

## **UNDERWATER PIPE ASSEMBLY AND METHOD FOR ASSEMBLING UNDERWATER PIPES**

### **FIELD**

5       The disclosure relates to a pipe assembly, more particularly to an underwater pipe assembly and method for assembling the underwater pipes.

### **BACKGROUND**

10       Referring to Figure 1, an existing large-diameter underwater pipe for used in pumping seawater is made into a plurality of pipes 1 using a PE material. Two adjacent pipes 1 are welded at their corresponding ends using a welding equipment (not shown) to obtain the desired length. The pipes 1 are pressed toward each  
15       other along an axial direction so as to be welded.

      The structure of an existing welding equipment is rather complicated, and a welded junction of the two pipes 1 has an uneven shape, so that turbulence and resistance are prone to occur during pumping of the  
20       seawater. Furthermore, the structural strength of the welded junction of the two adjacent pipes 1 is insufficient, so that it is susceptible to torque and pressure, thereby generating breakage.

### **SUMMARY**

25       Therefore, an object of the present disclosure is to provide an underwater pipe assembly that can alleviate at least one of the drawbacks of the prior

art.

Another object of the disclosure is to provide a method for assembling underwater pipes.

According to one aspect of the disclosure, an  
5 underwater pipe assembly includes first and second  
pipes, a coupling unit and a clamping unit. The first  
pipe is made of a plastic material, extends along a  
longitudinal axis, and has an inner circumferential  
surface surrounding the longitudinal axis, an outer  
10 circumferential surface opposite to the inner circum-  
ferential surface, and an annular end face between the  
inner and outer circumferential surfaces. The second  
pipe is made of a plastic material, abuts against the  
first pipe along the longitudinal axis, and has an inner  
15 circumferential surface surrounding the longitudinal  
axis, an outer circumferential surface opposite to the  
inner circumferential surface of the second pipe, and  
an annular end face between the inner and outer  
circumferential surfaces of the second pipe. The  
20 annular end faces of the first and second pipes abut  
against each other. The coupling unit includes an inner  
coil surrounding the inner circumferential surfaces of  
the first and second pipes at a junction therebetween,  
an annular inner cover layer covering the inner coil,  
25 an outer coil sleeved on the outer circumferential  
surfaces of the first and second pipes at a position  
corresponding to the inner coil, and an annular outer

cover layer covering the outer coil. Each of the inner and outer coils has a first end portion located on one side of the junction of the first and second pipes, and a second end portion located on the other side of the junction of the first and second pipes and opposite to the first end portion. When the inner and outer coils are energized, the annular end faces of the first and second pipes are melted to fuse together the first and second pipes along the longitudinal axis, and the annular inner and outer cover layers are melted to fuse with the first and second pipes.

According to another aspect of the disclosure, a method for assembling underwater pipes includes the steps of: (A) preparing first and second pipes, a coupling unit and a clamping unit, each of the first and second pipes being made of a plastic material and extending along a longitudinal axis, each of the first and second pipes having an inner circumferential surface surrounding the longitudinal axis, an outer circumferential surface opposite to the inner circumferential surface, and an annular end face between the inner and outer circumferential surfaces, the coupling unit including inner and outer coils and annular inner and outer cover layers; (B) abutting the annular end faces of the first and second pipes against each other, disposing the inner coil on the inner circumferential surfaces of the first and second pipes

at a junction therebetween, and covering the inner coil with the annular inner cover layer; (C) sleeving the outer coil on the outer circumferential surfaces of the first and second pipes at a position corresponding to the inner coil, and covering the outer coil with the annular outer cover layer; (D) clamping tightly the first and second pipes and the coupling unit using the clamping unit; (E) energizing the inner and outer coils so as to generate heat which melts the annular end faces of the first and second pipes to fuse together the first and second pipes along the longitudinal axis and which melts the annular inner and outer cover layers to fuse with the first and second pipes; and (F) removing the clamping unit from the first and second pipes.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

Other features and advantages of the present disclosure will become apparent in the following detailed description of the embodiment with reference to the accompanying drawings, of which:

Figure 1 is a fragmentary sectional view for illustrating how two underwater pipes are connected in a conventional manner;

Figure 2 is a fragmentary assembled sectional view of an underwater pipe assembly according to the embodiment of the present disclosure;

Figure 3 is a partly enlarged fragmentary sectional view of Figure 2;

Figure 4 is an exploded sectional view of Fig. 3;

Figure 5 is an enlarged fragmentary sectional view for illustrating how the first and second pipes are assembled; and

5        Figure 6 is a sectional view of the embodiment taken along line VI-VI of Figure 5.

#### DETAILED DESCRIPTION

Referring to Figures 2 to 6, a large-diameter underwater pipe assembly according to the embodiment  
10 of the present disclosure is shown to comprise a first pipe 10, a second pipe 20, a coupling unit 30 and a clamping unit 40.

The first pipe 10 is made of a plastic material, extends along a longitudinal axis (L), and has an inner  
15 circumferential surface 11 surrounding the longitudinal axis (L), an outer circumferential surface 12 opposite to the inner circumferential surface 11, and an annular end face 13 between the inner and outer circumferential surfaces 11, 12. The inner circum-  
20 ferential surface 11 has a first annular recess 14 extending inwardly and axially from the end face 13. In this embodiment, the first pipe 10 is made of a polyethylene (PE) material.

The second pipe 20 is made of a plastic material,  
25 abuts against the first pipe 10 along the longitudinal axis (L), and has an inner circumferential surface 21 surrounding the longitudinal axis (L), an outer

circumferential surface 22 opposite to the inner circumferential surface 21, and an annular end face 23 between the inner and outer circumferential surfaces 21, 22. The inner circumferential surface 21 has a  
5 second annular recess 24 extending inwardly and axially from the end face 23. The end faces 13, 23 of the first and second pipes 10, 20 abut against each other. The first and second annular recesses 14, 24 are aligned and communicate with each other along the longitudinal  
10 axis (L), and cooperatively form an elongated annular notch 50 that extends from the inner circumferential surface 11 of the first pipe 10 to the inner circumferential surface 21 of the second pipe 20. In this embodiment, the second pipe 20 is also made of a  
15 polyethylene (PE) material.

In this embodiment, the coupling unit 30 includes an inner coil 31 disposed in the annular notch 50, an annular inner cover layer 32 disposed in the annular notch 50 and covering the inner coil 31, an annular outer  
20 coil 33 sleeved on the outer circumferential surfaces 12, 22 of the first and second pipes 10, 20 at a junction therebetween and corresponding in position to the inner coil 31, and an annular outer cover layer 34 covering the outer coil 33. In this embodiment, each of the inner  
25 and outer coils 31, 33 is made of copper wire, and a length of the outer cover layer 34 along the longitudinal axis (L) is greater than that of the inner

cover layer 32 along the longitudinal axis (L). Each  
of the inner and outer cover layers 32, 34 is made of  
one of the polyethylene and polypropylene materials.  
The inner cover layer 32 is flush with the inner  
5 circumferential surfaces 11, 21.

The inner coil 31 has a first end portion 311 located  
in the first annular recess 14, and a second end portion  
312 opposite to the first end portion 311 and located  
in the second annular recess 24. The outer coil 33 has  
10 a first end portion 331 located on the outer  
circumferential surface 12, and a second end portion  
332 opposite to the first end portion 331 and located  
on the outer circumferential surface 22.

With reference to Figures 5 and 6, the clamping unit  
15 40 is removably mounted on the first and second pipes  
10, 20 at the junction therebetween, and includes a  
support member 41 movably disposed inside the first and  
second pipes 10, 20, an inflatable ring 42 disposed  
between the support member 41 and the inner cover layer  
20 32, and a clamping member 43 clamped around the outer  
cover layer 34. The support member 41 includes a support  
ring 411 surrounding the longitudinal axis (L), a  
connecting ring 412 disposed inside the support ring  
411, a plurality of angularly spaced-apart spokes 413  
25 connected between the support ring 411 and the  
connecting ring 412, a cross frame 414 connected to the  
connecting ring 412, and a plurality of rollers 415

mounted on the cross frame 414 and rollable on the inner circumferential surfaces 11, 21 along the longitudinal axis (L). The inflatable ring 42 is sleeved on the support ring 411. The cross frame 414 is configured as  
5 an inverted U-shaped frame. The clamping member 43 includes a pair of semi-circular clamping frames 431 removably coupled to each other through a plurality of bolts 432.

As shown in Figure 4, during assembly, the annular  
10 end faces 13, 23 of the first and second pipes 10, 20 are first brought to abut against each other, after which the inner coil 31 is disposed in the annular notch 50 and the inner cover layer 32 is also disposed in the annular notch 50 to cover the inner coil 31. Next, the  
15 outer coil 33 is sleeved on the outer circumferential surfaces 12, 22 corresponding in position to the inner coil 31, and the outer cover layer 34 is sleeved on the outer coil 33 to cover the same. Afterwards, as shown in Figure 5, the support member 41 and the inflatable  
20 ring 42 are moved along the longitudinal axis (L) to a position corresponding to the inner cover layer 32 through the rollers 415, and the clamping frames 431 of the clamping member 43 are clamped and tightened around the outer cover layer 34.

25 As shown in Figures 5 and 6, the inflatable ring 42 is then inflated so as to expand radially outward so that the first and second pipes 10, 20 and the coupling

unit 30 are pressed outward by the support member 41, while the clamping member 43 moves radially inward to generate a clamping effect. Simultaneously, the inner coil 31 and the outer coil 33 are energized to generate heat so as to melt the first pipe 10, the second pipe 20, the inner cover layer 32 and the outer cover layer 34 under the pressure of the clamping unit 40. Specifically, the annular end faces 13, 23 of the first and second pipes 10, 20 are melted to fuse together the first and second pipes 10, 20 along the longitudinal axis (L), and the inner and outer cover layers 32, 34 are melted to radially fuse with the first and second pipes 10, 20 through the inner and outer coils 31, 33. Moreover, through the clearance of the inner coil 31, the inner cover layer 32 can be melted to radially fuse with the inner circumferential surfaces 11, 21 of the first and second pipes 10, 20. The inner coil 31 is completely embedded between the inner cover layer 32 and the first and second pipes 10, 20, so that generation of voids and bubbles can be prevented. By the same token, through the clearance of the outer coil 33, the outer cover layer 34 can be melted to radially fuse with the outer circumferential surfaces 12, 22 of the first and second pipes 10, 20. The outer coil 33 is completely embedded between the outer cover layer 34 and the first and second pipes 10, 20, so that generation of voids and bubbles can be similarly prevented.

Referring again to Figures 2 and 3, after the first and second pipes 10, 20 are fused together, the clamping unit 40 is removed from the first and second pipes 10, 20. Because the inner coil 31 is embedded between the inner cover layer 32 and the first and second pipes 10, 20, and because outer coil 33 is embedded between the outer cover layer 34 and the first and second pipes 10, 20, the structural strength of the junction between the first and second pipes 10, 20 is enhanced. Furthermore, because the inner cover layer 32 can be melted to radially fuse with the inner circumferential surfaces 11, 21 of the first and second pipes 10, 20 through the clearance of the inner coil 31, because the outer cover layer 34 can also be melted to radially fuse with the outer circumferential surfaces 12, 22 of the first and second pipes 10, 20 through the clearance of the outer coil 33, and through the use of the coupling unit 30, the structural strength of the junction between the first and second pipes 10, 20 can be further enhanced.

Additionally, with the inner coil 31 and the inner cover layer 32 being disposed in the annular notch 50, and with the inner cover layer 32 being flush with the inner circumferential surfaces 11, 21, pumped water can flow smoothly in the first and second pipes 10, 20 without resistance.

A method for assembling large-diameter underwater pipes according to this disclosure is described with

reference to Figures 2 to 6, and includes the following steps:

Step 1: preparing the first pipe 10, the second pipe 20, the coupling unit 30 and the clamping unit 40;

5        Step 2: as shown in Figure 4, abutting the annular end faces 13, 23 of the first and second pipes 10, 20 against each other, disposing the inner coil 31 in the annular notch 50, and covering the inner coil 31 with the annular inner cover layer 32;

10       Step 3: sleeving the outer coil 33 on the outer circumferential surfaces 12, 22 of the first and second pipes 10, 20 at a position corresponding to the inner coil 31, and covering the outer coil 33 with the annular outer cover layer 34;

15       Step 4: disposing the support member 41 inside the first and second pipes 10, 20 and sleeving the inflatable ring 42 around the support ring 411 of the support member 41;

20       Step 5: moving the support member 41 and the inflatable ring 42 inside the first and second pipes 10, 20 to a position corresponding to the inner cover layer 32 through the rollers 415;

25       Step 7: clamping and tightening the clamping frames 431 of the clamping member 43 around the outer cover layer 34 through the bolts 432;

Step 8: as shown in Figures 5 and 6, inflating the inflatable ring 42 so as to expand radially outward so

that the first and second pipes 10, 20 and the coupling unit 30 are pressed outward by the support member 41, while the clamping member 43 moves radially inward to generate a clamping effect;

5        Step 9: energizing the inner and outer coils 31, 33 so as to generate heat which melts the annular end faces 13, 23 of the first and second pipes 10, 20 to fuse together the first and second pipes 10, 20 along the longitudinal axis (L) and which melts the annular inner  
10      and outer cover layers 32, 34 to radially fuse with the first and second pipes 10, 20 through the inner and outer coils 31, 33; and

      Step 10: removing the clamping unit 40 from the first and second pipes 10, 20.

15        By using the foregoing steps, the coupling unit 30 and the junction between the first and second pipes 10, 20 can be firmly connected. Hence, the manufacturing process is easy, and the equipments used in the manufacturing process are simple, so that the  
20      manufacturing cost associated therewith can be reduced.

      In the description above, for the purposes of explanation, numerous specific details have been set forth in order to provide a thorough understanding of  
25      the embodiment(s). It will be apparent, however, to one skilled in the art, that one or more other embodiments may be practiced without some of these specific details.

It should also be appreciated that reference throughout this specification to "one embodiment," "an embodiment," an embodiment with an indication of an ordinal number and so forth means that a particular  
5 feature, structure, or characteristic may be included in the practice of the disclosure. It should be further appreciated that in the description, various features are sometimes grouped together in a single embodiment, figure, or description thereof for the purpose of  
10 streamlining the disclosure and aiding in the understanding of various inventive aspects.

While the disclosure has been described in connection with what is considered the exemplary embodiment, it is understood that this disclosure is  
15 not limited to the disclosed embodiment but is intended to cover various arrangements included within the spirit and scope of the broadest interpretation so as to encompass all such modifications and equivalent arrangements.

**CLAIMS**

1. An underwater pipe assembly comprising:

5 a first pipe made of a plastic material, extending along a longitudinal axis, and having an inner circumferential surface surrounding the longitudinal axis, an outer circumferential surface opposite to said inner circumferential surface, and an annular end face between the inner and outer circumferential surfaces;

10 a second pipe made of a plastic material, abutting against said first pipe the longitudinal axis, and having an inner circumferential surface surrounding the longitudinal axis, an outer circumferential surface opposite to said inner circumferential surface of said second pipe, and an annular end face between said inner and outer circumferential surfaces of said second pipe, said annular end faces of said first and second pipes abutting against each other;

20 a coupling unit including an inner coil surrounding said inner circumferential surfaces of said first and second pipes at a junction therebetween, an annular inner cover layer covering said inner coil, an outer coil sleeved on said outer circumferential surfaces of said first and second pipes at a position corresponding to said inner coil, and an annular outer cover layer covering said outer

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coil, each of said inner and outer coils having a first end portion located on one side of the junction of said first and second pipes, and a second end portion located on the other side of the junction of said first and second pipes and opposite to said first end portion; and

5 a clamping unit removably mounted on said first and second pipes at the junction therebetween, said clamping unit including a support member movably disposed inside said first and second pipes, an inflatable ring disposed between said support member and the junction between said first and second pipes, and a clamping member clamped around said annular outer cover layer, said support member including a support ring surrounding the longitudinal axis, a connecting ring disposed inside said support ring, a plurality of angularly spaced-apart spokes connected between said support ring and said connecting ring, a cross frame connected to said connecting ring, and a plurality of rollers mounted on said cross frame and rollable along said inner circumferential surfaces of said first and second pipes;

15 wherein, when said inner and outer coils are energized, said annular end faces of said first and second pipes are melted to fuse together said first and second pipes along the longitudinal axis, and

said annular inner and outer cover layers are melted to radially fuse with said first and second pipes.

2. The underwater pipe assembly as claimed in Claim 1,  
5 wherein said inner circumferential surface of said first pipe has a first annular recess extending inwardly and axially from said annular end face of said first pipe, said inner circumferential surface of said second pipe having a second annular recess  
10 extending inwardly and axially from said annular end face of said second pipe, said first and second annular recesses communicating with each other along the longitudinal axis and cooperatively forming an annular notch, said inner coil and said annular inner  
15 cover layer being disposed in said annular notch, said first end portion of said inner coil being located in said first annular recess, said second end portion of said inner coil being located in said second annular recess, said annular inner cover  
20 layer being flush with said inner circumferential surfaces of said first and second pipes.
3. The underwater pipe assembly as claimed in Claim 1,  
25 wherein a length of said annular outer cover layer along the longitudinal axis is greater than that of said annular inner cover layer along the longitudinal axis.

4. The underwater pipe assembly as claimed in Claim 1,  
wherein each of said first and second pipes is made  
of a polyethylene material, and each of said annular  
5 inner and outer cover layers is made of one of  
polyethylene and polypropylene materials.
5. A method for assembling underwater pipes, comprising  
the steps of:
  - 10 (A) preparing a first pipe, a second pipe, a  
coupling unit and a clamping unit, each of the first  
and second pipes being made of a plastic material  
and extending along a longitudinal axis, each of the  
first and second pipes having an inner circum-  
15 ferential surface surrounding the longitudinal axis,  
an outer circumferential surface opposite to the  
inner circumferential surface, and an annular end  
face between the inner and outer circumferential  
surfaces, the coupling unit including inner and  
20 outer coils and annular inner and outer cover layers,  
the clamping unit including a support member, an  
inflatable ring and a clamping member, the support  
member including a support ring surrounding the  
longitudinal axis;
  - 25 (B) abutting the annular end faces of the first  
and second pipes against each other, disposing the  
inner coil on the inner circumferential surfaces of

the first and second pipes at a junction therebetween, and covering the inner coil with the annular inner cover layer;

5 (C) sleeving the outer coil on the outer circumferential surfaces of the first and second pipes at a position corresponding to the inner coil, and covering the outer coil with the annular outer cover layer;

10 (C-1) disposing the support member inside the first and second pipes;

(C-2) sleeving the inflatable ring on the support ring of the support member;

15 (C-3) moving the support member and the inflatable ring to a position corresponding to the annular inner cover layer;

(C-4) clamping the clamping member around the annular outer cover layer;

(D) clamping tightly the first and second pipes and the coupling unit using the clamping unit;

20 (E) energizing the inner and outer coils so as to generate heat which melts the annular end faces of the first and second pipes to fuse together the first and second pipes along the longitudinal axis and which melts the annular inner and outer cover layers to radially fuse with the first and second  
25 pipes; and

(F) removing the clamping unit from the first and

second pipes.

6. The method as claimed in Claim 5, further comprising  
the step of inflating the inflatable ring after step  
5 (D) and before the step (E).

7. The method as claimed in Claim 5, wherein, in step  
(A), the inner circumferential surface of the first  
pipe has a first annular recess extending inwardly  
10 and axially from the annular end face of the first  
pipe, the inner circumferential surface of the  
second pipe having a second annular recess extending  
inwardly and axially from the annular end face of  
the second pipe, the first and second annular  
15 recesses communicating with each other along the  
longitudinal axis and cooperatively forming an  
annular notch, the inner coil and the annular inner  
cover layer being disposed in the annular notch.

20 8. The method as claimed in Claim 5, wherein, in step  
(A), each of the first and second pipes is made of  
a polyethylene material, and each of the annular  
inner and outer cover layers is made of one of  
polyethylene and polypropylene materials.

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9. The method as claimed in Claim 5, wherein, in step  
(A), the support member further includes a

connecting ring disposed inside the support ring,  
a plurality of angularly spaced-apart spokes  
connected between the support ring and the  
connecting ring, a cross frame connected to the  
5 connecting ring, and a plurality of rollers mounted  
on the cross frame and rollable along the inner  
circumferential surfaces of the first and second  
pipes; and wherein, in step (C-3), the support member  
and the inflatable ring are moved using the rollers.