

Specification

NAME OF INVENTION : A method for producing a three-layer coated metal tube

TECHNICAL FIELD

[0001]

The present invention relates to a method for producing a three-layer coated metal tube on which an epoxy resin layer, an adhesive layer and a polyolefin resin layer is laminated in this order.

BACKGROUND ART

[0002]

Conventionally, steel tubes used for steel structures used in sea areas and steel tubes used for pipelines to be laid under severe environments such as cold regions are required corrosion resistance and impact resistance. As a steel tube satisfying such a demand, a three-layer coated metal tube, on whose outer peripheral surface an epoxy resin layer, an adhesive layer and a polyolefin resin layer is laminated and coated, is used, and various methods for producing thereof have been proposed.

[0003]

For example, in Patent Document 1, a three layer coating is formed on a surface of a steel tube, by coextruding a polyolefin resin and a modified polyolefin resin in a strip from respective extruders through T-dies, and by forming an adhesive layer and a polyolefin resin layer on a rotating steel tube, after coating an epoxy powder coating material on the steel tube.

However, this method has a disadvantage that it cannot be applied to a curved tube because it forms layers while rotating a steel tube.

[0004]

In Patent Document 2, a three layer coating is formed on a surface of a steel tube, by fusing a polyolefin molding having a polyolefin adhesive layer and a polyolefin layer on the steel tube, after forming an epoxy primer layer on the outer surface of the steel tube. The polyolefin molding in Patent Document 2 has a sheet shape or a panel shape.

[0005]

In Patent Document 3, a three layer coating is formed on a curved metal tube by first forming an incompletely cured fixing layer of a reaction curable epoxy resin on the outer peripheral surface of a curved metal tube, then forming a temporary combined multi layer coating in which a thin film layer of a hot melt adhesive and a thick film layer of polyolefin are arranged in a contacted state on the fixing layer, and thereafter performing inductive heating against a curved metal tube under the coating.

In Patent Document 3, as methods of forming a thick film layer of polyolefin on a curved tube, a method of wrapping a polyolefin tape like a bandage, a method by thermal spraying, a method of loosely fitting multiple short tubes made of polyolefin in a state of temporarily expanding the diameter and closely fitting by restoring to the original diameter, and a method of integrating by welding and jointing the end portions of curved tubular molded body segments made of polyolefin divided into multiple segments, are described.

[0006]

In a method using a sheet or a tape, described in Patent Document 2 or Patent Document 3, it is necessary to pay close attention to prevent contamination of bubbles, and it is also difficult to control the thickness of the polyolefin resin layer. Also, in the case of a method by thermal spraying, it is not possible to thicken a polyolefin resin layer.

In addition, in a method using multiple short tubes and a method using curved tubular molded body segments, the thickness of a joint part of short tubes or segments differs from that of other parts, and there is a case in which failure is caused.

[0007]

Besides, it is described in Patent Document 3 that forming of three layer coating using powder coating is theoretically possible but practical application of that is difficult.

[0008]

Three-layer coated metal tubes are expected to be used under various conditions, and it is desirable to develop a method that enables production of three-layer coated metal tubes according to the conditions of use, with high productivity.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0009]

Patent Document 1: JP 2006-247887 A

Patent Document 2: JP 2017-177458 A

Patent Document 3: JP 2004-130669 A

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0010]

The present invention has been accomplished in view of the above-mentioned background art. A problem to be solved by the present invention is to provide a method for producing a three-layer coated metal tube with large adhesion strength and high reliability with high productivity, and to provide a three-layer coated metal tube produced by such a method.

MEANS FOR SOLVING THE PROBLEMS

[0011]

As a result of extensive studies to solve the above problems, the present inventor has found the following and has completed the present invention. It is possible to produce a three-layer coated metal tube with large adhesion strength and high reliability even when the three layers are all formed by powder painting, by preheating a metal tube at specified temperature before forming an epoxy resin layer and by heating (reheating) the metal tube at a higher temperature after application of the epoxy resin layer and an adhesive layer, that is, by heating the metal tube in two stages.

[0012]

That is, the present invention is directed to a method for producing a three-layer coated metal tube which is made by laminating an epoxy resin layer, an adhesive layer and a polyolefin resin layer is laminated in this order on an outer peripheral surface of the metal tube, wherein the epoxy resin layer, the adhesive layer and the polyolefin resin layer are formed by powder coating, wherein the following step (1) to step (5) are performed in this order.

[0013]

- (1) a step of heating the metal tube to a temperature equal to or greater than a glass-transition point (T_g) of the epoxy resin which is a material of the epoxy resin layer, and equal to or less than a crosslinking-reaction temperature of the epoxy resin
- (2) a step of forming a coating film of the epoxy resin on the outer peripheral surface of the metal tube by electrostatic coating method or fluidized immersion method
- (3) a step of forming a coating film of a hot melt adhesive by electrostatic coating method or fluidized immersion method on the coating film of the epoxy resin which is in a semi-molten state

(4) a step of heating the metal tube at a temperature greater than that in step (1)
(5) a step of forming a coating film of a polyolefin resin on the coating film of the hot melt adhesive

[0014]

Further, the present invention is directed to the above-mentioned method for producing a three-layer coated metal tube, wherein the step (5) is performed by electrostatic coating method or fluidized immersion method, and the following step (6) is performed after the step (5).

[0015]

(6) a step of heating the metal tube

[0016]

Further, the present invention is directed to the above-mentioned method for producing a three-layer coated metal tube, wherein the following step (7) is performed one or more times after the step (6).

[0017]

(7) a step of further coating a polyolefin resin on the top layer of the coating film of the polyolefin resin on the outer peripheral surface of the metal tube by electrostatic coating method or fluidized immersion method in order to thickening the coating film of the polyolefin resin, and subsequently heating the metal tube

EFFECTS OF THE INVENTION

[0018]

According to the present invention, a three-layer coated metal tube with large adhesion strength and high reliability can be produced with high productivity.

[0019]

In the present invention, the preheating temperature of the metal tube before forming an epoxy resin layer is less than the degradation temperature of an epoxy resin, and degradation of the epoxy resin layer does not occur.

Hence, the metal tube produced by the method of the present invention has excellent corrosion resistance.

[0020]

In the present invention, after the epoxy resin is applied in a semi-molten state, a hot melt adhesive is immediately applied. That is, the open time between application of the first layer and application of the second layer can be made to be substantially zero. Therefore, in the present invention, not only productivity is improved, adhesivity of the adhesive layer is also improved, thus it is possible to produce a three-layer coated metal tube with high reliability can be produced.

[0021]

In the present invention, after application of the first layer and the second layer, the first layer, preferably the first layer and the second layer are cured in the step (4). Thus, it is not necessary to heat the metal tube more than necessary before application of the first layer. Therefore, in the present invention, degradation of the epoxy resin, which is a material of the first layer, hardly occurs.

For example, using powder coating, in order to form a polyolefin resin, which is a material of the third layer, with a sufficient thickness, it is necessary that the temperature of the metal tube is about 250°C. When applying the third layer at such a temperature, the temperature of the metal tube before application of the first layer needs to be set to about 320°C, which causes degradation of the epoxy resin. Therefore, in Patent Document 3, it is said that practical application of the three layer coating by powder coating is difficult.

In the present invention, since the metal tube is heated stepwise, it is possible to prevent degradation of the epoxy resin due to excessive heating of the metal tube.

[0022]

In the present invention, since the polyolefin resin layer, which is the top layer, is formed by powder coating, a problem of generation of bubbles found in methods using a sheet or a tape, as in Patent Document 2 or Patent Document 3, does not occur.

[0023]

The method of the present invention has a step of heating (reheating) a metal tube before forming a polyolefin resin layer, which is the top layer. Therefore, it is easy to control the thickness of the polyolefin resin layer as compared with a method of forming the polyolefin resin layer only by preheating at a stage before application of an epoxy resin, as in Patent Document 3. In particular, in the present invention, since the polyolefin resin layer can be coated over by multiple times, it is possible to produce a three-layer coated metal tube having a thick polyolefin resin layer.

[0024]

In the present invention, in the stage where application of materials of an epoxy resin layer, i.e. the first layer and an adhesive layer, i.e. the second layer have complete (in the stage before a metal tube is heated (reheated) at a high temperature), the crosslinking reaction of the epoxy resin does not proceed. Therefore, a metal tube in a state in which an epoxy resin is applied or in a state in which an epoxy resin and a hot melt adhesive are applied, can be stored, and forming of a polyolefin resin layer, i.e. the third layer can be separately performed, for example, at another place.

[0025]

In the present invention, the metal tube can be uniformly heated by inductive heating, rather than mobile heating as in Patent Document 3. Therefore, in the present invention, it is possible to make adhesivity of the entire metal tube uniform.

[0026]

In the present invention, since it is not necessary to rotate a metal tube at the time of forming a coating film, the present invention can be applied to a metal tube which is a curved tube.

BRIEF DESCRIPTION OF DRAWINGS

[0027]

[Figure 1] Figure 1 is a schematic diagram showing the structure of a three-layer coated metal tube produced according to a method for producing a three-layer coated metal tube of the present invention.

[Figure 2] Figure 2 is a schematic diagram showing the structure of a three-layer coated metal tube produced according to a method for producing a three-layer coated metal tube of the present invention (when a polyolefin resin layer is formed by multiple times).

EMBODIMENTS TO CARRY OUT THE INVENTION

[0028]

In the following, the present invention is explained, but the present invention is not limited by the following specific embodiments, and can be optionally changed.

[0029]

A schematic diagram of a three-layer coated metal tube produced according to the present invention is shown in Figures 1 and 2. In the present invention, a three-layer coated metal tube 1 is produced by laminating an epoxy resin layer 11, an adhesive layer 12 and a polyolefin resin layer 13 in this order on an outer peripheral surface 10S of the metal tube 10. In the present invention, the epoxy resin layer 11, the adhesive layer 12, and the polyolefin resin layer 13 are all formed by powder coating.

[0030]

In the present invention, the polyolefin resin layer

13 of the top layer of the three-layer coated metal tube 1, can be formed by multiple times. For example, in Figure 2, an example that a polyolefin resin layer 13A and a polyolefin resin layer 13B are formed by two times, is shown.

[0031]

As a metal tube 10 of the present invention, an electrical stitching steel tube, a forged-joined steel tube, a seamless steel tube, a spiral steel tube, a UOE steel tube, or the like can be exemplified, but it is not limited thereto.

[0032]

Further, for example, a method for forming a coating film while rotating a metal tube, as shown in Patent Document 1, cannot be applied to a curved tube. Thus, the feature of the present invention that all layers are formed by powder painting, is more likely to be utilized when the metal tube 10 is a curved tube. However, when the metal tube 10 is a straight tube, it is not beyond the scope of the present invention.

[0033]

In the present invention, since the epoxy resin layer 11, the adhesive layer 12, and the polyolefin resin layer 13 are all formed by powder coating, problems such as contamination of bubbles hardly occur, and uniformity of the respective layers is easily secured.

[0034]

The epoxy resin layer 11 is formed using a powder epoxy resin as a material. As the epoxy resin, a commercially available powder epoxy resin can be used appropriately. By establishing an epoxy resin layer 11, corrosion resistance of a metal tube can be enhanced.

[0035]

As an epoxy resin which is a material of the epoxy resin layer 11, a bisphenol A type epoxy resin, a bisphenol F type epoxy resin, an o-cresol novolac type

epoxy resin, or the like can be exemplified.

[0036]

The average thickness of the epoxy resin layer 11 is preferably equal to or greater than 50 μ m, more preferably equal to or greater than 70 μ m, and particularly preferably equal to or greater than 100 μ m. Besides, the average thickness is preferably equal to or less than 1000 μ m, more preferably equal to or less than 500 μ m, and particularly preferably equal to or less than 300 μ m.

When the average thickness is within the above range, corrosion resistance is sufficiently exhibited and it is easy to suppress the cost.

[0037]

The polyolefin resin layer 13 is established for the purpose of enhancing impact resistance, or the like. The polyolefin resin layer 13 is formed using a polyolefin resin as a material.

[0038]

There is no particular limitation on the polyolefin resin, and a low-density polyethylene resin, a medium-density polyethylene resin, a high-density polyethylene resin, a polypropylene resin, a polybutene resin, a polyethylene-propylene copolymer resin, or the like can be exemplified.

One type of them may be used alone, or two or more type thereof may be used.

[0039]

The average thickness of the polyolefin resin layer 13 is preferably equal to or greater than 0.1mm, more preferably equal to or greater than 0.3mm, and particularly preferably equal to or greater than 0.5mm. Besides, the average thickness is preferably equal to or less than 10mm, more preferably equal to or less than 7mm, and particularly preferably equal to or less than 5mm.

When the average thickness is equal to or greater than the above lower limit, sufficient impact resistance

can be exerted. When the average thickness is equal to or less than the above lower limit, it is advantageous in terms of cost.

[0040]

The average thickness of the polyolefin resin layer 13 is usually appropriately selected according to the required protective property within the above range. In the present invention, it is easy to form the polyolefin resin layer 13 with a uniform thickness, and it is also easy to control the thickness. Further, in the present invention, it is also possible to form the polyolefin resin layer over by multiple times. The present invention is suitable for producing a three-layer coated metal tube 1 having a polyolefin resin layer 13 having a thickness near the above upper limit (i.e. a large thickness).

[0041]

An adhesive layer 12 is established to improve adhesiveness between the epoxy resin layer 11 and the polyolefin resin layer 13. The adhesive layer 12 is formed using a hot melt adhesive as a material. The hot melt adhesive has the property of bonding well to both an epoxy resin and a polyolefin resin.

[0042]

There is no particular limitation on the hot melt adhesive as long as it has the above property, and a modified polyolefin resin obtained by modifying a polyolefin resin with an acid anhydride such as maleic anhydride, copolymer of an olefin and another monomer, or the like can be exemplified. Examples of the latter include an ethylene-maleic anhydride copolymer, an ethylene-maleic anhydride-acrylic ester copolymer, an ethylene-acrylic acid copolymer (EAA), an ethylene-methacrylic acid copolymer (EMAA), an ethylene-vinyl acetate copolymer (EVA), an ethylene-acrylic acid ester copolymer, or the like.

One type of them may be used alone, or two or more

type thereof may be used.

[0043]

The average thickness of the adhesive layer 12 is preferably equal to or greater than 50 μ m, more preferably equal to or greater than 70 μ m, and particularly preferably equal to or greater than 100 μ m. Besides, the average thickness is preferably equal to or less than 400 μ m, more preferably equal to or less than 300 μ m, and particularly preferably equal to or less than 200 μ m.

When the average thickness is within the above range, adhesiveness is sufficiently exhibited and it is easy to suppress the cost.

[0044]

In the present invention, a three-layer coated metal tube 1 is produced by performing the following step (1) to step (5) in this order. In the present invention, the following step (6) and step (7) and other steps may be performed, if necessary.

[0045]

<step (1)>

In the step (1), a metal tube is heated to a temperature equal to or greater than a glass-transition point (Tg1) of the epoxy resin which is a material of the epoxy resin layer, and equal to or less than a crosslinking-reaction temperature of the epoxy resin.

[0046]

The step (1) is a step of preheating the metal tube 10 in order to form the epoxy resin layer 11, i.e. the first layer, and the adhesive layer 12, i.e. the second layer on the metal tube.

The heating temperature of the metal tube 10 in the step (1) is equal to or greater than a glass-transition point (Tg1) of the epoxy resin, and equal to or less than a crosslinking-reaction temperature of the epoxy resin. That is, the temperature is such that in the next step (2) when the epoxy resin is applied to the metal tube 10, the

epoxy resin becomes a semi-molten state.

[0047]

In the step (1), since the metal tube 10 is preheated in such a temperature range, in step (3) which is described later, a hot melt adhesive can be applied on the coating film of the epoxy resin which is in a semi-molten state, and adhesivity between the first layer (the epoxy resin layer 11) and the second layer (the adhesive layer 12) improves.

[0048]

If, without performing the step (1), application of the epoxy resin (step (2)) and application of the hot melt adhesive (step (3)) are performed, due to electrostatic repulsion, the second layer (the adhesive layer 12) may peel off.

Further, as described in Patent Document 3, anticipating the step of application of a polyolefin resin and heating the metal tube 10 at a high temperature of about 320 °C in a stage before application of an epoxy resin, degradation of the epoxy resin occurs. In contrast, in the heating temperature in the step (1) of the present invention, degradation of the epoxy resin does not occur.

That is, in the present invention, since the step (1) is performed, failure such as peeling of the first layer (the epoxy resin layer 11) and the second layer (the adhesive layer 12) hardly occur.

[0049]

Note that, "the temperature equal to or less than a crosslinking-reaction temperature of the epoxy resin" refers to the temperature range in which the epoxy resin is not completely cured by crosslinking and is kept in a semi-molten state. Even if crosslinking-reaction has been partially started, the temperature in which the epoxy resin is kept in a semi-molten state corresponds to "the temperature equal to or less than a crosslinking-reaction

temperature of the epoxy resin".

[0050]

The heating temperature suitable for performing the step (1) differs depending on the type of the epoxy resin to be used, or the like. The heating temperature in the step (1) is preferably equal to or greater than 60°C, more preferably equal to or greater than 70°C, and particularly preferably equal to or greater than 80°C. Besides, the heating temperature is preferably equal to or less than 140°C, more preferably equal to or less than 120°C, and particularly preferably equal to or less than 100°C.

[0051]

In the step (1), there is no particular limitation on a specific method for heating the metal tube 10 to a predetermined temperature. A method of feeding in a furnace and heating, a method of performing inductive heating, a method by gas burner, or the like can be exemplified.

In terms of uniformity, the method of performing inductive heating is particularly desirable.

[0052]

<step (2)>

In the step (2), a coating film of an epoxy resin is formed on the outer peripheral surface 10S of a metal tube 10 by electrostatic coating method or fluidized immersion method.

It is desirable that the step (2) is performed immediately after the temperature of the metal tube 10 becomes the above temperature range in step (1).

[0053]

In the step (2), the epoxy resin applied on the metal tube 10 heated in the above temperature range becomes in a semi-molten state.

[0054]

In the step (2), the coating film of the epoxy resin is formed by electrostatic coating method or fluidized

immersion method. It is not desirable to apply thermal spraying method in the step (2), because it markedly increases the temperature of the metal tube, and, for example, disadvantages of the conventional method are exposed.

[0055]

<step (3)>

In the step (3), a coating film of a hot melt adhesive is formed by electrostatic coating method or fluidized immersion method on the coating film of the epoxy resin which is in a semi-molten state.

[0056]

It is desirable that the step (3) is performed immediately after completion of step (2) from the viewpoint of productivity and from the viewpoint of quality of the three-layer coated metal tube 1.

[0057]

In the step (3), a coating film of a hot melt adhesive is formed by electrostatic coating method or fluidized immersion method. As same as the case of the step (2), it is not desirable to apply thermal spraying method in the step (3), because it markedly increases the temperature of the metal tube.

[0058]

Since a hot melt adhesive is used in order to bond the epoxy resin and the polyolefin resin, it is not necessary to thicken the adhesive layer 12 formed by the hot melt adhesive. Therefore, it is desirable that the step (3) is performed by electrostatic coating method from the viewpoint of productivity.

[0059]

When the step (1) to step (3) is performed, a coating film of an uncured epoxy resin and a coating film of a hot melt adhesive are applied on the metal tube 10.

In the present invention, the metal tube 10 can be stored in a state in which steps up to the step (3) is

performed. For example, steps from the step (4) can be performed after transfer to a different location.

[0060]

<step (4)>

In the step (4), the metal tube 10 is heated at a temperature greater than that in step (1).

[0061]

The step (4) is a step of heating the metal tube 10 in order to cure the coating film of the epoxy resin formed in step (2).

In addition, heating in the step (4) also has as a role of preheating in order to enable powder coating of a coating film of a polyolefin resin with a sufficient thickness in the next step (5).

[0062]

In order to fulfill the above two roles, the heating temperature in the step (4) is necessary to be higher than the heating temperature in the step (1).

Meanwhile, in order to prevent degradation of the epoxy resin, the heating temperature in the step (4) is necessary not to be too high.

[0063]

The heating temperature in the step (4) depends on the type of the epoxy resin to be used. The heating temperature is preferably equal to or greater than 200°C, more preferably equal to or greater than 210°C, and particularly preferably equal to or greater than 220°C. Besides, the heating temperature is preferably equal to or less than 300°C, more preferably equal to or less than 290°C, and particularly preferably equal to or less than 280°C.

If the heating temperature is less than the above lower limit, the epoxy resin may not cure sufficiently. On the other hand, if the heating temperature is greater than the above upper limit, degradation of the epoxy resin may proceed.

[0064]

In the step (4), there is no particular limitation on a specific method for heating the metal tube 10 to a predetermined temperature. A method of feeding in a furnace and heating, a method of performing inductive heating, a method by gas burner, or the like can be exemplified.

In terms of uniformity, the method of performing inductive heating is particularly desirable.

[0065]

<step (5)>

In the step (5), a coating film of a polyolefin resin is formed on the coating film of the hot melt adhesive.

It is desirable that the step (5) is performed immediately after the temperature of the metal tube 10 becomes the above temperature range in step (4).

[0066]

In the step (5), a method for forming a coating film of the polyolefin resin is not particularly limited as long as it is a method belonging to powder coating. For example, electrostatic coating method, fluidized immersion method, thermal spraying method, or the like can be exemplified.

[0067]

From the viewpoint of uniformity of the thickness of the polyolefin resin layer 13, cost, and the like, an electrostatic coating method or fluidized immersion method is desirable, and fluidized immersion method is particularly desirable.

In addition, depending on the required protective property, there is a demand for forming a polyolefin resin layer 13 thick. Thermal spraying method is unsuitable for forming a thick film. Therefore, when a thick polyolefin resin layer 13 is to be preferred, electrostatic coating method or fluidized immersion method is desired.

[0068]

<step (6)>

The step (6) is performed after step (5), if necessary. The step (6) is a step of heating the metal tube 10.

The step (6) is required when the step (5) is performed by electrostatic coating method or fluidized immersion method.

[0069]

When the step (5) is performed by electrostatic coating method or fluidized immersion method, heating of the metal tube 10 is required.

On the other hand, when the step (5) is performed by thermal spraying method, the temperature of the metal tube 10 increases sufficiently, therefore it is not necessary to perform the step (6).

[0070]

The heating temperature in the step (6) depends on the type of the polyolefin resin to be used. The heating temperature is preferably equal to or greater than 200°C, and particularly preferably equal to or greater than 220°C. Besides, the heating temperature is preferably equal to or less than 300°C, and particularly preferably equal to or less than 260°C.

[0071]

In the step (6), there is no particular limitation on a specific method for heating the metal tube 10 to a predetermined temperature. A method of feeding in a furnace and heating, a method of performing inductive heating, a method of passing vapor inside the metal tube, or the like can be exemplified.

In terms of uniformity and productivity, the method of performing inductive heating is particularly desirable.

[0072]

<step (7)>

When the step (5) is performed by electrostatic

coating method or fluidized immersion method, the step (7) is performed one or more times after step (6), if necessary. The step (7) is a step of further coating a polyolefin resin on the top layer of the coating film of the polyolefin resin on the outer peripheral surface 10S of the metal tube 10 by electrostatic coating method or fluidized immersion method in order to thickening the coating film of the polyolefin resin, and subsequently heating the metal tube.

[0073]

When the step (7) is performed, the polyolefin resin layer 13 is formed by coating over by multiple times. For example, Figure 2 is a schematic diagram when the step (7) is performed one time. Among the polyolefin resin layers 13, the portion which originates from the coating film of the polyolefin resin formed in a step (5) is 13A, and the portion which originates from the coating film of the polyolefin resin formed in a step (7) is 13B.

[0074]

By performing step (7), the polyolefin resin layer 13 is thickened by the portion of 13B. Therefore, a three-layer coated metal tube 1 having a thick polyolefin resin layer 13 can be easily produced, and it is possible to meet the demand of such a three-layer coated metal tube 1.

[0075]

The preferred range of the heating temperature in the step (7) is similar to the preferred range of the heating temperature in the step (6).

[0076]

In the step (6), there is no particular limitation on a specific method for heating the metal tube 10 to a predetermined temperature. A method of feeding in a furnace and heating, a method of performing inductive heating, a method of passing vapor inside the metal tube, or the like can be exemplified.

[0077]

The step (7) may be performed two or more times. That is, 13C, 13D, ... (not shown in Figures) may be exist on top of 13B in Figure 2.

[0078]

In the present invention, there are multiple steps of heating the metal tube 10 (the step (1), the step (4), the step (6) and the step (7)). The heating method in each step may be the same or different. At least, since the step (4), the step (6) and the step (7) are usually performed continuously, it is desirable to be the same.

Further, in the present invention, it is desirable that the metal tube 10 is uniformly heated by inductive heating in the step of heating the metal tube 10.

INDUSTRIAL APPLICABILITY

[0079]

A three-layer coated metal tube produced by the method of the present invention has large adhesion strength and high reliability, control of the thickness of a polyolefin resin layer which is the top layer is easy, and thickening of the polyolefin resin layer is possible. A three-layer coated metal tube produced by the method of the present invention can be widely used as a gas tube, a water tube, a cable protection tube, or the like.

REFERENCE SIGNS LIST

[0080]

1 : three-layer coated metal tube
10 : metal tube
10S : outer peripheral surface
11 : epoxy resin layer
12 : adhesive layer
13 : polyolefin resin layer
13A : polyolefin resin layer
13B : polyolefin resin layer

Claims

1. A method for producing a three-layer coated metal tube which is made by laminating an epoxy resin layer, an adhesive layer and a polyolefin resin layer is laminated in this order on an outer peripheral surface of the metal tube, wherein the epoxy resin layer, the adhesive layer and the polyolefin resin layer are formed by powder coating, wherein the following step (1) to step (5) are performed in this order.

(1) a step of heating the metal tube to a temperature equal to or greater than a glass-transition point (T_g1) of the epoxy resin which is a material of the epoxy resin layer, and equal to or less than a crosslinking-reaction temperature of the epoxy resin

(2) a step of forming a coating film of the epoxy resin on the outer peripheral surface of the metal tube by electrostatic coating method or fluidized immersion method

(3) a step of forming a coating film of a hot melt adhesive by electrostatic coating method or fluidized immersion method on the coating film of the epoxy resin which is in a semi-molten state

(4) a step of heating the metal tube at a temperature greater than that in step (1)

(5) a step of forming a coating film of a polyolefin resin on the coating film of the hot melt adhesive

2. A method for producing a three-layer coated metal tube according to Claim 1, wherein the step (3) is performed immediately after completion of step (2).

3. A method for producing a three-layer coated metal tube according to Claim 1 or 2, wherein the metal tube is uniformly heated by inductive heating in the step of heating the metal tube.

4. A method for producing a three-layer coated metal tube according to any of Claims 1 to 3, wherein the heating temperature in the step (1) is equal to or greater than 60°C and equal to or less than 140°C.

5. A method for producing a three-layer coated metal tube according to any of Claims 1 to 4, wherein the heating temperature in the step (4) is equal to or greater than 200°C and equal to or less than 300°C.

6. A method for producing a three-layer coated metal tube according to any of Claims 1 to 5, wherein the step (5) is performed by electrostatic coating method or fluidized immersion method, and the following step (6) is performed after the step (5).

(6) a step of heating the metal tube

7. A method for producing a three-layer coated metal tube according to Claim 6, wherein the following step (7) is performed one or more times after the step (6).

(7) a step of further coating a polyolefin resin on the top layer of the coating film of the polyolefin resin on the outer peripheral surface of the metal tube by electrostatic coating method or fluidized immersion method in order to thickening the coating film of the polyolefin resin, and subsequently heating the metal tube

8. A method for producing a three-layer coated metal tube according to any of Claims 1 to 7, wherein the average thickness of the polyolefin resin layer is equal to or greater than 0.1mm and equal to or less than 10mm.