in the second welding step, the additional metal layers are formed on the compressed metal layers, and therefore the pit can be repaired substantially without deformation.

In the pit repairing process of the present invention, it is preferable that following the second welding step, the compression step and the second welding step are sequentially conducted twice or more.

As a result, since the compression step is conducted more than once, a more amount of the metal is moved into the pit, and thus the pit can be blocked up by the more

amount of the metal. In addition, since the second welding step is conducted more than once, a thickness of the metal layers is increased, and thus the pit can be repaired more strongly.

5 A metal member repairing process of the present invention is, in order to solve the above problem, a process for repairing a metal member in which a blowhole comprising a heat transfer salt therein is formed, which process comprises forming a plurality of metal layers on a
10 surface of the metal member which surface is located within a distance of typically 2.0 mm from the blowhole by a micro-TIG method in which welding is conducted by arc discharge to a welding material.

 According to the above process of the present
15 invention, since the plurality of the metal layers is formed on the surface of the metal member and the micro-TIG method is a method in which welding is conducted by arc discharge, the surface of the metal member can be repaired substantially without influence on the blowhole and the
20 heat transfer salt.

Advantageous Effects of Invention

 The pit repairing process of the present invention is, as described above, a process for repairing (by welding) a
25 pit which has formed on or through a metal member and

comprises a heat transfer salt therein, which process comprises a first welding step for forming a plurality of metal layers over (or on) the pit by a micro-TIG method in which welding is conducted by arc discharge to a welding material, a compression step for compressing the formed metal layers by applying impact on the metal layers so that a thickness of the metal layers is compressed at a compression ratio of 50% or less, and thereafter a second welding step for forming a plurality of additional metal layers on the compressed metal layers by the micro-TIG method.

Therefore, the present invention has an advantage in that the pit can be repaired while preventing the pit from deforming and preventing the heat transfer salt from leaking.

Further, the metal member repairing process of the present invention is, in order to solve the above problem, a process for repairing a metal member in which a blowhole comprising a heat transfer salt therein is formed, which process comprises forming a plurality of metal layers on a surface of the metal member which is located within a distance of 2.0 mm from the blowhole by a micro-TIG method in which welding is conducted by arc discharge to a welding material.

Therefore, since the plurality of the metal layers is

formed on the surface of the metal member and the micro-TIG method is a method in which welding is conducted by arc discharge, the present invention has an advantage in that the surface of the metal member can be repaired
5 substantially without influence on the blowhole and the heat transfer salt.

Brief Description of Drawings

Fig. 1 (a) shows a cross sectional view of a reactor,
10 and Fig. 1 (b) shows a cross sectional view of a region in the vicinity of a reaction tube and a heating medium reserving part shown in Fig. 1 (a).

Fig. 2 shows cross sectional views of respective steps of repairing processes in embodiments of the present
15 invention.

Fig. 3 shows cross sectional views of objects to be repaired by a repairing process in Examples.

Fig. 4 shows cross sectional views of a part around a pit after being subjected to a repairing process in
20 Examples 1 and 2.

Fig. 5 shows cross sectional views of a part around a blowhole after subjected to a repairing process in Example 3 and Comparative Example 3.

Fig. 6 shows cross sectional views of a part around a
25 pit after subjected to a repairing process in Comparative

Examples 1 and 2.

Following reference signs denote the following elements:

8 ... tube sheet (metal member)

5 8a ... metal surface (surface of the metal member)

9 ... pit

10 ... blowhole

11 ... metal layer

11a ... compressed metal layer

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Description of Embodiments

[Embodiment 1]

A pit repairing process of the present invention in one embodiment will be hereinafter described with reference to Fig. 1 and Fig. 2. Firstly, in Fig. 1 (a), there is shown a reactor 1 to which a heat transfer salt has been introduced. Fig. 1 (a) is a cross sectional view of the reactor 1. The reactor 1 is a known reactor to which an inorganic heat transfer salt is introduced and which is used for various reactions.

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The reactor 1 is provided with a bottom cover 2 at a lower section, reaction tubes 3 at a middle section, and a top cover 4 at an upper section. The reactor 1 is also provided with a heating medium reserving part 5 surrounding the reaction tubes 3, an inorganic heat transfer salt is

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reserved (or stored) in the heating medium reserving part 5. The inorganic heat transfer salt is heated with a heater (not shown), various raw materials introduced into an internal space of the bottom cover 2 are heated to a high temperature in the reaction tubes 3 to make a chemical reaction proceed. The resultant which is generated through the reaction tubes 3 is recovered into an internal space of the top cover 4. The heating medium reserving part 5 is provided with a heating medium supply part (or port) 6 and a heating medium discharge part (or port) 7, so that the inorganic heat transfer salt can be supplied thereto and discharged therefrom. For illustrative purposes, the number of reaction tubes 3 is shown as four in the drawing, but it is not limited to the number shown in the drawing. The number may be a very large number, for example, 100 or more, and further be 10,000 or more. In place of the heating medium supply part 6 and the heating medium discharge part 7, other configuration such as a circulation pump may be applied.

The inorganic heat transfer salt used in the reactor 1 is in a solid state at ordinary temperature (25°C) and, in the context of the present specification, a salt mixture of alkali nitrate and alkali nitrite which melt and become liquid at a high temperature of 130°C or more. As the inorganic heat transfer salt, those known as such can be

applied with no limitation. More specifically, examples of alkali nitrate and alkali nitrite may include NaNO_2 , NaNO_3 , KNO_3 , and so on. In general, the salt mixture is composed to have a molar ratio of $\text{NaNO}_2 : \text{KNO}_3 = 1 : 1$, or of $\text{NaNO}_3 :$
5 $\text{NaNO}_2 : \text{KNO}_3 = 7 : 44 : 49$. Of course, the mixing ratio can be changed appropriately.

The inorganic heat transfer salt may be gasified during welding and cause a pit or a blowhole in a weld metal in some cases. They are deferent from each other in
10 that a pit is an opening to outside of a metal member, while a blowhole is a hole existing in a metal member.

The heating medium reserving part 5 is fixed by a tube sheet 8. The gas described above is likely to get into, for example, a space between the reaction tube 3 and the
15 heating medium reserving part 5, or the tube sheet 8 contacting with the heating medium reserving part 5, so that the pit or the blowhole tends to be formed there. Fig. 1 (b) shows a cross sectional view of a region A in the vicinity of the reaction tube 3 and the heating medium
20 reserving part 5 shown in Fig. 1 (a). As shown in Fig. 1 (b), more specifically, the reaction tube 3 and the tube sheet 8 are connected to each other by a weld metal W. In the weld metal W, however, as shown in Fig. 1 (b), a pit 9 is formed, and a blowhole 10 is formed. The pit 9 is open
25 to outside of the weld metal W, while the blowhole 10

exists inside the weld metal W. Especially, it is more important to repair the pit 9 since the pit 9 is open to outside of the weld metal W from the heating medium reserving part 5. In this embodiment, the repairing process by welding the pit 9 will be described.

Although the size of the pit 9 is not limited, the pit 9 having a depth not smaller than 0.5 mm and not larger than 3 mm and a diameter not smaller than 0.1 mm and not larger than 2 mm can be preferably repaired.

The repairing process in this embodiment comprises (1) the first welding step for forming metal layers by conducting a micro-TIG method (micro-TIG welding) for the pit, (2) the compression step for compressing the metal layers, and (3) the second welding step for forming additional metal layers by further conducting a micro-TIG method for the compressed metal layers. Each of the steps will be hereinafter described.

<First welding step>

The first welding step forms metal layers by conducting a micro-TIG method for the pit. A micro-TIG method (micro-TIG welding, TIG: Tungsten Inert Gas) is a method in which a metal is molten by arc discharge for a controlled and limited short time period (for example, less than 3 sec) and thereby a metal layer is formed on or over an object to be welded (pit). As the micro-TIG method,

those known as such can be used. In the micro-TIG method, an inert gas is blown to the object to be welded so as to surround the object with the inert atmosphere, and then a welding material is subjected to arc discharge to melt and
5 form a metal layer.

As the inert gas, argon, nitrogen, helium or the like can be used, but not limited thereto. A current and discharge duration (time period) for the arc discharge are not specifically limited, but, for example, the current is
10 not smaller than 70 A and not larger than 80 A and the discharge duration is not smaller than 0.3 sec and not larger than 1 sec, preferably not smaller than 0.5 sec and not larger than 0.7 sec. By selecting such ranges, it become possible to avoid the inorganic heat transfer salt
15 existing in the pit from being heated excessively, and thereby it become possible to avoid a bad influence(s) such as flowing of the inorganic heat transfer salt out of the pit, or expansion of the gas existing in the pit.

In contrast, a TIG method (TIG welding) is a method in
20 which a metal is molten by arc discharge and thereby a metal layer is formed on or over an object to be welded, but the TIG method is different from the micro-TIG method in that continuous arc or pulsed arc is generated continuously for a relatively long time period than that in
25 the micro-TIG method. In the TIG method, a current and

discharge duration (time period) for the arc discharge is, for example, 120 A and 3 sec. Since in the TIG method an amount of heat is transferred to the object to be welded for a long time period, the large amount of heat is transferred to the pit. As a result, a preferable repair can not be achieved due to, for example, a hole formed in the welded metal layer.

The metal member (tube sheet 8) surrounding the pit is made of, for example, stainless steel, carbon steel, nickel, nickel base alloy or the like. On the other hand, the welding material is, for example, carbon steel, nickel, stainless steel, nickel base alloy or the like.

A thickness of the metal layer formed by conducting the micro-TIG method to the pit within the above ranges of the current and discharge duration is, although it depends on the weld material, generally not smaller than 0.3 mm and not larger than 0.5 mm. However, this step can be conducted with conditions outside the above ranges.

After the metal layer is formed as described above, on the formed metal layer, at least one metal layer is further formed similarly. The number of formation of the metal layers is at least two for the purpose of assuring a certain size in the total thickness of the metal layers, and is at most ten for the purpose of avoiding complexity of this step, although it depends on how many times the

compression step is conducted described below. Fig. 2 (a) shows a cross sectional view after the first welding step in which two metal layers 11 are formed over the pit 9. Fig. 2 (a) shows a case of a flat position welding, but
5 other type welding such as overhead position welding or horizontal welding can be conducted. In other words, an opening direction of the pit is not specifically limited, and may be upward, downward, or sideling.

<Compression step>

10 The compression step is a step for compressing the metal layers formed in the first welding step by applying impact on these metal layers. By conducting the compression step, a part of the laminated metal layers can be moved into the pit portion, and thus it is able to
15 obtain an effect of blocking up the pit.

A compression ratio of the metal layers (i.e. a ratio of a thickness of the metal layers after compression to a thickness of the metal layers before compression) is 50% or less. Thus, it is able to obtain an effect of blocking up
20 the pit, securely. The lower limit of the compression ratio is changeable depending on a kind of the metal, but it is generally 15% considering the relation with the compressed limit of the metal.

A manner of compression of the metal layers is not
25 limited as long as the metal layers are compressed at a

compression ratio of 50% or less. More specifically, such manner may be a compression by applying impact on the metal layer with a hammer or the like. Fig. 2 (b) shows a cross sectional view after the compression step in which the metal layers are compressed. As shown in Fig. 2 (b), a part of the compressed metal layers 11a resulted by compressing the metal layers 11 enters the pit 9.

In general, the micro-TIG method is used in an application where a part of a metal member is broken and the broken part is to be repaired by welding with a metal. Such broken part is welded with a metal to fill the broken part. Then, the welded metal is processed to restore the metal member. That is, the micro-TIG method has not been used for the purpose of repairing an opening such as a pit. And therefore, of course, the formed metal layer is not generally compressed. The compression step is found by the inventor as a result of the study for the purpose of blocking up a pit.

<Second welding step>

In this step, on the compressed metal layers obtained in the compression step, additional metal layers are formed by the micro-TIG method. The micro-TIG method conducted in this step is the same as that described in the first welding step.

As shown in Fig. 2 (c), lamination of the metal layer

11 is conducted more than once. This is preferable since a thickness of the metal layers 11 for reinforcing the pit 9 is increased and therefore the reinforcement becomes strong.

According to this pit repairing process, in the first
5 welding step, the metal layers 11 are formed in a short time by the micro-TIG method, so that its heat is hard to be transferred to the pit 9. Therefore, the metal layers 11 can be formed while preventing the pit 9 from deforming and preventing the heat transfer salt from leaking.
10 Further, in the compression step, the compression of the metal layers 11 can make a part of the metal layers 11 move into the pit 9, so that the pit can be blocked up, strongly. Finally, in the second welding step, the additional metal layers 11 are formed on the compressed metal layers 11a
15 which has been obtained by compressing the former metal layers 11, and therefore the pit 9 can be repaired substantially without deformation.

This pit repairing process is conducted by the first welding step, the compression step, and the second welding
20 step described above. However, it is preferable that following the second welding step, the compression step and the second welding step are sequentially conducted once, additionally. It is more preferable that following the second welding step, the compression step and the second
25 welding step are sequentially conducted twice or more,

additionally. The more additional times of the compression step and the second welding step, the more preferable the process is. In a case of the additional times being about five times, most pits to be repaired can be repaired.

5 In a case where following to the second welding step, the compression step and the second welding step is additionally conducted, the compression step is conducted more than once, and thereby a more amount of the metal is moved into the pit 9, and thus the pit can be blocked up by
10 the more amount of the metal. In addition, since the second welding step is conducted more than once, a thickness of the metal layers 11 is increased, and thus the pit 9 can be repaired more strongly.

15 [Embodiment 2]

A blowhole repairing process of the present invention in one embodiment will be hereinafter described with reference to Fig. 1 and Fig. 2. In this embodiment, its configuration other than those described below is the same
20 as that in Embodiment 1. For the sake of simplicity of explanation, members having the same function as those described in Embodiment 1 are labeled with the same reference signs, and the explanation thereof is omitted.

In this embodiment, to be repaired is a metal member
25 in which a blowhole exists. As shown in Fig. 1, unlike the

pit 9, the blowhole 10 itself is not to be directly repaired since the blowhole 10 exists inside the metal member.

That is, as shown in Fig. 2 (d), in the repairing process of this embodiment, the metal surface 8a of the metal member (tube sheet 8) is an object to be repaired, and the blowhole 10 exists within a distance (distance L) of 2.0 mm from the metal surface 8a. The metal surface 8a may locate so that at least part of it is within 2.0 mm from the blowhole 10.

In the blowhole 10, the inorganic heat transfer salt exists. Whether the blowhole 10 exists at the above location or not can be confirmed by using a radiation transmission test method and observing a film obtained by the test. As a graphic instrument for the test, for example, a gamma-ray irradiation apparatus CTC15A (CXR Corporation, Japan) can be used.

In the repairing process of this embodiment, a plurality of the metal layers 11 is formed on the metal surface 8a by the micro-TIG method. More specifically, as shown in Fig. 2 (e), multiple metal layers 11 are formed on the metal surface 8a similarly to the first welding step of Embodiment 1. The micro-TIG method is a method in which welding is conducted by arc discharge for a short time, and thereby the metal surface 8a can be repaired substantially

without influence on the blowhole 10 and the heat transfer salt.

When the number of formation of the metal layers is at least two, the repair can be attained with a sufficient thickness. On the other hand, the number of formation has preferably the upper limit of ten in view of convenience and workload. If the number of formation is one, there is a risk that the metal surface 8a can not be repaired strongly.

[Embodiment 3]

A pit repairing process of the present invention in one embodiment will be hereinafter described with reference to Fig. 2. In this embodiment, its configuration other than those described below is the same as that in Embodiments 1 and 2. For the sake of simplicity of explanation, members having the same function as those described in Embodiments 1 and 2 are labeled with the same reference signs, and the explanation thereof is omitted.

This Embodiment 3 is a combination of the repairing processes of Embodiment 1 and Embodiment 2. More specifically, as shown in Fig. 2 (f), a pit 9 is formed in the tube sheet 8 by opening to outside of the tube sheet 8. The distance L from the metal surface 8a to the pit 9 is within 2.0 mm similarly to Embodiment 2.

In this embodiment, (1) similarly to the repairing process in Embodiment 2, a plurality of the metal layers 11 is formed on the metal surface 8a by the micro-TIG method. Then, (2) similarly to the repairing process in Embodiment 1, the welding comprising the compression step is conducted for the opening of the pit 9. The order of the above steps (1) and (2) may be inverted. According to this repairing process, with respect to the pit 9 locating at the edge of the tube sheet, it is possible to obtain an advantage in that the pit 9 itself is blocked up while the metal member in the vicinity of the pit 9 is reinforced.

The present invention has been described by the above embodiments. However, the present invention is not limited to these embodiments and can be modified variously within a scope covered by the appended claims. When the technical means disclosed in the different embodiments are combined appropriately to form other embodiments, these embodiments also will fall within the technical scope of the present invention.

Examples

[Example 1]

This example relates to the repairing process of a pit. According to the process shown in Fig. 2 (a) to (c), the repairing was conducted for the pit 9 shown in Fig. 3. The

pit had a depth of 3 mm and a diameter () of 1.2 mm, and the tube sheet 8 had a width of 8 mm along the pit 9. The pit 9 had been filled with powder of NaNO_2 : KNO_3 .

As an apparatus for conducting the micro-TIG method in the first welding step and the second welding step, DY-1000 (Japan Techno Engineering Co., Ltd, Japan) was used with a discharge current of 78 A and a discharge duration of 0.5 sec for conducting the welding once. As a welding material, carbon steel TGS-50 having a diameter (filler diameter) of 0.8 mm (Kobe Steel, Ltd., Japan) was used.

Regarding the pit repairing process, in the first welding step, seven metal layers (each metal layer had a thickness of 0.4 mm) were formed over the opening part of the pit 9; and thereafter in the compression step, the seven metal layers were compressed with a hammer at a compression ratio of 50%. Then, in the second welding step, on the compressed metal layers, additional six metal layers were formed. A cross sectional view of a part around the pit 9 after repair is shown in Fig. 4.

Fig. 4 shows images taken by a digital microscope (Keyence Corporation, Japan).

As shown in Fig. 4, the pit 9 was completely blocked up, and leakage of the inorganic heat transfer salt was not observed. Thus, it was understood that good pit repair was attained.

[Example 2]

Regarding the pit repairing process, in the first welding process, two metal layers were formed over the opening part of the pit 9; and thereafter in the compression step, the two metal layers were compressed with a hammer at a compression ratio of 50%. Then, in the second welding step, on the compressed metal layers, additional two metal layers were formed.

Following the above, the compression step (compression of the metal layers at a compression ratio of 50%) and the second welding step (formation of two metal layers) both of which were similar to the above steps were conducted once; and the compression step (compression of the metal layers at a compression ratio of 50%) which was similar to the above step and a second welding step in which on the compressed metal layers, additional three metal layers were formed were conducted. That is, the first welding step was conducted once (formation of two metal layers); the compression step was conducted three times; and the second welding step was conducted three times (formations of two metal layers, two metal layers, and three metal layers). A cross sectional view of a part around the pit after repair is shown in Fig. 4 similarly to Example 1.

As shown in Fig. 4, the pit was completely blocked up,

and leakage of the inorganic heat transfer salt was not observed. Further, the metal layers were formed with a larger thickness than that in Example 1, and thus it was understood that very good pit repair was attained.

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[Example 3]

This example relates to the repairing process of a metal member in which a blowhole exists. According to the process shown in Fig. 2 (d) to (e), on the metal surface 8a of the tube sheet 8 (metal member) in which the blowhole 10 exists shown in Fig. 3 (b), two metal layers were formed by the micro-TIG method with the same conditions as those in the first welding step of Example 1. As shown in Fig. 3 (b), metal welding 12 had been formed at the both ends of the blowhole 10 so that the blowhole 10 was formed. The blowhole 10 had been filled with powder of NaNO_2 : KNO_3 .

Similarly to Example 1, a cross sectional view of a part around the blowhole 10 after repair is shown in Fig. 5. In Fig. 5, the blowhole 10 has a round shape since the cylindrical blowhole 10 is shown from a direction along its central axis.

As shown in Fig. 5, in this example the welding was conducted by the micro-TIG method, so that its heat was hard to be transferred to the blowhole 10. Therefore, it was understood that repair of the metal member including

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the blowhole was attained while the shape of the blowhole 10 was not substantially deformed.

[Example 4]

5 This embodiment relates to the repairing process of a pit. An object to be repaired was the tube sheet 8 (metal member) having the pit 9 shown in Fig. 3 (c) in which the metal welding 12 had been formed at one end of the pit, unlike the blowhole 10 in Fig. 3 (b) in which the metal
10 welding 12 was formed at the both ends of the blowhole 10. Other configuration was same as the case shown in Fig. 3 (b).

 The repair by welding was conducted for the metal surface 8a of this tube sheet 8 similarly to Example 3.
15 The repair was attained while the shape of the pit was not substantially deformed, similarly to Example 3.

[Comparative Example 1]

 The pit 9 was repaired similarly to Example 1 except
20 that three metal layers were formed over the pit to block up the pit in the first welding step, thereafter the compression step was omitted, and on the metal layers formed in the first welding step, additional three metal layers were formed in the second welding step. Similarly
25 to Example 1, a cross sectional view of a part around the

pit 9 after repair is shown in Fig. 6.

As shown in Fig. 6, even though the metal layers 11 were formed over the pit 9, the pit 9 was moved into the formed metal layers 11 since the compression step was not
5 conducted in Comparative Example 1. That is, good repair of the pit 9 was not attained.

[Comparative Example 2]

The pit 9 was repaired similarly to Example 1 except
10 that three metal layers were formed over the pit to block up the pit in the first welding step, thereafter the compression step was omitted, and on the metal layers formed in the first welding step, additional six metal layers were formed in the second welding step. That is, a
15 different point from Comparative Example 1 was in that the number of formation of the metal layers in the second welding step was changed to six. Similarly to Example 1, a cross sectional view of a part around the pit 9 after repair is shown in Fig. 6.

20 As shown in Fig. 6, the pit 9 was blocked up more than the case of Comparative Example 1 since the number of formation of the metal layers in the second welding step was increased from Comparative Example 1. However, it was observed that a part of the pit 9 existed as a hole in an
25 upper part of the metal layers 11. When the hole exists in

this manner, crack or the like is easily generated in the metal layers 11. Thus, good repair of the pit was not attained.

5 [Comparative Example 3]

The blowhole was welded similarly to Example 3 except that the micro-TIG method used in Example 3 was replaced by a TIG method. In the TIG method, its conditions were a current of 110 A and a welding duration of 3 sec for
10 conducting the welding once. As a welding material, carbon steel TGS-50 having a diameter (filler diameter) of 0.8 mm (Kobe Steel, Ltd., Japan) was used. The two metal layers 11 were formed on the metal surface 8a.

Similarly to Example 1, a cross sectional view of a
15 part around the blowhole 10 after repair is shown in Fig. 5. As shown in Fig. 5, in this comparative example the welding was conducted by the TIG method, so that its heat was easily transferred to the blowhole 10. It was observed that the blowhole 10 was deformed and expanded. As a
20 result, the blowhole 10 came to exist in the metal layers 11, an effective welding thickness was not obtained, and good repair was not attained.

Industrial Applicability

25 The present invention can be used for repairing a

reactor which uses a heat transfer salt, and therefore the present invention can be utilized for a chemical plant and so on using the reactor.

5 The present application claims priority to Japanese Patent Application No. 2009-209219 filed on September 10, 2009, entitled "PROCESS FOR REPAIRING PIT AND PROCESS FOR REPAIRING METAL MEMBER." The contents of that application are incorporated herein by the reference thereto in their
10 entirety.

Claims

1. A process for repairing a pit which has formed on or through a metal member and comprises a heat transfer salt therein, which process comprises

5 a first welding step for forming a plurality of metal layers over the pit by a micro-TIG method in which welding is conducted by arc discharge to a welding material,

a compression step for compressing the formed metal layers by applying impact on the metal layers so that a
10 thickness of the metal layers is compressed at a compression ratio of 50% or less, and thereafter

a second welding step for forming a plurality of additional metal layers on the compressed metal layers by the micro-TIG method.

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2. The process according to claim 1, wherein following said second welding step, the compression step and the second welding step are sequentially conducted twice or more.

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3. A process for repairing a metal member in which a blowhole comprising a heat transfer salt therein is formed, which process comprises

forming a plurality of metal layers on a surface of
25 the metal member which is located within a distance of 2.0

mm from the blowhole by a micro-TIG method in which welding is conducted by arc discharge to a welding material.