

PIPE ASSEMBLY AND METHOD OF FITTING A PIPE ASSEMBLY

Cross Reference to Related Application(s)

- 5 The present disclosure claims the benefit of Singapore Patent Application 10202401260S filed on 30 April 2024, which is incorporated in its entirety by reference herein.

Technical Field

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The present disclosure generally relates to a pipe assembly and a method of fitting a pipe assembly.

Background

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Long lengths of pipelines are used in various applications, such as in oil and gas pipelines, water treatment plants, or chemical processing systems. Due to length limitation of individual pipes, multiple pipes need to be connected to extend the pipelines. Flanged joints are commonly used to connect pipes together.

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Figure 1A shows a conventional pipe assembly 10 including a first pipe 11 and a second pipe 12 joined together by a flanged joint 13. Bolt and nut sets 14 are used to tighten the flanged joint 13. As shown in Figures 1B and 1C, the flange joint 13 includes a lap flange 13a and a stub end 13b for each respective pipe 11,12. The lap flange 13a is slid over the respective pipe 11,12 and the stub end 13b is joined to the end of the respective pipe 11,12, such as by a butt weld 13c.

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Further as shown in Figure 1D, the pipe assembly 10 also includes a pipe lining material 15 formed on internal surfaces of the pipes 11,12. For example, the pipes 11,12 are steel pipes lined with a fluoropolymer material 15, such as polytetrafluoroethylene (PTFE) which is known for its chemical resistance and low friction. The PTFE material 15 helps to protect the internal surfaces of the pipes 11,12 from corrosions and damage, and allows for smooth liquid flow in the pipes 11,12. The

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PTFE material 15 flares out to the flange joint 13 that is tightened by the bolt and nut sets 14, thereby forming a seal to prevent leakage when liquid flows through the connected pipes 11,12. PTFE-lined steel pipes 11,12 are particularly useful in industries such as chemical processing, oil and gas, and pharmaceutical, where the pipes 11,12 are subject to corrosive chemicals, high temperatures, and high pressures.

However, when the pipe assembly 10 is used in high-temperature applications, such as when a hot liquid media 16 flows through the pipes 11,12, the PTFE material 15 gets heated by the hot liquid media 16 and softens. The tightened bolt and nut sets 14 provide continued compression on the softened PTFE material 15 between the stub ends 13b, forcing the PTFE material 15 to creep radially out from the flanged joint 13, as shown by the arrows 17 in Figure 1E. This creeping of PTFE material 15 thins the PTFE material 15 and weakens the seal at the flanged joint 13.

When the hot liquid media 16 stops flowing through the pipes 11,12, the temperature reduces and the PTFE material 15 cools down. However, the PTFE material 15 may not revert to its original thickness after cooling down due to intrinsic shape memory properties of the PTFE material 15. If the thickness of the PTFE material 15 is significantly reduced, the bolt and nut sets 14 cannot tighten the flanged joint 13 sufficiently to maintain the seal at flanged joint 13. When the liquid media 16 next flows through the pipes 11,12, the liquid media 16 may leak out through the flanged joint 13 since the seal is no longer properly formed. Depending on the application or industry, this liquid leakage may be hazardous to people and the environment.

One way to address this problem is to re-torque the bolt and nut sets 14 to tighten the flanged joint 13 and repair the seal. This can be done after a few rounds of temperature cycles in addition to the regular maintenance requirements. However, the maintenance costs for such set-ups can be prohibitively high, especially for set-ups at heights or in inaccessible locations where scaffolding or personnel lifting equipment is required. Moreover, there are potential risks of chemical leakages of the PTFE material 15 and/or the liquid media 16 during maintenance.

This problem of regularly re-torquing the bolt and nut sets 14 is even more significant for large plants and systems with longer pipelines. These long pipelines have a large number of flanged joints 13 that present multiple points of leakage risk. Regularly tightening this large number of flanged joints 13 would require even higher maintenance costs.

Therefore, in order to address or alleviate at least one of the aforementioned problems and/or disadvantages, there is a need to provide an improved pipe assembly and a method of fitting a pipe assembly.

Summary

According to a first aspect of the present disclosure, a pipe assembly is disclosed. The pipe assembly comprises: a first pipe; a first flange collar joined to an end of the first pipe, the first flange collar comprising a circumferential lip that defines a flare cavity; a second pipe coupled to the first pipe; a second flange collar joined to an end of the second pipe, the second flange collar comprising a circumferential lip that defines a flare cavity, the flange collars facing towards each other; a pipe lining material formed on internal surfaces of the pipes and flared out into the flare cavities of the flange collars; and a flange assembly at the ends of the pipes and coupling the pipes to each other. The flange assembly is configured to couple the flange collars towards each other and force physical contact between the circumferential lips, thereby compressing the pipe lining material in the flare cavities to seal the pipe lining material in the flare cavities.

According to a second aspect of the present disclosure, a method for fitting a pipe assembly is disclosed. The method comprises: joining a first flange collar to an end of a first pipe, the first flange collar comprising a circumferential lip that defines a flare cavity; joining a second flange collar to an end of a second pipe, the second flange collar comprising a circumferential lip that defines a flare cavity; forming an pipe lining material on internal surfaces of the pipes; flaring out the pipe lining material into the flare cavities of the flange collars; coupling the pipes to each other using a flange assembly at the ends of the pipes, the flange collars facing towards each other; and

forcing the flange collars towards each other using the flange assembly, thereby compressing the pipe lining material in the flare cavities and forcing physical contact between the circumferential lips to seal the pipe lining material in the flare cavities.

- 5 The pipe assembly and the method for fitting a pipe assembly according to the present disclosure advantageously tightly seals the flange collars and eliminates or reduces the leaks in the pipe assembly.

10 A pipe assembly and a method for fitting a pipe assembly according to the present disclosure are thus disclosed herein. Various features, aspects, and advantages of the present disclosure will become more apparent from the following detailed description of the embodiments of the present disclosure, by way of non-limiting examples only, along with the accompanying drawings.

15 **Brief Description of the Drawings**

Figures 1A to 1E are illustrations of a conventional pipe assembly.

20 Figures 2A to 2C are illustrations of a pipe assembly according to embodiments of the present disclosure.

Figures 3A and 3B are further illustrations of the pipe assembly according to embodiments of the present disclosure.

25 Figure 4 is a flowchart illustration of a method of fitting the pipe assembly according to embodiments of the present disclosure.

Detailed Description

30 For purposes of brevity and clarity, descriptions of embodiments of the present disclosure are directed to a pipe assembly and a method for fitting a pipe assembly in accordance with the drawings. While aspects of the present disclosure will be described in conjunction with the embodiments provided herein, it will be understood

that they are not intended to limit the present disclosure to these embodiments. On the contrary, the present disclosure is intended to cover alternatives, modifications and equivalents to the embodiments described herein, which are included within the scope of the present disclosure as defined by the appended claims. Furthermore, in the following detailed description, specific details are set forth in order to provide a thorough understanding of the present disclosure. However, it will be recognized by an individual having ordinary skill in the art, i.e. a skilled person, that the present disclosure may be practiced without specific details, and/or with multiple details arising from combinations of aspects of particular embodiments. In a number of instances, well-known systems, methods, procedures, and components have not been described in detail so as to not unnecessarily obscure aspects of the embodiments of the present disclosure.

In embodiments of the present disclosure, depiction of a given element or consideration or use of a particular element number in a particular figure or a reference thereto in corresponding descriptive material can encompass the same, an equivalent, or an analogous element or element number identified in another figure or descriptive material associated therewith.

References to “an embodiment / example”, “another embodiment / example”, “some embodiments / examples”, “some other embodiments / examples”, and so on, indicate that the embodiment(s) / example(s) so described may include a particular feature, structure, characteristic, property, element, or limitation, but that not every embodiment / example necessarily includes that particular feature, structure, characteristic, property, element or limitation. Furthermore, repeated use of the phrase “in an embodiment / example” or “in another embodiment / example” does not necessarily refer to the same embodiment / example.

The terms “comprising”, “including”, “having”, and the like do not exclude the presence of other features / elements / steps than those listed in an embodiment. Recitation of certain features / elements / steps in mutually different embodiments does not indicate that a combination of these features / elements / steps cannot be used in an embodiment.

As used herein, the terms “a” and “an” are defined as one or more than one. The use of “/” in a figure or associated text is understood to mean “and/or” unless otherwise indicated. The term “set” is defined as a non-empty finite organisation of elements that
5 mathematically exhibits a cardinality of at least one (e.g. a set as defined herein can correspond to a unit, singlet, or single-element set, or a multiple-element set), in accordance with known mathematical definitions. The terms “first”, “second”, etc. are used merely as labels or identifiers and are not intended to impose numerical requirements on their associated terms.

10 A pipe assembly 100 is disclosed according to various embodiment of the present disclosure with reference to Figure 2. The pipe assembly 100 includes a first pipe 110 and a second pipe 120 coupled to the first pipe 110. Preferably, the pipes 110,120 are metal pipes. More preferably, the metal pipes are steel pipes.

15 The pipe assembly 100 includes a first flange collar 130 joined to an end of the first pipe 110. The pipe assembly 100 includes a second flange collar 140 joined to an end of the second pipe 120. The flange collars 130,140 are metal collars, such as steel, aluminium etc., depending on the application and/or the material of the pipes 110,120.
20 Preferably, the flange collars 120,140 are steel collars. Preferably, the flange collars 130,140 are fillet welded 131,141 to the respective pipes 110,120.

The flange collars 130,140 may alternatively be made of exotic metals which are specialized alloys that offer enhanced properties beyond standard steel, particularly
25 to resist corrosion by harsh liquid media flowing through the pipes 110,120. These exotic metals include but are not limited to stainless steel, titanium alloys, and nickel alloys.

As shown in Figure 2B, the first flange collar 130 has a circumferential lip 132 that
30 defines a flare cavity 134. As shown in Figure 2C, the second flange collar 140 comprises a circumferential lip 142 that defines a flare cavity 144. The circumferential lips 132,142 are protruding edges extending outward from the respective flange collars

130,140. For example, the flange collars 130,140 have an annular shape and the circumferential lips 132,142 form a ring around the annular flange collars 130,140.

In the pipe assembly 100, the first and second flange collars 130,140 face towards each other and are aligned so that the circumferential lips 132,142 are mated together with direct physical contact between them. The mating surfaces of the circumferential lips 132,142 are preferably flat to ensure no or very minimal gap between the mating surfaces.

The pipe assembly 100 further includes a pipe lining material 150 formed on internal surfaces of the pipes 110,120. Further, the pipe lining material 150 is flared out into the flare cavities 134,144 of the flange collars 130,140. Preferably, the pipe lining material 150 comprises a fluoropolymer material. More preferably, the fluoropolymer material is PTFE for its chemical resistance and low friction properties. Other fluoropolymer materials for the pipe lining material 150 may be used, such as but not limited to perfluoroalkoxy alkanes (PFA), fluorinated ethylene propylene (FEP), polyvinylidene fluoride (PVDF). Other materials that may be suitable for the pipe lining material 150 include polypropylene (PP). Particularly, PTFE and PFA fluoropolymer materials are chemically inert with near universal corrosion resistance, allowing the pipe assembly 100 to transport highly corrosive and toxic liquid media that may be necessary in certain applications and industries.

The thickness of the pipe lining material 150 may vary depending on factors such as the diameter of the pipes 110,120, the liquid media being carried, and the materials of the pipes 110,120. For example, the pipe lining material 150 may have a thickness of at least 3 mm on the internal surfaces of the pipes 110,120.

The pipe assembly 100 further includes a flange assembly 160 at the ends of the pipes 110,120 and coupling the pipes 110,120 to each other. The flange assembly 160 includes lap flanges 162 coupled to the respective pipes 110,120, as well as bolt and nut sets 164 to tighten the flange assembly 160. The lap flanges 162 are freely rotatable around the pipes 110,120 to facilitate alignment of flange bolt holes for the bolt and nut sets 164.

The flange assembly 160 is configured to couple the first and second flange collars 130,140 towards each other and force physical contact between the circumferential lips 132,142, thereby compressing the pipe lining material 150 in the flare cavities 134,144. For example in the first flange collar 130, the pipe lining material 150 extends axially out of the flare cavity 134 beyond the circumferential lip 132, and in the second flange collar 140, the pipe lining material 150 extends axially out of the flare cavity 144 beyond the circumferential lip 142. When the mating surfaces of the circumferential lips 132,142 are in direct physical contact with each other, the pipe lining material 150 in both flare cavities 134,144 are also in direct physical contact with each other and are compressed by the flange assembly 160. For example, the bolt and nut sets 164 are appropriately torqued to tighten the flange assembly 160 and force the flange collars 130,140 towards each other, thereby compressing the pipe lining material 150 and sealing the pipe lining material 150 in the flare cavities 134,144. This compression of the pipe lining material 150 may cause the pipe lining material 150 to creep radially towards the circumferential lips 132,142, but the pipe lining material 150 remains sealed within the flare cavities 134,144 due to the forced physical contact between the circumferential lips 132,142.

In some embodiments, the flange collars 130 are made of metal and the flange assembly 160 couples the flange collars 130,140 to achieve metal-to-metal contact at the aligned mating surfaces of the circumferential lips 132,142. The pipe lining material 150 is preferably PTFE that is compressed by the flange assembly 160, thus forming a tight seal between the connected pipes 110,120. Because of the metal-to-metal contact, the bolt and nut sets 164 can be tightened beyond the typical tightening torques for PTFE-lined pipes, such as of the conventional pipe assembly 10, to provide a more rigid and tight connection at the flange collars 130,140.

When the pipe assembly 100 is used in high-temperature applications, such as when a hot liquid media flows through the pipes 110,120, the PTFE material 150 gets heated by the hot liquid media and softens. However, the softened PTFE material 150 cannot creep radially out because it is sealed within the flare cavities 134,144 and by the

forced metal-to-metal contact between the circumferential lips 132,142. Thus, there is no thinning of the PTFE material 150 and the seal is properly maintained.

When the hot liquid media stops flowing through the pipes 110,120, the temperature
5 reduces and the PTFE material 150 cools down. As the PTFE material 150 has not
thinned, it maintains its original thickness after cooling down, and the bolt and nut sets
164 retain their tension and the flange collars 130,140 remain tightly coupled by the
flange assembly 160, thereby maintaining the seal. When the liquid media next flows
10 through the pipes 110,120, the liquid media would not leak out as the seal formed by
the compressed PTFE material 150 is still properly formed. This helps to improve
industrial safety as leakage of hazardous liquid media can be prevented or reduced,
especially in the event of a fire which can also melt away the PTFE material 150.

Further, as the flange assembly 160 remain adequately tightened even after several
15 temperature cycles, the torque provided by the bolt and nut sets 164 is not reduced.
This eliminates or reduces the need for regular re-tightening of the bolt and nut sets
164, thus reducing maintenance costs and requirements for the pipe assembly 100.

In some embodiments, the flange collars 130 are made of an exotic metal or exotic
20 steel to resist corrosion by the liquid media flowing through the pipes 110,120.
Particularly, the liquid media may seep through the PTFE material 150 and contact the
flange collars 130. The liquid media may be a harsh substance that would corrode
standard steel easily. Flange collars 130,140 made of exotic steels would be more
corrosion resistant to the harsh liquid media, consequently prolonging the lifespan of
25 the pipe assembly 100. Further, having just the flange collars 130,140 made of exotic
steels would be more economical compared to having a complete piping system
including the entire pipe assembly 100 and the pipes 110,120 made of exotic steels.

In some embodiments as shown in Figures 2B and 2C, the first flange collar 130
30 includes a set of grooves 136 and the second flange collar 140 includes a set of
grooves 146. Preferably, the first flange collar 130 includes two or more grooves 136
and the second flange collar 140 includes two or more grooves 146. When the flange
assembly 160 compresses the pipe lining material 150 in the flare cavities 134,144,

the grooves 136,146 may become filled with the pipe lining material 150. Specifically, the compression of the pipe lining material 150 may cause the pipe lining material 150 to creep into the grooves 136,146, in addition to or instead of creeping radially towards the circumferential lips 132,142. The grooves 136,146 also help to prevent the pipe lining material 150 from creeping inward into the pipes 110,120 and prevent slippage of the pipe lining material 150 along the surfaces of the flange collars 130,140 as the pipe lining material 150 has low coefficient of friction. The number and arrangement of the grooves 136,146 may vary depending on the size of the pipes 110,120 and flange collars 130,140.

In some embodiments as shown in Figures 3A and 3B, the pipe assembly 100 includes an elastomeric O-ring 170 disposed between the circumferential lips 132,142. The elastomeric O-ring 170 is compressible by the flange assembly 160 forcing physical contact between the circumferential lips 132,142. The elastomeric O-ring 170 provides an additional leakproof and pressure-tight seal between the flange collars 130,140, further helping to prevent or reduce leakage from the pipes 110,120. Preferably the O-ring 170 is made of an elastomeric material that is suitable for use and compatible with the liquid media carried by the pipes 110,120.

With reference to Figure 4, various embodiments of the present disclosure also describe a method 300 for fitting a pipe assembly, such as the pipe assembly 100 as described above. It will be appreciated that various aspects of the pipe assembly 100 described above apply equally to the method 300 and vice versa.

The method 300 includes a step 302 of joining a first flange collar 130 to an end of a first pipe 110, the first flange collar 130 having a circumferential lip 132 that defines a flare cavity 134. For example, the first flange collar 130 is joined to the first pipe 110 by a fillet weld 131.

The method 300 includes a step 304 of joining a second flange collar 140 to an end of a second pipe 120, the second flange collar 140 having a circumferential lip 142 that defines a flare cavity 144. For example, the second flange collar 140 is joined to the second pipe 120 by a fillet weld 141.

The method 300 includes a step 306 of forming an pipe lining material 150 on internal surfaces of the pipes 110,120. For example, the pipe lining material 150 includes PTFE, PFA, FEP, PVDF, or PP. Preferably, the pipe lining material 150 includes the PTFE fluoropolymer material. The method 300 includes a step 308 of flaring out the pipe lining material 150 into the flare cavities 134,144 of the flange collars 130,140.

The pipe lining material 150 may be deposited by coating, rotational lining, spray coating, insert lining, sheet lining, etc. depending on the pipe material and diameter, the required lining thickness, and/or operating condition.

As an example of lining the pipes 110,120 with PTFE, PTFE cylinders are first heated to a temperature until it becomes pliable. A heated PTFE cylinder is then inserted into the respective pipe 110,120. The PTFE cylinder normally has a larger diameter than the pipe 110,120, but heating the PTFE cylinder stretches the PTFE cylinder and facilitates its insertion into the respective pipe 110,120. As the PTFE cylinder cools in the respective pipe 110,120, it returns to its original size and forms a tight fit against the internal surface of the respective pipe 110,120. Further, by heating and compressing the PTFE cylinder against both ends of the respective pipe 110,120, the extra length of the PTFE cylinder that is permitted at either end of the respective pipe 110,120 is flared, thus flaring out the PTFE material 150 into the flare cavities 134,144.

The method 300 includes a step 310 of coupling the pipes 110,120 to each other using a flange assembly 160 at the ends of the pipes 110,120. Specifically, the pipes 110,120 are aligned and the flange collars 130,140 are arranged to face towards each other. The flange assembly 160 includes lap flanges 162 that can be slid along the respective pipes 110,120 towards the respective flange collars 130,140. The lap flanges 162 are freely rotatable around the pipes 110,120 to facilitate alignment of flange bolt holes of the lap flanges 162. The flange assembly 160 includes bolt and nut sets 164 through the flange bolt holes to tighten the flange assembly 160.

The method 300 includes a step 312 of forcing the flange collars 130,140 towards each other using the flange assembly 160. For example, the bolt and nut sets 164 are

appropriately torqued to tighten the flange assembly 160. This compresses the pipe lining material 150 in the flare cavities 134,144 and forces physical contact between the circumferential lips 132,142 to seal the pipe lining material 150 in the flare cavities 134,144.

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In some embodiments, the flange collars 130,140 include respective sets of grooves 136,146. When the flange assembly 160 compresses the pipe lining material 150 in the flare cavities 134,144, the grooves 136,146 become filled with the pipe lining material 150. In some embodiments, the method 300 includes disposing an elastomeric O-ring 170 between the circumferential lips 132,142. The elastomeric O-ring 170 is compressible by the flange assembly 160 forcing physical contact between the circumferential lips 132,142, thus forming an additional leakproof seal.

The pipe assembly 100 according to various embodiments of the present disclosure advantageously ensure leakproof seal in the joint between the flange collars 130,140. The seal prevents leakage of the pipe lining material 150 and/or liquid media carried in the pipes 110,120, even in extreme conditions such as fire. In addition, minimal maintenance is required on the flange assembly 160, such as regular re-torquing of the bolt and nut sets 164, hence reducing the costs and manpower for maintenance.

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The pipe assembly 100 may be used in various piping systems. For example, the pipe assembly 100 may be used in a fire-safe lined piping system designed to resist fire damage and maintain structural integrity during a fire. The fire-safe lined piping system may include fire-safe lined valves and other sealing components to prevent or reduce spillage of hazardous liquid media, especially if the PTFE material 150 lining the pipes 110,120 melt away during the fire.

The pipe assembly 100 may also be used in pipe-ring fire system that transports seawater in the pipe network, such as to cool storage tanks in the event of a fire. Standard pipes in the pipe-ring fire system are typically made of carbon steel. These carbon steel pipes can corrode over time and often require cleaning to remove the internal rust, or even need to be replaced if the corrosion is extensive. Pipes with PTFE

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lining material can protect the internal surfaces of the pipes and reduce maintenance costs for the pipe-ring fire system using PTFE-lined pipes.

5 In the foregoing detailed description, embodiments of the present disclosure in relation to a pipe assembly and a method for fitting a pipe assembly are described with reference to the provided figures. The description of the various embodiments herein is not intended to call out or be limited only to specific or particular representations of the present disclosure, but merely to illustrate non-limiting examples of the present disclosure. The present disclosure serves to address at least one of the mentioned
10 problems and issues associated with the prior art. Although only some embodiments of the present disclosure are disclosed herein, it will be apparent to a person having ordinary skill in the art in view of this disclosure that a variety of changes and/or modifications can be made to the disclosed embodiments without departing from the scope of the present disclosure. Therefore, the scope of the disclosure as well as the
15 scope of the following claims is not limited to embodiments described herein.

Claims

1. A pipe assembly comprising:
 - a first pipe;
 - 5 a first flange collar joined to an end of the first pipe, the first flange collar comprising a circumferential lip that defines a flare cavity;
 - a second pipe coupled to the first pipe;
 - a second flange collar joined to an end of the second pipe, the second flange collar comprising a circumferential lip that defines a flare cavity, the
 - 10 flange collars facing towards each other;
 - a pipe lining material formed on internal surfaces of the pipes and flared out into the flare cavities of the flange collars; and
 - a flange assembly at the ends of the pipes and coupling the pipes to each other,
 - 15 wherein the flange assembly is configured to couple the flange collars towards each other and force physical contact between the circumferential lips, thereby compressing the pipe lining material in the flare cavities to seal the pipe lining material in the flare cavities.
- 20 2. The pipe assembly according to claim 1, wherein each flange collar comprises a set of grooves, and wherein compressing the pipe lining material in the flare cavities causes the pipe lining material to fill the grooves.
3. The pipe assembly according to claim 1 or 2, further comprising an elastomeric
- 25 O-ring disposed between the circumferential lips, wherein the elastomeric O-ring is compressible by the flange assembly forcing physical contact between the circumferential lips.
4. The pipe assembly according to any one of claims 1 to 3, wherein the respective
- 30 flange collar is fillet welded to the respective pipe.
5. The pipe assembly according to any one of claims 1 to 4, wherein the pipe lining material comprises a fluoropolymer material.

6. A method for fitting a pipe assembly, the method comprising:

joining a first flange collar to an end of a first pipe, the first flange collar comprising a circumferential lip that defines a flare cavity;

5 joining a second flange collar to an end of a second pipe, the second flange collar comprising a circumferential lip that defines a flare cavity;

forming a pipe lining material on internal surfaces of the pipes;

flaring out the pipe lining material into the flare cavities of the flange collars;

10 coupling the pipes to each other using a flange assembly at the ends of the pipes, the flange collars facing towards each other; and

forcing the flange collars towards each other using the flange assembly, thereby compressing the pipe lining material in the flare cavities and forcing physical contact between the circumferential lips to seal the pipe lining material
15 in the flare cavities.

7. The method according to claim 6, wherein each flange collar comprises a set of grooves, and wherein compressing the pipe lining material in the flare cavities causes the pipe lining material to fill the grooves.

8. The method according to claim 6 or 7, further comprising disposing an elastomeric O-ring between the circumferential lips, wherein the elastomeric O-ring is compressible by the flange assembly forcing physical contact between the circumferential lips.

9. The method according to any one of claims 6 to 8, wherein joining the respective flange collar to the respective pipe comprises fillet welding the respective flange collar to the respective pipe.

10. The method according to any one of claims 6 to 9, wherein the pipe lining material comprises a fluoropolymer material.