

Method for lining existing pipe on inside and inner lining pipe

Background of the invention

The invention relates to a method for lining an existing pipe on the inside.

5 The invention also relates to an inner lining pipe intended for application inside an existing pipe.

Damaged or leaking sewage pipes can be repaired by arranging a flattened and folded plastic pipe inside the existing sewage pipe. The plastic pipe that has been flattened and folded is made round by using heat and internal pressure inside the sewage pipe. This type of solution is disclosed in publications EP 0593564 and DE 3519439, for instance. However, there is a need to provide an even more versatile solution for lining the inside of an existing pipe.

Publication US 4867921 also discloses a solution, in which a flattened and folded plastic pipe is arranged inside a sewage pipe and said plastic pipe is then expanded to a round shape inside the sewage pipe. In this solution, the sewage pipe is formed in the flattened and folded shape, which means that making it round requires a high internal pressure. Further, in view of this solution, too, there is a need to provide a more versatile inner lining solution of a pipe.

Brief description of the invention

It is an object of the present invention to provide a novel solution for lining an existing pipe on the inside.

The method of the invention is characterised by forming an inner lining pipe mainly of polyvinyl chloride, the pipe having a certain original outer dimension that is smaller than the inner circumference of the existing pipe to be lined, placing the inner lining pipe inside the pipe to be lined and expanding the inner lining pipe in such a manner that its original outer dimension becomes larger by causing a radial orientation in the wall material of the inner lining pipe.

Further, the inner lining pipe of the invention is characterised in that the inner lining pipe has an original outer dimension that is smaller than the inner circumference of the existing pipe to be lined, whereby the inner lining pipe is expandable from its original outer dimension to have a larger outer dimension.

sion in such a manner that a radial orientation is formed in the wall material of the inner lining pipe.

In the present solution, an inner lining pipe with a certain original outer dimension is made mainly of polyvinyl chloride. Said original outer dimension is smaller than the inner circumference of the existing pipe to be lined. The inner lining pipe is installed inside the pipe to be lined. After this, the inner lining pipe is expanded in such a manner that the original outer dimension becomes larger such that a radial orientation in the wall material of the inner lining pipe is caused. This way, the inside pressure resistance of the inner lining pipe can be substantially increased. Orientation also improves the mechanical properties of the pipe wall in general, that is, the wall of a pipe made of oriented material need not be as thick as the wall of a pipe having corresponding mechanical properties and made of similar but non-oriented material. This way, the inner lining pipe can be used in the repair and renovation of both existing pressure less pipes, such as sewage pipes, and existing pressure-water pipes, such as tap water pipes.

In an embodiment, the inner lining pipe is expanded from its original outer dimension by at least 10%, in another embodiment by at least 20%. Further, in an embodiment, the wall material of the inner lining pipe has eight parts or less plasticizer to 100 parts polyvinyl chloride.

Brief description of the figures

The invention will be described in greater detail in the attached drawings, in which:

Figure 1 is a block diagram illustrating the implementation of the inner lining of an existing pipe;

Figure 2 is a schematic representation of the installation of an inner lining pipe inside an existing pipe; and

Figures 3, 4, and 5 are schematic cross-sections of point A-A of Figure 2 illustrating the different steps of the installation of the inner lining pipe.

Detailed description of the invention

Figure 1 is a schematic illustration of the repair of an existing pipe with an inner lining pipe. In step 1, the inner lining pipe is formed by extruding a PVC pipe made mainly of polyvinyl chloride and having a round cross-sectional shape and a certain original outer dimension, which in the case of a round pipe is thus the outer circumference. The outer dimension is the length

of the border line of the pipe's cross-sectional shape along the outer surface of the pipe. Said original outer dimension or circumference is smaller than the inner circumference of the existing pipe. The inner circumference is the length of the border line of the pipe's cross-sectional shape along the inner surface of the pipe. If said original outer circumference is to a sufficient degree smaller than the inner circumference of the existing pipe, the routine can proceed directly to step 3, or if pre-heating is not required, to step 4.

However, in the present embodiment, the outer dimension of the pipe is made smaller in step 2. In the presented embodiment, the outer dimension is made smaller at such a temperature that the material of the inner lining pipe keeps a memory of the original round shape and size. In step 2, the outer dimension is altered for instance by flattening and folding the round pipe. The pipe then does not require as much space during storage and transportation as a pipe of the original diameter. Further, a pipe that is smaller in its outer dimension is easier to arrange inside an existing pipe. The decrease in the outer dimension may also take place in such a manner that the round shape of the pipe is kept, that is, the pipe is reduced with a round condensing cone, for instance.

In step 3, the inner lining pipe is pre-heated at the installation site. The pre-heating facilitates the handling of the pipe, that is, its installation inside an existing pipe becomes easier. In step 4, the inner lining pipe is installed inside the existing pipe. If necessary, at this stage, it is possible to apply traction to the inner lining pipe in such a manner that an axial-direction orientation is formed in the wall of the inner lining pipe.

In step 5, the inner lining pipe is heated in such a manner that it returns to its original round shape and size. This heating may be done by arranging warm fluid, such as warm air, vapour, or water, inside the inner lining pipe. If the inner lining pipe has been made round and its outer dimension has not been decreased after its manufacture, step 5 is naturally not needed at all.

In step 6, the inner lining pipe is expanded in such a manner that an outer circumference is formed that is larger than said original outer dimension. This way, a radial-direction orientation is achieved in the material of the inner lining pipe, which significantly improves the strength properties of the inner lining pipe, especially its internal pressure resistance. If the inner lining pipe has been stretched to provide axial orientation, a biaxial orientation has been achieved to the inner lining pipe after step 6.

The expansion of the inner lining pipe in step 6 may be done in such a manner, for example, that plugs are arranged at each end of the inner lining pipe and pressurized fluid is arranged inside the pipe. The expansion according to step 6 may also be done mechanically, for example, by pulling an expanding piece, such as a liquid-containing bag, through it.

The inner lining pipe can also be formed by extrusion in such a manner that during formation the inner lining pipe has a cross-section that differs from round. The decrease in the outer dimension of the pipe, that is step 2, is then not necessary. Further, in such a case, in step 5, the inner lining pipe is made round by means of heat and internal pressure achieved by means of fluid, for instance, arranged inside it. After this, the outer dimension of the inner lining pipe is increased, as described earlier in connection with step 6. In this embodiment, too, the original outer dimension of the inner lining pipe, that is, the outer dimension created during manufacture, is smaller than the inner circumference of the existing pipe to be lined, so that the outer dimension can be increased to achieve radial orientation and, consequently, internal pressure resistance.

Figure 2 is a schematic representation of the installation of an inner lining pipe 7 inside an existing pipe 8. The existing pipe 8 is lined with the inner lining pipe 7 between two inspection wells or manholes 9, for instance. Figure 2 also shows schematically heating means 10 for pre-heating the inner lining pipe 7.

The existing pipe 8 may be a cast iron, steel, plastic, or concrete pipe that is typically installed underground. The inner diameter of the existing pipe may be in the range of 50 to 500 mm, for instance. According to the present solution, the existing pipe may be a water pipe, inside which pressurized water is conveyed, because the present inner lining pipe can be made to have extremely high internal pressure resistance. The nominal operating pressure inside the pipe may be in the range of 10 bar, for instance. The pressure resistance of the inner lining pipe is tested according to standard. In the test, different loads that are determined according to the wall thickness and diameter of the pipe and endure certain time periods at certain temperatures in accordance with the standard defining the test arrangements for pressure pipes, are applied to the inner lining pipe. Said tests are not described in more detail herein, because the standard related to testing pressure pipes and the tests are known to a person skilled in the art. With the solution disclosed in this

specification, it is possible to form an inner lining pipe that alone, that is, without the existing pipe 8 outside it, endures pressure water use, in other words, an inner lining pipe that meets the requirements set on the pressure water pipe in the standard. The inner lining pipe of this specification can be used to line
5 pipes in a pressure sewage system. Further, the inner lining pipe of this specification can also be used to line so-called pressureless pipes, such as the sewage pipes of a pressureless sewage system.

Figure 3 illustrates a situation, where the inner lining pipe has been installed inside an existing pipe 8 in a flattened and folded shape.

10 In Figure 4, the inner lining pipe 7 has been returned to its round shape so that the length of the outer circumference of the inner lining pipe 7 equals the original outer circumference produced during manufacture.

Figure 5 shows a situation, where the outer dimension of the inner lining pipe 7 has been expanded to achieve radial orientation. In an embodiment, the inner lining pipe is expanded so that its outer dimension increases at
15 least 10% and in another embodiment at least 20%. Naturally, increasing the outer dimension of the inner lining pipe is technically the more demanding the more the outer dimension is increased. However, for orientation, increasing the outer dimension as much as possible provides a good end result. Taking different viewpoints into consideration, the outer dimension is increased in an
20 embodiment less than 80%. In yet another embodiment, the outer dimension is increased 20 to 50%.

Typically, the radial orientation degree of the pipe wall is the larger the more the outer dimension is increased. On the other hand, the radial orientation degree of the pipe wall typically corresponds to how much the outer dimension is increased, in other words, when in an embodiment the outer dimension is increased 20 to 50%, the radial orientation degree of the pipe wall is correspondingly 20 to 50% after the outer dimension has been increased. In yet another embodiment, the radial orientation degree of the pipe wall is, after
30 the expansion, at least 10% and in another embodiment at least 20%.

Typically, the inner lining pipe 7 is expanded so much that the final outer dimension is essentially equal to the inner circumference of the pipe 8 to be lined.

To obtain good mechanical strength for the inner lining pipe, the increase in the outer dimension from the original outer dimension, in other
35 words, the radial orientation, must take place at the correct temperature. If the

temperature is too low, cracking occurs on the wall of the inner lining pipe, which weakens the mechanical properties of the inner lining pipe. If the expansion takes place at too high a temperature, the orientation does not form evenly and the material wall may even weaken. Therefore, the orientation must take place at a temperature of 60 to 110°C, for example. In an embodiment, the temperature is at least 70°C, and in yet another embodiment, over 80°C. In yet another embodiment, the orientation takes place at a temperature of 90 to 100°C.

The inner lining pipe is formed of mainly polyvinyl chloride PVC. In addition to polyvinyl chloride, different additives may be mixed with the material. One example of the composition of the inner lining material is as follows:

100 parts polyvinyl chloride PVC
3 to 10 parts filler
1 to 4 parts stabilizer
0.1 to 1 part lubricant
0 to 8 parts co-stabilizer
0 to 5 parts process auxiliary agent
0 to 8 parts plasticizer.

The filler may be one or more of the following: calcium carbonate CaCO_3 , talcum, wollastonite, and any other filler known per se, such as a mineral-based filler.

The stabilizer may be one or more of the following: calcium-zinc stabilizer, tin stabilizer, organic stabilizer, and any other stabilizer known per se.

The lubricant may be one or more of the following: paraffin wax, stearic acid, polyethylene wax, and any other lubricant known per se.

The co-stabilizer may be one or more of the following: antioxidant, epoxidized soybean oil, and any other co-stabilizer known per se.

The process auxiliary agent may be one or more of the following: calcium stearate, acryl process auxiliary agent, and any other process auxiliary agent known per se.

The plasticizer may be a polymer plasticizer, a monomer plasticizer, or a mixture thereof. Thus, the plasticizer may be one or more of the following: urethane, such as thermoplastic polyurethane (TPU), acryl, nitrile, chlorinated polyethylene, synthetic rubber, ethyl vinyl acetate copolymer, acryl nitrile / bu-

tadiene polymer, nitrile butyl rubber, ethylene propylene diene monomer rubber, phthalate plasticizer, adipate plasticizer, citrate plasticizer, and any other plasticizer known per se. In an embodiment, the plasticizer is one or more of the following: urethane, such as thermoplastic polyurethane (TPU), nitrile, chlorinated polyethylene, synthetic rubber, ethyl vinyl acetate copolymer, acryl nitrile / butadiene polymer, nitrile butyl rubber, ethylene propylene diene monomer rubber, phthalate plasticizer, adipate plasticizer and citrate plasticizer.

The plasticizer is used to facilitate the handling of the manufactured pipe. The plasticizer improves the flexibility of the pipe, whereby the installation of the pipe is easier and the installation temperature need not be high. On the other hand, the use of the plasticizer makes it more difficult to achieve sufficiently good pressure resistance for the pipe. Therefore, in an embodiment, 8 parts plasticizer or less is used for 100 parts polyvinyl chloride.

Further, in an embodiment, in which 8 parts plasticizer or less is used for 100 parts polyvinyl chloride, the plasticizer is one or more of the following: urethane, such as thermoplastic polyurethane (TPU), acryl, nitrile, chlorinated polyethylene, synthetic rubber, ethyl vinyl acetate copolymer, acryl nitrile / butadiene polymer, nitrile butyl rubber, ethylene propylene diene monomer rubber, phthalate plasticizer, adipate plasticizer, and citrate plasticizer.

In another embodiment, in which 8 parts plasticizer or less is used for 100 parts polyvinyl chloride, the plasticizer is one or more of the following: urethane, such as thermoplastic polyurethane (TPU), acryl, nitrile, chlorinated polyethylene, synthetic rubber, ethyl vinyl acetate copolymer, acryl nitrile / butadiene polymer, nitrile butyl rubber, ethylene propylene diene monomer rubber, phthalate plasticizer, adipate plasticizer, and citrate plasticizer, wherein the amount of acryl is less than 3 parts.

In a further embodiment, in which 8 parts plasticizer or less is used for 100 parts polyvinyl chloride, the plasticizer is one or more of the following: urethane, such as thermoplastic polyurethane (TPU), nitrile, chlorinated polyethylene, synthetic rubber, ethyl vinyl acetate copolymer, acryl nitrile / butadiene polymer, nitrile butyl rubber, ethylene propylene diene monomer rubber, phthalate plasticizer, adipate plasticizer, and citrate plasticizer.

In a further embodiment, in the inner lining material the total amount of acryl is less than 3 parts.

In this specification part refers to weight fraction.

In some cases, the features described in this specification may be used as such, regardless of other features. On the other hand, the features described in this specification may also be combined to provide various combinations as necessary.

5 The drawings and the relating description are only intended to illustrate the idea of the invention. Details of the invention may vary within the scope of the claims.

 It is also possible to arrange an insulation layer outside the inner lining pipe. Such an insulation layer facilitates the heating that takes place inside
10 the inner lining pipe. Further, the insulation layer prevents the inner lining pipe from cooling, so that for example the cold seeping from the ground during installation does not cool the inner lining pipe too much. This external insulation may be made of softened polyvinyl chloride foam, for instance. The external insulation layer does not necessarily need to be fastened to the inner layer of
15 the inner lining pipe.

Claims

1. A method for lining an existing pipe on the inside, comprising:
forming an inner lining pipe (7) of mainly polyvinyl chloride with a
certain original outer dimension that is smaller than the inner circumference of
5 an existing pipe (8) to be lined,
placing the inner lining pipe (7) inside the pipe (8) to be lined, and
expanding the inner lining pipe (7) in such a manner that the original
outer dimension becomes larger by causing a radial orientation into the wall
material of the inner lining pipe (7).
- 10 2. The method of claim 1, c h a r a c t e r i s e d by
forming the inner lining pipe (7) originally into a round cross-
sectional shape,
decreasing the outer dimensions of the inner lining pipe (7) having a
round cross-sectional shape and said original outer dimension at a tempera-
15 ture, in which the inner lining pipe (7) material keeps a memory of the original
round shape and size, before the inner lining pipe (7) is installed inside the ex-
isting pipe (8), and
heating the inner lining pipe (7) when it is inside the existing pipe (8)
to be lined in such a manner that under the influence of the material memory,
20 the inner lining pipe (7) returns essentially to its original round shape and size.
3. A method as claimed in claim 1 or 2, c h a r a c t e r i s e d by
pre-heating the inner lining pipe (7) before installing it inside the ex-
isting pipe (8) to facilitate the handling of the inner lining pipe (7).
4. A method as claimed in any one of the preceding claims, c h a r -
25 a c t e r i s e d by
expanding the inner lining pipe (7) from its original outer dimension
by at least 10%, preferably by at least 20%.
5. A method as claimed in any one of the preceding claims, c h a r -
a c t e r i s e d by
30 forming the wall material of the inner lining pipe (7) in such a man-
ner that it has eight parts or less plasticizer to 100 parts polyvinyl chloride.
6. A method as claimed in any one of the preceding claims, c h a r -
a c t e r i s e d by
forming the wall material of the inner lining pipe (7) by using a plas-
35 ticizer that is one or more of the following: urethane, acryl, nitrile, chlorinated
polyethylene, synthetic rubber, ethyl vinyl acetate copolymer, acryl nitrile / bu-

tadiene polymer, nitrile butyl rubber, ethylene propylene diene monomer rubber, phthalate plasticizer, adipate plasticizer, and citrate plasticizer.

7. A method as claimed in any one of claims 1 to 5, characterized by

5 forming the wall material of the inner lining pipe (7) by using a plasticizer that is one or more of the following: urethane, nitrile, chlorinated polyethylene, synthetic rubber, ethyl vinyl acetate copolymer, acryl nitrile / butadiene polymer, nitrile butyl rubber, ethylene propylene diene monomer rubber, phthalate plasticizer, adipate plasticizer, and citrate plasticizer.

10 8. A method as claimed in any of the preceding claims, characterized by forming the wall material of the inner lining pipe (7) such that the total amount of acryl is less than 3 parts.

9. An inner lining pipe that is intended to be arranged inside an existing pipe (8), wherein the inner lining pipe (7) has an original outer dimension
15 that is smaller than the inner circumference of the existing pipe (8) to be lined, and the inner lining pipe (7) is expandable to have a larger outer dimension than its original outer dimension so that a radial orientation is formed in the wall material of the inner lining pipe (7).

20 10. An inner lining pipe as claimed in claim 9, characterized in that

the wall material of the inner lining pipe (7) has eight parts or less plasticizer to 100 parts polyvinyl chloride.

11. An inner lining pipe as claimed in claim 9 or 10, characterized in that

25 the wall material of the inner lining pipe (7) has a plasticizer that is one or more of the following: urethane, acryl, nitrile, chlorinated polyethylene, synthetic rubber, ethyl vinyl acetate copolymer, acryl nitrile / butadiene polymer, nitrile butyl rubber, ethylene propylene diene monomer rubber, phthalate plasticizer, adipate plasticizer, and citrate plasticizer.

30 12. An inner lining pipe as claimed in claim 9 or 10, characterized in that

the wall material of the inner lining pipe (7) has a plasticizer that is one or more of the following: urethane, nitrile, chlorinated polyethylene, synthetic rubber, ethyl vinyl acetate copolymer, acryl nitrile / butadiene polymer,
35 nitrile butyl rubber, ethylene propylene diene monomer rubber, phthalate plasticizer, adipate plasticizer, and citrate plasticizer.

13. An inner lining pipe as claimed in any one of claims 9 to 12, characterised in that

in the wall material of the inner lining pipe (7) the total amount of acryl is less than 3 parts.