

Method for forming a socket on a pipe of biaxially oriented polyvinyl chloride.

The invention relates to a method for forming a socket on a pipe of biaxially oriented polyvinyl chloride according to the preamble of claim 1.

Such a method is disclosed by NL-A-9400894. The
5 pipe of biaxially oriented polyvinyl chloride may, for example, have been fabricated by means of the methods as described in WO 95/25627, WO 95/25628 and WO 95/30533.

In the case of the method disclosed by NL-A-9400894, an end section of the pipe on which the socket is
10 to be formed, is slipped onto a support section of a mandrel, which support section fits into the pipe. Then the internally supported pipe end section is heated, whereupon a socket-forming mandrel section which adjoins the support section and whose shape substantially corresponds to the
15 intended shape of the socket is forced into the heated end section of the pipe. Finally, the pipe end section still supported by the mandrel is cooled.

It was found that in the case of pipes on which sockets had been formed by means of the known method,
20 cracking occurred in a large number of cases in the socket section of the pipes. These cracks sometimes occurred even while the sockets were being formed, but also if the sockets were subsequently subjected to an impact load.

It is an object of the present invention to provide
25 a method which will afford sockets of better quality.

The present invention provides a method according to the preamble of claim 1, which is characterized in that, for the purpose of heating the internally supported end section of the pipe, said end section is first heated until
30 said end section has reached, substantially homogeneously, the glass transition temperature of polyvinyl chloride and is then further heated until the end section has reached, substantially homogeneously, a temperature near, preferably just above, the orientation temperature of polyvinyl

chloride.

In other words, the invention therefore proposes that the relevant internally supported end section of the pipe be heated in at least two steps: first to about the
5 glass transition temperature of polyvinyl chloride, which is at 80 - 85 °C, said heating being maintained for a sufficiently long period to ensure that the end section, as seen across the wall thickness, virtually uniformly is at this temperature, and in one or more subsequent steps to a
10 higher temperature which is in the vicinity of the orientation temperature, which is about 110 °C, and preferably to a value somewhat above the orientation temperature, for example to about 120 °C.

Preferably, the heating of the pipe in the region
15 of the end section comprises the external heating of the pipe and/or the heating of the support.

The heating means may comprise a heating ring, for example including an infrared radiator, which is situated around the support section of the mandrel, if this has
20 first been inserted into the pipe. The heat output of such a heating ring to the pipe can be controlled in a simple and accurate manner.

The invention will be explained hereinafter in more detail with reference to the drawing, in which:

25 Figure 1 shows a schematic longitudinal section of an illustrative embodiment of an apparatus for forming a socket on a biaxially oriented pipe during the initial phase of the method according to the invention,

Figure 2 shows a view corresponding to Figure 1
30 during the end phase of the method according to the invention, and

Figure 3 shows the variation with time of the temperature of the internally supported end section of the pipe during the heating operation in the manner according
35 to the invention.

The following description starts from a previously fabricated pipe of biaxially oriented polyvinyl chloride having a smooth, cylindrical wall, which is to be provided with a socket.

The apparatus 10 shown in Figures 1 and 2 enables a socket to be formed on a biaxially oriented pipe 11, the socket being provided directly with an elastic sealing ring 12.

- 5 The apparatus 10 comprises a hollow cylindrical mandrel 13 which is open at one end. The mandrel 13 has a support section 14, a transition section 15 and a socket-forming section 16. The socket-forming section 16 is provided with a circumferential groove 17 on the outside.
- 10 The apparatus 10 further comprises a support ring 18 which can slide over the socket-forming section 16. For the purpose of heating and subsequent cooling of the end section of the pipe 11 to be processed, the apparatus comprises a heating device 20 and a cooling device 22.
- 15 The fabrication of a socket with sealing ring by means of the apparatus shown in Figures 1 and 2 proceeds as follows. First the sealing ring 12 is pushed over the mandrel 13 until it comes to lie in the relatively shallow groove 17, the support ring 18 bearing against that side of
- 20 the sealing ring 12 which faces away from the insertion side of the mandrel 13. Then the support section 14 is inserted, for example by a double-acting hydraulic cylinder (not shown), into the end section of the pipe 11.

When the end section of the pipe 11 is supported

25 internally by the support section 14 of the mandrel 13, said pipe end section is heated by means of the heating device 20. If required it is possible, via the support section 14 of the mandrel 13, to effect internal heating of the end section of the pipe 11. The internal support by the

30 support section 14 prevents shrinkage, in a radial direction, of the pipe 11 whose plastic material, under the influence of the heating, is trying to revert to the state of the plastic material prior to being oriented biaxially. Some shrinkage in the heated end section does occur in the

35 axial direction. This axial shrinkage of the end section is advantageous, however, because it is thus possible to compensate for the wall becoming thinner in the socket region as a result of the radial expansion yet to be effected.

When the end section of the pipe 11 has been suitably heated, the mandrel 13 is pushed further into the pipe 11. At the moment when the sealing ring 12 comes up against the pipe 11, the pipe 11 will be further expanded by the sealing ring 12. The sealing ring 12 is supported, in the process, by the support ring 18 which moves in tandem with the mandrel 13. As a result, the pipe 11 slides over the sealing ring 12 and subsequently over the support ring 18 situated behind it. As soon as the intended position of the socket-forming section 16 in the tube 11 has been reached, the support ring 18 is drawn backwards out of the pipe 11, by means which are likewise not shown, to the position shown in Figure 2. Because the biaxially oriented pipe 11 is still warm and therefore has a tendency to shrink in a radial direction, the pipe 11 automatically comes to lie, in the state shown in Figure 2, against the socket-forming section 16 and then traps the sealing ring 12. Then the end section, still internally supported, of the pipe 11 can be cooled by means of the cooling device 22 and/or by cooling the mandrel 13. Finally, the mandrel 13 can be pulled from the pipe 11 in its entirety, the sealing ring 12 disengaging from the shallow groove 17 of the mandrel 13 and remaining behind in the socket formed.

The present invention provides for a special manner of heating the end section, internally supported by the support section 14, of the pipe 11. The variation in temperature against time, as preferentially aimed for, of the end section of the pipe 11 is shown in Figure 3. In the first instance, the heating device 20 is set so as to reach an end section temperature which roughly corresponds to the glass transition temperature of polyvinyl chloride (about 80-85 °C). This setting of the heating device 20 is maintained for some time, to ensure that the end section of the pipe 11 is at this temperature as uniformly as possible. Only when it can be assumed that this is the case is the heating device 20 set so as to heat the end section of the pipe 11 to a higher temperature. The temperature ultimately to be reached for the end section of the pipe 11 preferably roughly corresponds, according to the invention,

to the orientation temperature of polyvinyl chloride (about 110 °C), preferably slightly above, for example 120 °C.

For that matter, once the end section of the pipe 11 has been heated uniformly to the glass transition temperature, it is important, when the end section is heated to a higher temperature, that the temperature differences in the wall of the end section of the pipe 11 be kept within limits. This can be done by the end section being heated stepwise, so that the end section will first uniformly have reached a particular temperature and will only then be heated further once more. Thus it is even possible for the end section to be heated to a higher temperature than is preferable according to the invention, for example to about 135 - 140 °C. If the end section were to be heated in one step from the glass transition temperature to such a high temperature, the probability of cracking is high.

Although the mechanism involved is not entirely clear, the abovedescribed manner of heating is found to avoid the inception of undesirable stresses in the socket, which lead to cracking.

It is evident that in the process of forming the socket by the method according to the present invention, other mandrel designs may alternatively be used. One possibility, for example, is that of a radially expandable mandrel.

CLAIMS

1. Method for forming a socket on a pipe of biaxially oriented polyvinyl chloride, comprising the successive steps of:
 - placing a support in an end section of the pipe,
 - 5 - heating the pipe in the region of the end section,
 - deforming the pipe to produce a socket in the region of the heated end section, the heated end section being supported internally while the socket is being formed,
 - 10 - cooling the pipe in the region of the end section, the end section being supported internally during the cooling operation, and
 - removing the support from the pipe, characterized in that:
 - 15 - for the purpose of heating the internally supported end section of the pipe, said end section is first heated until said end section has reached, substantially homogeneously, the glass transition temperature of polyvinyl chloride and is then further heated until the end
 - 20 section has reached, substantially homogeneously, a temperature near, preferably just above, the orientation temperature of polyvinyl chloride.
2. Method according to claim 1, wherein the placing of a support in the end section of the pipe comprises a
- 25 support section of a rigid mandrel being inserted into the end section, and
 - the deformation of the pipe to produce a socket in the region of the end section comprises a socket-forming section, which adjoins the support section, of the rigid
 - 30 mandrel being forced into the pipe.
3. Method according to claim 1 or 2, wherein the heating of the pipe in the region of the end section comprises the external heating of the pipe and/or the heating of the support.
- 35 4. Method according to one or more of the preceding claims, wherein the cooling of the pipe in the region of the end section comprises the external cooling of the pipe



and/or the cooling of the support.

