

# **DUCTILE IRON PIPE LINED WITH PLASTIC PIPE LINER AND METHOD FOR MANUFACTURING SAME**

## **TECHNICAL FIELD**

The present invention relates to a ductile iron pipe lined with a plastic pipe liner and a method for manufacturing the same.

## **BACKGROUND**

Existing ordinary ductile iron pipes are often used as water supply and water conveying pipes because of their good comprehensive performance. In order to solve the problem of anticorrosion of ductile iron pipes, a most common method is to use cement mortar liners or epoxy resin liners or epoxy ceramic liners in ductile iron pipes as a preferred mode for anti-corrosion of the pipes. Cement mortar liners are used as drinking water conveying pipes. The inner wall thereof is not smooth, has a large water flow resistance and easily scales, reacting substances generated by cement hardening affects the water quality and the thickness of the liner is larger and reaches 3-12mm, resulting in low water conveying efficiency; the cement liner leads to an increase in the weight of the whole pipe, which is not conducive to construction and installation, the cement liner is inconvenient to process and has poor adhesion, impact and pipe deformation during construction and installation easily make the cement fall off. The cement liner still has many difficult problems to be solved, so the cement liner is not a good liner method. When the epoxy resin liner is adopted, since a liner layer is delaminated and drops off easily and is high in material cost, and harmful substances generated in the curing process of oxygen resin have an influence on water quality and human health, it is difficult to promote the oxygen resin in a large scale. When the epoxy ceramic liner is used, although the epoxy ceramic liner has high adhesion and smooth finish, the manufacturing difficult is high, a device is complicated and the cost is high, so the epoxy ceramic liner can only be used for special projects and cannot be universally applied.

## **SUMMARY**

With respect to the technical problem to be solved by the present invention, the present invention provides a ductile iron pipe lined with a plastic pipe liner, which is simple in structure, easy to manufacture, low in cost, good in mechanical performance, hygienic, environmentally friendly, good in corrosion resistance and long in service life, has a smooth inner wall, small water flow resistance, high water conveying efficiency, low energy consumption, high liner adhesion, high environmental adaptability and high cost performance, and is easy to popularize.

With respect to the technical problem to be further solved by the present invention, the present invention provides a method for manufacturing a ductile iron pipe lined with a plastic pipe liner. According to the method, plastic composite pipe is manufactured on line continuously; an inner wall of a ductile iron pipe is polished and then subjected to sand blasting, shot peening

or shot blasting; the plastic composite pipe is pulled into the ductile iron pipe with the processed inner wall and is subjected to on-line operations of sealing, inflation, heating, cooling, trimming, spraying and marking processes, so that the ductile iron pipe lined with a plastic pipe liner is manufactured.

The technical solution adopted by the present invention to solve the technical problem thereof is as follows:

A ductile iron pipe lined with a plastic pipe liner provided by the present invention includes a ductile iron pipe and a plastic composite pipe; the plastic composite pipe is composed of an outer hot-melt adhesive layer and an inner plastic pipe; the plastic composite pipe is formed by means of on-line manufacturing; an inner wall of the ductile iron pipe is polished and then subjected to sand blasting, shot peening or shot blasting; the plastic composite pipe is pulled into the processed ductile iron pipe; after two ends of the plastic composite pipe are sealed and inflation and heating are performed, the plastic composite pipe is cooled; the ductile iron pipe firmly adheres to the plastic composite pipe, and then trimming, spraying and marking are performed.

Further, the plastic composite pipe is pulled into the processed ductile iron pipe and then placed on a liner platform, the two ends of the plastic composite pipe are sealed, inflation is performed; and the plastic composite pipe is heated by passing through a heating device of the liner platform through a mobile cart, or through the mobile device, the heating device passes through the pipe for heating.

Further, the heating mode is induction heating, which can be low-frequency, medium-frequency, high-frequency or super audio induction heating, preferably medium-frequency induction heating.

Further, the ductile iron pipe is a socket and spigot type ductile ductile iron pipe.

A method for manufacturing a ductile iron pipe lined with a plastic pipe liner according to the present invention includes the following steps:

step A of manufacturing of a plastic composite pipe by using a plastic resin and a hot-melt adhesive:

step 1) of drying of the plastic resin and the hot-melt adhesive;

step 2) of coextrusion or coating of the plastic pipe with the hot-melt adhesive;

step 3) of vacuum setting;

step 4) of cooling;

step 5) of traction;

step 6) of fixed length cutting;

step B of processing of an inner wall of the ductile iron pipe (including an outer wall zinc layer):

step 7) of polishing of the inner wall;  
step 8) of sand blasting, shot peening or shot blasting;  
step C of pipe pulling;  
step 9) of pipe clamping;  
step 10) of pulling in;  
step D of liner processing;  
step 11) of sealing;  
step 12) of inflation;  
step 13) of heating;  
step 14) of cooling;  
step 15) of trimming;  
step 16) of spraying;  
step 17) of marking; and  
step E of detection and acceptance and warehousing.

Further, in order to improve the quality and production efficiency of the ductile iron pipe lined with a plastic pipe liner, and reduce energy consumption and production cost, further measures are as follows:

In step 2), the thickness of the co-extruded hot-melt adhesive layer or the coated hot-melt adhesive layer is 0.2-0.5 mm.

In step 12), the inflation pressure is  $0.2 \text{ MPa} \pm 0.05 \text{ MPa}$ .

In step 13), the heating temperature is  $170^{\circ}\text{C} \pm 5^{\circ}\text{C}$  within 300 mm from a pipe port, and  $150^{\circ}\text{C} \pm 5^{\circ}\text{C}$  at 300 mm or further away the pipe port.

In step 13), the heating power or the relative movement speeds of the pipe and a heating ring are automatically adjusted according to changes in temperature to control the heating temperature.

In step 14), the temperature of an outer wall of the pipe is kept at  $50\text{-}60^{\circ}\text{C}$  after cooling.

The method for manufacturing a ductile iron pipe lined with a plastic pipe liner according to the present invention includes manufacturing on line plastic composite pipe with an inner layer of plastics (polyethylene) and an outer layer of hot-melt adhesive; internally grinding an inner wall of the ductile iron pipe and then performing sand blasting, shot peening or shot blasting on the inner wall of the ductile iron pipe; pulling the plastic composite pipe into the processed ductile iron pipe and then placing the plastic composite pipe on a liner platform, sealing the two ends of the pipe, and performing inflation; heating the pipe by passing through a heating device of the liner platform through a mobile cart, or through the mobile cart, the heating device passing through the pipe for heating; spraying water for cooling; or through the mobile cart, the heating device passing through the pipe for heating; trimming the pipe by a trimmer, spraying by a

sprayer, and marking by an inkjet printer. The ductile iron pipe lined with a plastic pipe liner overcomes the shortcomings that an inner wall of an existing ductile ductile iron pipe lined with a cement mortar liner is unsmooth, has a large water flow resistance and scales easily, harmful substances generated in the cement hardening process affects water quality and the thickness of the liner is large, resulting in low water conveying efficiency, and the pipe is impacted and deformed cement drops easily. The shortcomings that existing ductile ductile iron pipes lined with epoxy resin liners or epoxy ceramic liners have a high manufacturing costs and are delaminated easily and the epoxy resin curing process affects water quality and employees' health are overcome.

Compared with the prior art, the present invention has the following advantages:

(1) The present invention adopts the technical solution of integrally cementing a ductile iron pipe and a plastic composite pipe, so that the thickness of a ductile iron pipe liner is reduced, the inner diameter is increased, and the water passing capacity and the water conveying efficiency are greatly improved; and the effect of energy saving and consumption reduction is achieved. The liner is a plastic pipe with a low material cost.

(2) The present invention adopts the technical solution of integrally cementing the ductile iron pipe and the plastic composite pipe, so that the pipe wall of the ductile iron pipe becomes smooth, does not scale and has a small water flow resistance, and the comprehensive energy consumption and operating costs of the pipe are greatly reduced.

(3) The present invention adopts the technical solution of integrally cementing the ductile iron pipe and the plastic composite pipe, so that the liner plastics completely blocks the contact between water and the pipe wall of the ductile iron pipe, and eliminates secondary pollution of water during the water conveying process, making the water more hygienic and healthy.

(4) The present invention adopts the technical solution of integrally cementing the ductile iron pipe and the plastic composite pipe, so that a ductile ductile iron pipe maintains good mechanical properties of the ductile iron pipe itself, and the plastic pipe liner greatly improves the corrosion resistance and service life of the pipe.

(5) The present invention adopts the technical solution of integrally cementing the ductile iron pipe and the plastic composite pipe, and an inner layer is a polyethylene pipe, so that the toughness is good; and the inner and outer layers are bonded by a hot-melt adhesive, which greatly improves the adhesion between the ductile iron pipe and the polyethylene pipe liner, and the problem that other liner layers in other liner modes easily crack, delaminate and fall off is solved, so that the construction becomes convenient, fast and simple.

(6) According to the present invention, the inner wall of the ductile iron pipe is polished, so that the inner wall of the ductile iron pipe is smoother and then processed through a sand blasting,

shot peening or shot blasting process, the bonding quality of the ductile iron pipe and the hot-melt adhesive layer and the plastic pipe liner is greatly improved, the finished pipe is smoother, the water flow resistance is smaller, and the comprehensive energy consumption and operating cost of the pipe are lowered.

(7) The present invention is suitable for the production of large-diameter pipes (the prior art is only suitable for pipe with a diameter of less than 500 mm, and the present invention can be adapted to pipe with a diameter of 2600 mm or more), and a device is simple and flexible, is suitable for factory assembly lines and mass production, has high efficiency and low production cost, so that the market competitiveness of the ductile iron pipe lined with a plastic pipe liner is greatly improved.

(8) According to the technical solution of spraying after the liner compositing adopted by the present invention, the drying speed of the spraying can be accelerated by using residual heat of the pipe heating when the liner is combined, thereby improving the production efficiency.

(9) Preferably, the present invention automatically adjusts the heating power by changes of the heating temperature or achieves the heating stability by the relative moving speeds of the pipe and the heating ring, so that the heating temperature of each part of the pipe is uniform, thereby making bonding surfaces between the ductile iron pipe and the hot-melt adhesive layer and the plastic pipe have no leakage point, the product quality is stable, the one-time forming qualification rate is high, and the ductile iron pipe lined with a plastic pipe liner saves energy and is environmentally friendly.

## **DETAILED DESCRIPTION**

The present invention will be further described below in conjunction with the embodiments.

### **Embodiment**

A socket and spigot ductile ductile iron pipe lined with a plastic pipe liner according to the embodiment includes a socket and spigot ductile ductile iron pipe and a plastic composite pipe, and the plastic composite pipe is composed of an outer hot-melt adhesive layer and an inner plastic pipe (polyethylene).

The plastic composite pipe is formed by means of on-line manufacturing: the polyethylene and the hot-melt adhesive are dried and respectively extruded into a co-extrusion die through an extruder to manufacture double-layer plastic composite pipe with an outer layer of hot-melt adhesive and an inner layer of polyethylene. The thickness of the hot-melt adhesive is 0.3 mm, the thickness of the polyethylene layer is 3 mm, the external diameter of the polyethylene layer is smaller than the internal diameter of the ductile ductile iron pipe by 0.5 mm, and the length required for composite forming of the liner is obtained by vacuum setting, cooling, traction by a tractor and cutting.

An inner wall of the ductile ductile iron pipe is ground smooth by an internal grinder, and then the smoothed ductile ductile iron pipe is subjected to sand blasting, shot peening or shot blasting, so that an oxide layer and rust on the inner wall of the ductile ductile iron pipe are removed to obtain a frosted surface having a certain roughness.

In order to ensure that the plastic pipe liner is smoothly pulled into the ductile ductile iron pipe and facilitate the sealing of the plastic pipe liner by a sealing head, one end of the plastic composite pipe is sleeved inside a clamp of a pipe drawing machine, the ductile ductile iron pipe with the processed inner wall is placed on a pipe drawing machine platform, the plastic composite pipe is pulled into ductile ductile iron pipe, and lengths required for liner platform sealing heads are reserved at the two ends of the plastic composite pipe respectively.

In order to ensure that the ductile ductile iron pipe and the plastic pipe liner are bonded integrally, pipe is placed on a liner platform operation cart, the two ends of the plastic pipe are sealed by sealing heads, and the plastic pipe is inflated with compressed air to 0.2 MPa; after the operation cart is started, through an optoelectronic switch, a medium-frequency induction heating device (the medium-frequency induction heating device is an existing device) is started for heating; a heating control system sets a pipe heating temperature to 170°C within 300 mm from an insertion port end, and 150°C at 300 mm or further away from the insertion port end. The heating power or the relative movement speeds of the pipe and a heating ring are automatically adjusted according to changes in temperature to control the heating temperature, so that the pipe heating temperature meets the temperature program requirements, a cooling water ring is disposed 300-600 mm from the heating ring along the pipe moving direction; after the pipe is heated, water is sprayed for cooling to 50°C-60°C; at the same time, the air pressure in the pipe is kept for 3-10 min, and the pipe is unloaded into an unloading table, and then trimmed using a trimmer; after the trimming, spraying is carried out by a sprayer by using residual heat after the heating, and an inkjet printer sprays a code for marking.

A method for manufacturing a socket and spigot ductile ductile iron pipe lined with a plastic pipe liner includes the following steps:

step A of manufacturing of a plastic composite pipe by using polyethylene and a hot-melt adhesive:

- step 1) of drying of the polyethylene and the hot-melt adhesive by a dryer;
- step 2) of coextrusion by an extruder and a co-extrusion die;
- step 3) of vacuum setting by a sizing sleeve and a vacuum box;
- step 4) of cooling by a spraying water tank;
- step 5) of traction by a traction machine;
- step 6) of fixed length cutting by a cutting machine;

step B of processing of an inner wall of a socket and spigot ductile ductile iron pipe (including an outer wall zinc layer):

step 7) of polishing of the inner wall by an internal grinder;

step 8) of sand blasting, shot peening or shot blasting by a sand blasting machine, a shot peening machine or a shot blasting machine;

step C of pipe pulling:

step 9) of pipe clamping by a clamp;

step 10) of pulling in by a pipe drawing machine;

step D of liner processing:

step 11) of sealing by a sealing head;

step 12) of inflation by an inflation pipe;

step 13) of heating by a medium-frequency induction heating device and an operation cart;

step 14) of cooling by a water spraying ring;

step 15) of trimming by a trimmer;

step 16) of spraying by a sprayer;

step 17) of marking by an inkjet printer; and

step E of detection and acceptance and warehousing.

In step 13), specific operations can be performed by adopting the following solution: one or more temperature-measuring probes are placed on the surface of the ductile ductile iron pipe, the temperature-measuring probes feed the measured temperature back to a control system, and the control system calculates a difference value between the measured temperature and a set target temperature; the control system automatically adjusts the heating power of the medium-frequency induction heating device according to the difference value, or controls the relative movement speeds of the pipe and an induction ring to reach the required optimal set target temperature, so that bonding surfaces between the ductile ductile iron pipe and the hot-melt adhesive layer or the plastic pipe have no leakage point; the inner wall of the pipe liner is smooth, the product quality is good, the one-time forming qualification rate is high, and automatic production of an assembly line is truly achieved.

**What is claimed is:**

1. A ductile iron pipe lined with a plastic pipe liner, comprising a ductile iron pipe and a plastic composite pipe, wherein the plastic composite pipe is composed of an outer hot-melt adhesive layer and an inner plastic pipe; the plastic composite pipe is formed by means of on-line manufacturing; an inner wall of the ductile iron pipe is polished and then subjected to sand blasting, shot peening or shot blasting; the plastic composite pipe is pulled into the processed ductile iron pipe; after two ends of the plastic composite pipe are sealed and inflation and heating are performed, the plastic composite pipe is cooled; the ductile iron pipe firmly adheres to the plastic composite pipe, and then trimming, spraying and marking are performed.

2. The ductile iron pipe lined with a plastic pipe liner according to claim 1, wherein the plastic composite pipe is pulled into the processed ductile iron pipe and then placed on a liner platform, the two ends of the plastic composite pipe are sealed, and inflation is performed; and the plastic composite pipe is heated by passing through a heating device of the liner platform through a mobile cart, or through the mobile device, the heating device passes through the pipe for heating.

3. The ductile iron pipe lined with a plastic pipe liner according to claim 2, wherein the heating mode is induction heating.

4. The ductile iron pipe lined with a plastic pipe liner according to claim 3, wherein the induction heating is low-frequency, medium-frequency, high-frequency or super audio induction heating.

5. A method for manufacturing a ductile iron pipe lined with a plastic pipe liner, comprising the following steps:

step A of manufacturing of a plastic composite pipe by using a plastic resin and a hot-melt adhesive:

step 1) of drying of the plastic resin and the hot-melt adhesive;

step 2) of coextrusion or coating of the plastic pipe with the hot-melt adhesive;

step 3) of vacuum setting;

step 4) of cooling;

step 5) of traction;

step 6) of fixed length cutting;

step B of processing of an inner wall of the ductile iron pipe:

step 7) of polishing of the inner wall;

step 8) of sand blasting, shot peening or shot blasting;

step C of pipe pulling:

step 9) of pipe clamping;

step 10) of pulling in;  
step D of liner processing:  
step 11) of sealing;  
step 12) of inflation;  
step 13) of heating;  
step 14) of cooling;  
step 15) of trimming;  
step 16) of spraying;  
step 17) of marking; and  
step E of detection and acceptance and warehousing.

6. The method for manufacturing a ductile iron pipe lined with a plastic pipe liner according to claim 5, wherein in step 2), the thickness of the co-extruded hot-melt adhesive layer or the coated hot-melt adhesive layer is 0.2-0.5 mm.

7. The method for manufacturing a ductile iron pipe lined with a plastic pipe liner according to claim 6, wherein in step 12), the inflation pressure is  $0.2 \text{ MPa} \pm 0.05 \text{ MPa}$ .

8. The method for manufacturing a ductile iron pipe lined with a plastic pipe liner according to claim 7, wherein in step 13), the heating temperature is  $170^{\circ}\text{C} \pm 5^{\circ}\text{C}$  within 300 mm from a pipe port, and  $150^{\circ}\text{C} \pm 5^{\circ}\text{C}$  at 300 mm or further away from the pipe port.

9. The method for manufacturing a ductile iron pipe lined with a plastic pipe liner according to claim 8, wherein in step 13), the heating power or the relative movement speeds of the pipe and a heating ring are automatically adjusted according to changes in temperature to control the heating temperature.

10. The method for manufacturing a ductile iron pipe lined with a plastic pipe liner according to claim 9, wherein in step 14), the temperature of an outer wall of the pipe is kept at  $50\text{-}60^{\circ}\text{C}$  after cooling.