METAL-RESIN COMPOSITE PIPE THAT CAN BE EASILY WOUND INTO RING SHAPE AND METHODS FOR MANUFACTURING THE SAME

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The present invention may manufacture a composite pipe by forming an adhesive layer and a resin layer on an outer surface of a metal pipe, and although the composite pipe is wound in a ring shape after the composite pipe is manufactured, a circular cross sectional shape may be maintained without deformation, and after the composite pipe is straightened for the purpose of construction, separation or buckling may be prevented, resulting in excellent transportability and constructability of a product.
METAL-RESIN COMPOSITE PIPE THAT CAN BE EASILY WOUND INTO RING SHAPE AND, METHODS FOR MANUFACTURING THE SAME

TECHNICAL FIELD

[0001] The present invention relates to a metal resin composite pipe, and more particularly, to a metal resin composite pipe that can be wound in a ring shape without deformation of a circular shape of a cross section of the pipe and may be manufactured with a long length to provide excellent transportability and constructability. Also, the present invention relates to a method of manufacturing the metal resin composite pipe.

BACKGROUND ART

[0002] Generally, a high corrosion resistant metal pipe such as a stainless steel pipe has many advantages, but has a high unit cost of production resulting from use of a high priced material such as stainless steel, and has many difficulties in construction due to forming limitations in bending etc., and can be made straight only.

[0003] Also, a metal pipe manufactured in a straight shape has predetermined lengths for delivery, and an operation of connecting the metal pipes in a construction site requires considerable amounts of components, manpower, and time.

[0004] Also, when a metal pipe is buried in the ground, the metal pipe is inevitably susceptible to soil corrosion and electric corrosion etc.

[0005] Meanwhile, a resin pipe has a high corrosion resistance, a light weight, good constructability, and a low cost, but has a leakage risk due to separation of a connected portion caused by contraction and expansion with temperature changes and is vulnerable to pressure. Meanwhile, when manufacturing a resin pipe, extrusion is performed with an outer diameter of a resin pipe being slightly greater than a desired outer diameter, and the outer diameter is reduced through a sizing process during cooling to meet the density and surface requirements.

[0006] A metal resin composite pipe includes, as shown in FIGS. 1 and 2, a metal pipe 1 and a resin layer 5 formed on an outer surface of the metal pipe 1. A configuration and a manufacturing method of this metal resin composite pipe 10 is disclosed in Korean Patent No. 10-1994185.

[0007] The metal pipe 1 has a direct contact with a fluid flowing therethrough, and is made from a thin plate metal such as, for example, stainless steel, and thus has a high corrosion resistance. The resin layer 5 surrounds the metal pipe 1, and a thickness of the resin layer 5 is even greater than a thickness of the metal pipe 1. The resin layer 5 is made from a resin having a high corrosion resistance and a low cost. Accordingly, the metal resin composite pipe 10 has advantages of a high corrosion resistance to a fluid flowing therethrough, a high corrosion resistance to soils, and a low cost.

[0008] However, to deliver the metal resin composite pipe 10 to a construction site after manufacturing the metal resin composite pipe 10, the metal resin composite pipe 10 needs to be produced into a straight pipe having a predetermined length for the convenience of delivery, similar to a metal pipe. However, to use a straight pipe in a construction site, connecting the composite pipe 10 is required, and this connection operation involves considerable amounts of components, manpower, and time.

[0009] Accordingly, there is a need to manufacture the metal resin composite pipe 10 with a longer length while improving delivery performance.

[0010] To solve this problem, there was a need for production and supply of the metal resin composite pipe 10 by winding the metal resin composite pipe 10 circularly on a winder.

[0011] However, it is almost impossible to manufacture the metal pipe or the metal resin composite pipe 10 by winding in a ring shape due to characteristics of a material. To produce a pipe wound in a ring shape, development of a technique for winding the pipe while maintaining a circular cross section of the pipe is critical. Further, in view of storage and transportation of a product, minimizing the radius of curvature as much as possible while maintaining the circular cross section of the pipe was a problem that has to be solved. However, generally, when a bending force greater than or equal to an elastic limit is applied to the metal pipe to obtain a minimum curvature radius, a result is a deformation of the circular cross sectional shape or a folding of the pipe due to characteristics of steel, which cause a deformation of the pipe.

[0012] Meanwhile, as described in the foregoing, the metal resin composite pipe 10 is manufactured by coating an outer surface of the metal pipe 1 with a resin. The coating is implemented by a coating mold unit.

[0013] As shown in FIG. 3, a coating mold unit 20 includes an inner die 21, an inner die lip 23 disposed at the rear of the inner die 21, an outer die lip 25 disposed at the rear of the inner die lip 23, and an outer die 27 surrounding the outer die lip 25.

[0014] The metal pipe 1 (not shown in FIG. 3) passes through the inner die 21, the inner die lip 23, and the outer die lip 25 in a sequential order. An adhesive resin (not shown) is extruded on an outer surface of the metal pipe 1 through an adhesive resin injection hole 24a, and a resin is extruded through a resin injection hole 25a.

[0015] Meanwhile, as described in the foregoing, when manufacturing a resin pipe, extrusion is performed with an outer diameter of a resin pipe being slightly greater than a desired outer diameter and the outer diameter is reduced through a sizing process during cooling to meet the density and surface requirements.

[0016] However, because the metal resin composite pipe 10 includes the metal pipe 1 embedded therein, the sizing process is infeasible, resulting in a low surface quality of the composite pipe 10. When an outer diameter of the composite pipe 10 is greater than an inner diameter S1, a resin flows back and remains in a carrier within an extruder. When the outer diameter of the composite pipe 10 is less than the inner diameter S1, an outer surface of the resin layer 5 fails to contact an inner wall of the outer die lip 25 so that a surface polishing effect is not obtained, and as a result, the resin layer 5 cannot have a proper density and the surface of the resin layer 5 becomes rough, which cause a poor quality.

DISCLOSURE OF INVENTION

Technical Goals

[0017] The present invention is designed to solve the foregoing problems, and an object of the present invention is to provide a metal resin composite pipe that may be wound in a ring shape to provide excellent transportability and constructability as well as high economic efficiency, and avoids dam-
Another object of the present invention is to provide a metal resin composite pipe having a high surface quality and a proper density without passing through a sizing process, and a manufacturing method thereof.

Technical Solutions

To achieve the objects of the present invention, a metal resin composite pipe according to the present invention may include a metal pipe, a resin layer formed by coating an outer surface of the metal pipe, and an adhesive layer formed between the metal pipe and the resin layer. The resin layer adheres to the metal pipe by the adhesive layer. To wind the metal resin composite pipe in a ring shape having a minimum curvature radius, a shape deformation problem of the pipe caused by ovality of a circular cross section or folding has to be solved by adjusting a bending force greater than or equal to an elastic limit.

To wind the pipe without deformation of the circular cross section of the pipe against the bending force, rigidity may be reinforced and the radius of curvature in winding in a ring shape may be minimized as much as possible by coating with a synthetic resin having an even lower elastic coefficient than that of the metal pipe. In this instance, a thickness ρ of the metal pipe may be within a range of 5% to 20% of a thickness q of the resin layer.

When a thickness q of the resin layer is even greater than a thickness ρ of the metal pipe, that is, when a thickness ratio ρ/q is very small (ρ/q is less than 5%), a surface defect such as, for example, corrugation, may occur due to a compressive force being applied to an inner part of the composite pipe when winding, which makes it impossible to minimize the radius of curvature when winding the pipe in ring shape while maintaining the shape of the pipe and to obtain a target radius of curvature due to restoration of the resin layer.

Meanwhile, when the thickness ratio ρ/q exceeds 20%, that is, when the thickness q of the resin layer is relatively small, the thickness ρ of the metal pipe may reach a similar level to a thickness of a conventional metal pipe, which results in difficulty in bending. Also, in order to bend the composite pipe without deformation, the radius of curvature may be increased greatly, which may be unfavorable in terms of transportation and storage. Further, in outer part of the composite pipe where a tensile force is being applied while winding, plastic deformation of the resin may occur because the tensile force exceeds a yielding point of the resin due to the thickness q of the resin layer is thin, accordingly the resin may lose its unique property.

Through trial and error, it is concluded that when a polymer synthetic resin is used for coating, the coating may reinforce rigidity of a stainless steel pipe, and when a ratio of thickness ρ of the metal pipe to the thickness q of the resin layer has a particular range, that is, 5% to 20%, a pipe wound in ring shape which is free of a cross sectional deformation may be manufactured.

The resin layer may be formed by extruding the resin on the adhesive layer continuously to coat the metal pipe with the resin. The coating may be performed by extruding the resin under a pressure of 88 kg/cm² to 96 kg/cm² while the metal pipe passes through an outer die having an inner diameter D₁ equal to an outer diameter of a composite pipe intended to manufacture or less than the outer diameter of the composite pipe intended to manufacture by 1 mm or less.

According to another aspect of the present invention, a method of manufacturing a metal resin composite pipe may comprise the steps of (a) preparing a metal pipe, and (b) coating the metal pipe by forming an adhesive layer on an outer surface of the metal pipe and by forming a resin layer by extruding a resin on the adhesive layer. A thickness ρ of the metal pipe may be within a range of 5% to 20% of a thickness q of the resin layer.

The step (b) may be performed by extruding the adhesive resin and the resin in a sequential order while the metal pipe passes through a coating mold unit. The coating mold unit may include an inner dice, an inner die lip disposed at a rear of the inner dice, an outer die lip disposed at a rear of the inner die lip, and an outer dice surrounding the outer die lip. The metal pipe may be coated while passing through the inner dice, the inner die lip, and the outer die lip in a sequential order. An inner diameter D₁ of the outer dice may be equal to an outer diameter of the composite pipe or less than the outer diameter of the composite pipe by 1 mm or less, and the extrusion may be performed by extruding the resin under a pressure of 88 kg/cm² to 96 kg/cm² being applied to the resin.

Preferably, an inner diameter D₃ at a tip 233 of a slope surface 232 of the inner die lip may be greater than an outer diameter of the metal pipe by 0.1 mm to 0.2 mm.

Further, the manufacturing method may comprise, after the step (b), winding the resulting composite pipe in a ring shape. In this instance, a diameter u of the ring shape may be preferably greater 20 times to 50 times than the outer diameter of the composite pipe.

Effects of Invention

The present invention may have the following effects.

First, provided is a metal resin composite pipe that may be wound in a ring shape to provide excellent transportability and constructability as well as high economic efficiency, avoids damaging roundness when winding, and is easy to straighten, and a manufacturing method thereof.

Second, provided is a metal resin composite pipe having a high surface quality and a proper density without undergoing a sizing process during the cooling, and a manufacturing method thereof.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a perspective view illustrating a metal resin composite pipe according to prior art.
FIG. 2 is a cross sectional view taken along a line A-F in FIG. 1.
FIG. 3 is a cross sectional view illustrating a coating mold unit used to manufacture the metal resin composite pipe according to prior art.
FIG. 4 is a perspective view illustrating a metal resin composite pipe wound in a ring shape according to a preferred embodiment of the present invention.
FIG. 5 is a cross sectional view of the metal resin composite pipe of FIG. 4.
FIG. 6 is a cross sectional view illustrating a main configuration of a coating mold unit used to manufacture the metal resin composite pipe according to the present invention.

REFERENCE SYMBOLS

1, 30: metal pipe
5, 50: resin layer
MODE FOR CARRYING OUT THE INVENTION

Hereinafter, embodiments of the present invention are described in detail with reference to the accompanying drawings. Prior to the description, the terms and words used in the following description and claims are not limited to the bibliographical meanings, but are merely used by the inventor to enable a clear and consistent understanding of the invention. Accordingly, it should be apparent to those skilled in the art that the following description of exemplary embodiments of the present invention is provided for illustration purpose only and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

The present invention relates to a metal resin composite pipe and a manufacturing method thereof, and is characterized in that the composite pipe may be wound in a ring shape, for example, in a shape of a roll, and the composite pipe having excellent density and surface quality may be manufactured without undergoing a sizing process. Accordingly, the following description is provided based on these characteristics. For a detailed description of a configuration of a general metal resin composite pipe and a manufacturing method thereof, reference may be made to Korean Patent No. 10-1094185 etc., the disclosure of which is incorporated herein in the condition of understanding a configuration of a general metal resin composite pipe and a manufacturing method thereof.

FIG. 4 is a perspective view illustrating a metal resin composite pipe wound in a ring shape according to a preferred embodiment of the present invention. FIG. 5 is a cross sectional view of the metal resin composite pipe.

Referring to FIGS. 4 and 5, the metal resin composite pipe 100 may include a metal pipe 30, an adhesive layer 40 formed on an outer surface of the metal pipe 30, and a resin layer 50.

The metal pipe 30 may have a direct contact with a fluid flowing therethrough. Preferably, the metal pipe 30 may be made from a good corrosion resistant metal such as, for example, stainless steel.

The metal pipe 30 may be formed of a thin plate, and the thin plate may be thinner than the resin layer 50.

The applicant discovered through long-term experience and research that if a thickness ratio p/q of the metal pipe 30 and the resin layer 50 has a certain range, the composite pipe 100 may be easy to wind in a ring shape, for example, in a shape of a roll, and a property change of the metal pipe 30 may be prevented.

Specifically, according to the study of the applicant, in a case in which a thickness p of the metal pipe 30 is within a range of 5% to 20% of a thickness q of the resin layer 50, when the composite pipe 100 is wound in a ring shape, roundness of the cross section of the metal pipe 30 can be maintained and plasticity may be maintained so that a circular shape can be maintained and deformation of the metal pipe 30 can be prevented. In this instance, when the composite pipe 100 is wound in a ring shape, a diameter u of the ring shape may be preferably greater about 20 times to about 50 times than an outer diameter G of the composite pipe 100.

Meanwhile, the term "roundness" used herein refers to a shape of a circle in a mathematical sense or a shape analogous or similar thereto, other than a crushed circle, for example, an oval. A reference numeral 9 is a strip used to fix the wound composite pipe 100 in a ring shape.

When the thickness ratio p/q is less than 5%, plasticity may not be maintained due to elasticity or resilience of the resin layer 50 and consequently, the ring shape, for example, the shape of the roll, may not be maintained. When the thickness ratio p/q exceeds 20%, the resin layer 50 may fail to prevent deformation of the metal pipe 30, circularly winding and straightening may be difficult, properties of the metal pipe 30 may be liable to change, and economic efficiency may be reduced.

The adhesive layer 40 may be made from an adhesive resin and may allow a strong adhesion of the resin layer 50 to the metal pipe 30. The adhesive resin may include a general adhesive resin.

The resin layer 50 may be extruded on the adhesive layer 40 to coat the metal pipe 30. The resin layer 50 may be formed to have a thickness greater than the thickness p of the metal pipe 30. The resin layer 50 may be made from a resin, and the resin may include polyethylene and the like.

The adhesive resin and the resin may be extruded to form the adhesive layer 40 and the resin layer 50 while the metal pipe 30 passes through a coating mold unit.

As shown in FIG. 6, the coating mold unit 200 may include an inner die 210, an inner die lip 230 disposed at the rear of the inner die 210, an outer die lip 250 disposed at the rear of the inner die lip 230, and an outer die lip 270 surrounding the outer die lip 250.

The metal pipe 30 (not shown in FIG. 6) may pass through the inner die 210, the inner die lip 230, and the outer die lip 250 in a sequential order. That is, the metal pipe 30 may move inside the coating mold unit 200 in a direction of an arrow.

An inner diameter D4 of the inner die 210 may be greater than a maximum possible outer diameter of the metal pipe 30 in the coating mold unit 200.

The inner die lip 230 may include a slope surface 232 formed inside, and an inner diameter D3 at a tip 233 of the slope surface 232 may be greater than an outer diameter of the metal pipe 30 by 0.1 mm to 0.2 mm. The tip 233 may guide the sliding of the metal pipe 30 together with a metal ring 211.

Meanwhile, the inner die lip 230, the outer die lip 250, the outer die lip 270, and the metal ring 211 may be detachably installed, and may be properly replaced in consideration of the outer diameter of the metal pipe 30 to guide the sliding of the metal pipe 30 and to allow proper extrusion.

The outer die lip 250 may have an inner diameter D2 greater than an inner diameter D3. An inner diameter difference D2-D3 may allow a space for extrusion of an adhesive resin. The adhesive resin (not shown) may be extruded on the outer surface of the metal pipe 30 through an adhesive resin injection hole 231 formed between the inner die lip 230 and the outer die lip 250.

The outer die lip 270 may surround the outer die lip 250, and may have an inner diameter D1 greater than the inner
diameter D2. An inner diameter difference D1-D2 may allow a space for extrusion of a resin. The resin (not shown) may be extruded through a resin injection hole 251 formed between the outer die lip 250 and the outer die 270.

[0072] Meanwhile, as described in the foregoing, when manufacturing a resin pipe, extrusion is performed with an outer diameter of a resin pipe being greater than a desired outer diameter by 2 mm to 5 mm, and the outer diameter is reduced through a sizing process during the cooling to meet the density and surface requirements.

[0073] However, because the metal resin composite pipe 100 includes the metal pipe 30 embedded therein, the sizing process may be infeasible, resulting in a low surface quality of the composite pipe 100. When the outer diameter of the resin layer 50 is greater than the inner diameter D1 of the outer die 270, an excessive resin of the resin layer 50 may flow back. When the outer diameter of the resin layer 50 is less than the inner diameter D1 of the outer die 270, an outer surface of the resin layer 50 may fail to contact an inner surface of the outer die 270, leading to an improper density of the resin layer 50, and the absence of a surface polishing effect may contribute to a rough surface, resulting in a low surface quality.

[0074] To solve these problems, the present invention may set the inner diameter D1 of the outer die 270 to be equal to an outer diameter G of a resulting composite pipe (a composite pipe intended to manufacture) or less than the outer diameter G of the resulting composite pipe (the composite pipe intended to manufacture) by 1.0 mm or less. Also, when extruding, the present invention may apply to the resin a pressure in a range of 88 kg/cm² to 96 kg/cm² that is higher by about 10% to about 20% than a pressure of about 80 kg/cm² used in a general case.

[0075] Accordingly, when the resin is extruded under the conditions of the inner diameter D1 of the outer die 270 equal to the outer diameter of the resulting composite pipe (the composite pipe intended to manufacture) or less than the outer diameter of the resulting composite pipe by 1 mm or less and the increased pressure, the resin may be expanded after the composite pipe is discharged from the outer die 270 so that the resin layer 50 greater than the inner diameter D1 of the outer die 270 may be obtained. Also, the resin layer 50 formed through this process may have a proper density and a high surface quality. That is, a product having a quality as good as a product obtained through a sizing process may be obtained without passing through a sizing process.

[0076] As described in the foregoing, because the metal pipe 30 passes through the inner die 210 and the inner die lip 230, a gap between the tip 233 of the slope surface 232 and the metal pipe 30 may be important in ensuring roundness of the resin layer 50 of the resulting composite pipe 100 by forming the resin layer 50 uniformly. When the gap is excessively great, the resin layer 50 may have a non-uniform thickness, and preferably, the inner diameter D3 at the tip 233 may be greater than the outer diameter of the metal pipe 30 by 0.1 mm to 0.2 mm.

[0077] Hereinafter, a method of manufacturing the metal resin composite pipe 100 is described. The following description includes an extrusion process only in the manufacturing process of the metal resin composite pipe 100. Certain processes before and after the extrusion process, for example, a metal pipe manufacturing process, a cooling process, and the like, are well known in the art and disclosed in Korean Patent No. 10-1094185 etc., and thus a detailed description is omitted herein.

[0078] After the metal pipe 30 is manufactured, the metal pipe 30 may be inserted into the coating mold unit 200. When the metal pipe 30 is inserted into the inner die 210 and makes a movement, the movement of the metal pipe 30 may be guided by the metal ring 211 and the tip 233. The adhesive resin may be extruded from the adhesive resin injection hole 231 and applied to the outer surface of the metal pipe 30, and subsequently, the resin may be extruded from the resin injection hole 251. In this instance, the resin may be extruded under a pressure of 88 kg/cm² to 96 kg/cm² that is higher than a general extrusion pressure of about 80 kg/cm² by 10% to 20%. Meanwhile, because the inner diameter D1 is equal to an outer diameter of a resulting composite pipe (composite pipe intended to manufacture) or less than the outer diameter of the resulting composite pipe by 1 mm or less, the resin layer 50 may be expanded after the composite pipe is discharged from the outer die 270 and a composite pipe having a desired outer diameter may be manufactured by the expansion. The composite pipe 100 manufactured through this process may have advantages of a proper density and a good surface quality of the resin layer 50 without passing through a sizing process.

1. A method of manufacturing a metal resin composite pipe, the method comprising the steps of:
   (a) preparing a metal pipe; and
   (b) coating the metal pipe by forming an adhesive layer on an outer surface of the metal pipe and by forming a resin layer by extruding a resin on the adhesive layer, wherein a thickness p of the metal pipe is within a range of 5% to 20% of a thickness q of the resin layer.

2. The method of claim 1, wherein the step (b) is performed by extruding the adhesive resin and the resin in a sequential order while the metal pipe passes through a coating mold unit, the coating mold unit comprises an inner die, an inner die lip disposed at a rear of the inner die, an outer die lip disposed at a rear of the inner die lip, and an outer die surrounding the outer die lip, and the metal pipe is coated while passing through the inner die, the inner die lip, and the outer die lip in a sequential order, and an inner diameter D1 of the outer die is equal to an outer diameter of the composite pipe or less than the outer diameter of the composite pipe by 1 mm or less, and the extrusion is performed by extruding the resin under a pressure of 88 kg/cm² to 96 kg/cm² being applied to the resin.

3. The method of claim 2, wherein an inner diameter D3 at a tip (233) of a slope surface (232) of the inner die lip is greater than an outer diameter of the metal pipe by 0.1 mm to 0.2 mm.

4. The method of claim 1, wherein after the step (b), the method comprises winding the composite pipe in a ring shape, and a diameter of the ring shape is greater than 20 times to 50 times than the outer diameter of the composite pipe.

5. A metal resin composite pipe, comprising:
   a metal pipe;
   a resin layer formed by coating an outer surface of the metal pipe; and
   an adhesive layer formed between the metal pipe and the resin layer for the resin layer adhering to the metal pipe, wherein a thickness p of the metal pipe is within a range of 5% to 20% of a thickness q of the resin layer.
6. The metal resin composite pipe of claim 5, wherein when the composite pipe is wound in a ring shape with a diameter \( u \) of the ring shape being greater 20 times to 50 times than an outer diameter \( G \) of the composite pipe, roundness of the metal pipe is maintained and deformation of the metal pipe is prevented.

7. The metal resin composite pipe of claim 5, wherein the resin layer is formed by extruding a resin on the adhesive layer continuously to coat the metal pipe with the resin, and the coating is performed by extruding the resin under a pressure of 88 kg/cm\(^2\) to 96 kg/cm\(^2\) while the metal pipe passes through an outer dice having an inner diameter equal to an outer diameter of a composite pipe intended to manufacture or less than the outer diameter of the composite pipe by 1 mm or less, and the resin layer is formed by expansion of the coating resin after the composite pipe is discharged from the outer dice.

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