

The invention relates to a method of producing a tube conduit connection from a tube end of a tube made of polyolefin and a connecting member, in which method the tube end of the tube made of polyolefin has an inner diameter smaller than the outer diameter of the connecting member and the tube end is expanded at environmental temperature with the use of an expanding mandrel to an inner diameter greater than the outer diameter of the connecting member, the expanding mandrel is removed and the still expanded tube end of the tube and the connecting member are telescoped onto each other and subsequently interconnected by shrinking after removal of the expanding mandrel.

The invention also relates to a tube conduit connection comprising an end portion of a connecting member and a tube end of a tube made of polyolefin and having an inner diameter which is smaller than the outer diameter of the end portion of the connecting member, whereby the tube end of the tube, which tube end has been expanded at environmental temperature, is shrunk onto the end portion of the connecting member.

Finally, the invention further relates to a tube conduit connection comprising a first tube end of a first tube and a second tube end of a second tube made of polyolefin and having an inner diameter which is smaller than the outer diameter of the first tube end, whereby the first tube end, which has been expanded at environmental temperature, is shrunk onto the second tube end.

In a known method and a known tube conduit connection of this type (DE-A-3 817 442) the tube conduit connection is produced by means of, for example, a shrink-on sleeve which

bridges the tube ends of two tubes. The shrink-on sleeve may consist of a thermo-elastic material like cross-linked polyolefin. The shrink-on sleeve is connected to the tube ends due to the fact that the cross-linked polyolefin can be deformed after being heated above the crystallite melting point and pushed onto the tube ends with expansion in this heated condition. In the same manner the tube end of a tube which is made of cross-linked polyolefin, can be pushed onto a connecting member, for example, a T-piece.

From EP-A-0 102 919 there are known a method of connecting tubes and a thus produced tube connection in which a first tube end made of cross-linked polyolefin is expanded in the cold state, preferably, however, in a condition heated above the crystallite melting temperature. A second tube end is, then, inserted into the expanded and cooled first tube end. Subsequently, the expanded tube is heated above the crystallite melting temperature, whereby it shrinks onto the second tube end and a sealing connection is formed between the tube ends.

Carrying out these known methods leads in practice to certain difficulties because the cross-linked polyolefin must be heated to relatively high temperatures, for instance, above 135°C in the case of cross-linked polyethylene, and can be deformed sufficiently readily only at this temperature. Therefore, if cooling and "freezing" of the deformed state are considered unacceptable, it will be decisive that the parts in question are interconnected within a sufficiently brief period of time so that no cooling below the crystallite melting point of, for example, above 135°C can occur during this period of time.

It is the object of the invention to provide a method of the initially mentioned type for producing a tube conduit

connection and which method permits producing a secure tube conduit connection under normal, i.e. ambient temperatures, as well as to provide a tube conduit connection of the initially mentioned type which can be produced under environmental conditions and constitutes a secure sealing connection.

With respect to the method, this object is achieved according to the invention by firmly and sealingly connecting the tube end, which is made of polyolefin and which has been expanded at environmental temperature, to the connecting member by self-reconversion at environmental temperature.

Regarding the tube conduit connection of the connecting member and the tube end, this object is achieved in that the tube end which is made of polyolefin and reversibly expanded at environmental temperature, is firmly and sealingly connected to the connecting member by self-reconversion at environmental temperature.

With respect to the tube conduit connection made of two tube ends, this object is achieved in that the first tube end which is made of polyolefin, is reversibly expanded and firmly and sealingly connected to the second tube end by self-reconversion at environmental temperature.

The invention is based on the surprising recognition that thermo-elastic polyolefins, particularly medium density, high density or cross-linked polyolefins, have sufficiently extensive, reversible deformability even in the cold and partially crystalline condition, i.e. in a condition in which such material is not heated above the crystallite melting point. This means that the polyolefin can be deformed under mechanical action but tends to re-assume the

original shape in the deformed condition. Upon application of sufficiently high forces, for example, by means of an expanding mandrel of conventional construction for expanding tubes, it is thus possible to reversibly expand tube ends of tubes which are made of polyolefin. Under the conditions prevailing at ambient or environmental temperature, self-reconversion to the original condition, i.e. the original tube width, proceeds at relatively low rate so that the expanding mandrel can be removed from the expanded tube end and the still expanded tube end can be telescoped onto the respectively desired connecting member. The rate of self-reconversion, on the other hand, is sufficiently high so that there do not arise any undue waiting periods.

When compared to other materials, polyolefins have the advantage that the expansion, as far as remaining after connection to the connecting member, does not result in stress cracks.

The inventive method thus offers a particularly advantageous possibility of connecting tubes which are made of polyolefin, especially of medium density, high density and cross-linked polyolefins, to the respectively desired connecting member without the expense of heat energy. When carrying out this method, there is obtained an especially firm and sealing, specifically gas-tight connection due to the self-reconversion of the expanded tube end. During such self-reconversion, the polyolefin is fitted to surface structures which may be present at the connecting member. Such surface structures which increase the bonding strength, may be, for instance, beads, flutes, grooves or knurlings which are engaged by the reconverted polyolefin.

In connection with the method as described hereinbefore, further securing of the produced tube conduit connections is rendered possible, if required. Tube clamps of conventional type may be used therefore. However, it is also possible to attach a tension ring to the tube end of the tube made of polyolefin. If likewise being formed of a reversibly deformable material, such tension ring may be attached to the tube end from the start. It is, however, also possible pushing onto the tube conduit connection, at the end on the side of the tube and after the tube conduit connection has been produced, a tension ring which is not or only little deformable and made of, for example, metal with the use of known hydraulic means.

Exemplary embodiments of tube conduit connections produced by the method according to the invention, are illustrated in the drawings and will be discussed and described in detail hereinbelow in relation to reference characters. There are shown in

Figure 1 a sectional view of a tube conduit connection produced from a connecting member and a tube end applied thereto according to the inventive method;

Figure 2 a sectional view of a tube conduit connection as shown in Figure 1 and including a tension ring;

Figure 3 a sectional view of a tube conduit connection according to the invention between two tube ends.

In the sectional view of Figure 1, there will be recognized a connecting member 1 which may constitute, for instance, a straight piece of tubing, an angle tube, or

other connecting piece for connecting two tubes but which also may be, for example, a triple connector like a T-piece. This connecting member 1 is made of a material like metal, glass, ceramics, plastics or any other material selected for the respectively desired purpose of use. At each connecting location, the connecting member is provided with a surface structure which increases the bonding strength. In the illustrated exemplary embodiment this surface structure is formed by an end portion 2 which is thickened and tapers toward the end. Instead, there may be provided one or more beads, flutes or grooves or even knurlings or the like.

The illustration of Figure 1 shows a tube 3 which is made of polyolefin, preferably medium density, high density and in particular cross-linked polyolefin. The inner diameter of the tube 3 is smaller than the outer diameter of the connecting member 1; as illustrated, this diameter may be substantially equal to the inner diameter of the connecting member 1 whereby the formation of flow resistances due to constrictions and deposits can be prevented from forming at such constrictions in the medium flowing through the connecting member 1 and the tube 3. For producing the tube conduit connection, the tube end 4 is expanded at ambient temperature by means of, for example, an expanding mandrel of conventional construction to such extent that the inner diameter of the tube end 4 is at least as wide as the outer diameter of the connecting member 1 in the region of the thickened end portion 2. After pushing on beyond the thickened end portion 2, the tube end is subject to self-reconversion to the original dimensions. As a consequence, the tube end 4, as illustrated, is fitted to the outer profile of the connecting member 1. Since the tube end 3 originally had an inner diameter which was smaller than the outer diameter of the connecting member 1, the tube end 4

tightly engages along its length the end portion 2 of the connecting member 1. In the end, there is thus formed a relatively large-area, very tight connection between the tube end 4 and the connecting member 1.

Figure 2 shows a further embodiment of the tube conduit connection described hereinbefore and corresponding parts thereof are designated by the same reference characters. In this embodiment, a tension ring 5 is provided as additional safeguard for producing a sealing connection between the tube end 4 and the connecting member 1. This tension ring 5 preferably is made of the same material as the tube 3. In the illustrated exemplary embodiment the tube 3 as well as the tension ring 5 are made of cross-linked polyethylene. The inner diameter of the tension ring 5 is tightly fitted to the outer diameter of the tube 3 and pushed onto the tube end 4 prior to producing the tube conduit connection. During the subsequent expanding operation, the tension ring 5 is temporarily expanded conjointly with the tube end 4 so that the expanded tube end together with the attached tension ring 5 is applied to the end portion 2 of the connecting member 1. The following self-reconversion, then, will result in the sealing connection between the tube end 4 and the end portion 2 of the connecting member 1 in the above described manner, whereby also the tension ring 5 contracts and thus additionally presses the tube end 4 onto the the end portion 2 in the region of the tension ring 5.

Figure 3 shows a tube conduit connection which is formed between two tube ends. Both of the tubes may be made of the same material or may consist of different materials; preferably the tubes are made of cross-linked polyethylene and serve as tube conduits for corrosive media. As examples there are mentioned here industrial waste water, however, in particular domestic or community waste water which

require especially corrosion resistant tube materials and with respect to which tubes made of cross-linked polyolefin have proven useful in practice.

In the illustrated exemplary embodiment the two tubes have the same inner and outer diameters. However, this is of no concern, since the same tube conduit connection can also be produced between tubes having different diameters provided that the difference in the internal diameters connected therewith does not cause unacceptable flow resistances and deposits. A first tube 10 has a first tube end 11; a second tube 12 has a second tube end 13. It will be recognized that the inner diameter of the second tube end 13 has been expanded and this expanded second tube end 13 has been telescoped onto the first tube end 11 of the first tube 10. Like in the foregoing exemplary embodiments, this expansion is carried out at ambient temperature using a conventional expanding mandrel and is subject to the described self-reconversion due to which the expanded tube end 13 tends to re-assume its original shape. The large area, tight engagement between the two tube ends 11 and 13 also, in this case produces a sealing tube conduit connection which will not leak even during prolonged use due to the corrosion resistance of the material against the aforementioned waste waters.

Also here, like in the exemplary embodiment illustrated in Figure 2, the connection may be additionally secured by means of a tension ring. Care will have to be exercised, however, to ensure that there does not occur any undue deformation of the first tube end 11 under the action of the compressing pressure generated by such tension ring because such deformation would present a flow resistance for the throughflowing waste water or may cause deposits to form from the waste water in the region of the connecting

location. Instead of the tension ring, an adhesive agent may be employed, if desired, for additionally securing the connecting location.

Tubes made of cross-linked polyolefin thus are employed also for this reason in waste water technology because in this manner secure and self-sealing connections can be readily made between smooth tubes. Additionally thereto, there results the further advantage that the tubes 10 which are produced using a continuous process, can also be laid as endless tubes without there being required specific angle tubes or other connection implements in order to lay the tubes along to a desired course. Connections between the tubes, therefore, anyhow need only be provided at the input and output locations.



CLAIMS

1. Method of producing a tube conduit connection from a tube end (4) of a tube (3) made of polyolefin and a connecting member (1), in which method the tube end (4) of the tube (3) made of polyolefin has an inner diameter smaller than the outer diameter of the connecting member (1) and the tube end is expanded at environmental temperature with the use of an expansion mandrel to an inner diameter greater than the outer diameter of the connecting member (1), the expansion mandrel is removed, and the still expanded tube end (4) of the tube (3) and the connecting member (1) are telescoped onto each other and subsequently interconnected by shrinking,

characterised in that

the tube end (4) made of polyolefin, which has been expanded at environmental temperature, is firmly and sealingly connected to the connecting member (1) by self-reconversion at environmental temperature.

2. Method according to claim 1, characterised in that an end portion (2) of the connecting member (1) is provided with a surface structure for increasing the engagement surface with the tube end (4).
3. Method according to claim 1 or 2, characterised in that the connection is additionally secured by means of a tube clamp.
4. Method according to claim 1 or 2, characterised in that the connection is secured by means of a tension ring.



5. Method according to claim 4, characterised in that the tension ring (5) is made of a material which is expandable and self-reconvertible at environmental temperature and which is reversibly expanded conjointly with the tube end (4).
6. Method according to claim 4, characterised in that the tension ring is made of a material which is not or only little deformable, and hydraulically pushed onto the tube end surrounding the connecting member after making the connection.
7. Tube conduit connection comprising an end portion (2) of a connecting member (1) and a tube end (4) of a tube (3) made of polyolefin and having an inner diameter which is smaller than the outer diameter of the end portion (2) of the connecting member (1), whereby the tube end (4) of the tube (3), which has been expanded at environmental temperature, is shrunk onto the end portion (2) of the connecting member (1),

characterised in that

the tube end (4) made of polyolefin, which is reversibly expanded at environmental temperature, is firmly and sealingly connected to the end portion (2) of the connecting member (1) by self-reconversion at environmental temperature.

8. Tube conduit connection according to claim 7, characterised in that the end portion (2) of the connecting member (1) is provided with a surface structure for increasing the engagement surface with the tube end (4).



9. Tube conduit connection according to claim 7 or 8, characterised by a tension ring (5) applied to the tube end (4) and made of a material which is expandable and self-reconvertible at environmental temperature.
10. Tube conduit connection according to any one of claims 7 to 9, characterized in that the tube end (4) is selected from medium density, high density or cross-linked polyolefin.
11. Tube conduit connection comprising a first tube end (11) of a first tube (10) and a second tube end (13) of a second tube (12) made of polyolefin and having an inner diameter which is smaller than the outer diameter of the first tube end (11), whereby the first tube end (11), which has been expanded at environmental temperature, is shrunk onto the second tube end (13),

characterised in that

the first tube end (11) made of polyolefin, which is reversibly expanded at environmental temperature, is firmly and sealingly connected to the second tube end portion (13) by self-reconversion at environmental temperature.
12. Tube conduit connection according to claim 11, characterised in that the first tube end (11) of the first tube (10) is provided with a surface structure for increasing the engagement surface with the second tube end (13).
13. Tube conduit connection according to claim 11 or 12, characterised in that the connection is secured by means of a tension ring.



14. Tube conduit connection according to claim 13, characterised in that the tension ring (5) is made of a material which is expandable and self-reconvertible at environmental temperature.
15. Tube conduit connection according to any one of claims 11 to 14, characterised in that the first and second tube (10,12) are selected from medium density, high density or cross-linked polyolefin.