

PIPELINES

This invention relates to a method for lining existing pipes. The invention will be described in relation to gas, oil and water supply pipes, but it will be appreciated that the invention is applicable to pipes of all kinds.

This application is divided out from our copending UK patent application No. 8810894.9

When lining installed pipes (which pipes when ground embedded are prone to crack due to ground movement) it is known to draw a heated liner of plastic tube through a die to reduce the diameter and then into a length of the existing pipe.

The present invention relates to an improved method of lining installed pipework when using a swaging die to reduce the diameter of the liner pipe prior to its being drawn into the existing pipework. By "installed" pipework is meant pipework that has already been installed in position to carry out its intended purpose, such as for example, ground embedded pipework for gas, oil, water or sewage, pipework forming part of a larger installation such as in oil or gas refinery or storage installation, or pipework resting on the ground and laid down to connect a source of supply to the recipient such as an oil pipe connecting a well to a refinery or port.—

In the case of ground embedded pipework it will be appreciated

that the normal arrangement when such a process is being carried out will involve a winch adjacent to an excavation at one end of a length of pipe to be lined, whence a cable or similar flexible ligament passes through the length of pipe to a second excavation beyond which it is attached to the front end of a liner pipe of plastics material. Adjacent to the second excavation is a tube heating and compressing apparatus which has a heater and a size reduction die. At a downstream end of this apparatus there may be a reciprocable "pusher" which can grip the pipe and draw it from the apparatus and urge it towards the pipe to be lined.

According to the present invention, there is provided a method for lining installed pipework which includes the steps of taking a length of liner pipe made from a memory retaining plastics material of external diameter greater than the internal diameter of the pipework to be lined, and using pulling means under tension attached to the leading end of the liner pipe and threaded through the pipework, drawing the liner pipe through a swaging die attached to but spaced from the pipework to reduce the external diameter of the liner pipe

, the tension applied by the pulling means being such as partially to restrain the radial expansion of the outer surface of the liner pipe after its emergence from the die, drawing the liner pipe through the installed pipework with its outer diameter reduced to and/or maintained at a dimension less than that of the inner diameter of the pipe and thereafter allowing the liner pipe to expand within the

pipework by relaxation of the said tension followed by memory induced expansion at ordinary atmospheric pressure and at the ambient temperature of the pipework and gripping

the liner pipe emerging from the die within the space between the die and the pipework and urging the liner pipe towards and through the pipework.

The process of the invention defined above relies both upon the expansion of the liner pipe within the pipework as a result of relaxation of the pulling tension and also as a result of the memory induced expansion of the swaged liner pipe.

The length of the pipework which may be lined in a single operation by the method of this invention may typically be from 10 metres upwards. The limiting length of pipework which may be lined in any particular case will depend upon a combination of factors including the friction resistance to the movement of the liner within the pipework, the extent to which the liner pipe with reduced diameter after insertion into the pipework becomes subject to deformation (a problem encountered with larger diameter liner pipes of relatively large SDR ratio), the limiting tension on the leading end of the liner pipe beyond which it may suffer permanent damage or elongation, the capacity of the mechanism (such as a winch) operating the pulling means and the uniformity of diameter and/or direction or otherwise of the pipework interior. The most suitable practicable length to be lined in any particular case can readily be ascertained by trial and error. By the method of the present invention, it becomes possible to line lengths of pipework up to 450 metres or more.

It is unnecessary to have recourse to the means provided by the prior art for expanding the pipe lining within the pipework such as the application of internal super atmospheric pressure or the application of heat to the pipelining from within or the initial application of very high stretching forces to the pipelining to bring about an initial reduction in its diameter prior to insertion into the pipework. The precise operating conditions employed in order to carry out the method of the present invention will depend upon the several factors referred to above in any particular case and will vary according to the pipework internal diameter and the purpose for which it is put to use (for example whether for water or gas), the material of the pipelining and the SDR of the pipelining. (By SDR is meant the ratio of the diameter of the pipelining before swaging to its wall thickness).

A preferred material for the liner pipe is polyethylene, but other materials having the necessary memory retaining characteristics, such as a co-polymer of ethylene and at least one other alphaolefin of up to ten carbon atoms may equally be used. Although the reduction in diameter of the liner pipe during passage through the swaging die is up to 15%, reductions in the range 5.0% to 9.8% are preferred. The reduction should be such as to allow drawing of the liner pipe through the existing pipe. This somewhat simple requirement is complicated by the fact that existing pipes are often not accurately sized internally, that the internal diameter may vary along the length of the pipe, and that the rate of

recovery of the liner pipe may vary with ambient conditions and with the material from which the pipe is made. The wall thickness of the liner pipe should be as thin as possible consistent with the use to which the pipe is to be put and the requirement to provide adequate internal sealing of the existing pipe. A ratio of wall thickness to diameter of the liner pipe in the range 10 to 46 is preferred.

The maximum tension chosen for pulling the liner pipe through the existing pipe should advantageously be in the range 45% to 55% of the yield strength of the liner pipe in question, and in particular about 50%. The ratio of the throat diameter of the die to the diameter of the existing pipe should advantageously be in the range 1.05:1 to 1.15:1. A reciprocable pusher is employed to augment the tension exerted by the said pulling means to draw the liner pipe through the swaging die.

In order that the invention may be more clearly understood one embodiment of the invention will now be described by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a side elevational view in section of one form of apparatus used in the method according to the invention, and

Figure 2 is a side elevational view in section of a modification of the apparatus shown in Figure 1.

Referring to Figure 1, the apparatus comprises a supporting structure 1 which incorporates a pipe clamp 2 at one end and a swaging die 3 at the other. The swaging die 3 is generally cylindrical and comprises a section of larger diameter 4 joined to a section of smaller diameter 5 by a conical section 6. The swaging die has a polished swaging surface which is inclined at an angle of between 6° and 32° to the axis of the die advantageously between 12° to 29° and preferably between 20° to 25° . The polish is at least down to N7, typically down to N6 preferably down to N5 and ideally in the order of N4 or lower. The ratio between the diameters at 4 and 5 is preferably in the range 1.05:1 to 1.15:1. This has been found to provide an adequate level of clearance between pipe liner and internal pipe diameter for most normal pipes and to be comfortably within the diametric dimensional recovery of the material.

The body of the die 3 in the embodiment illustrated is hollow and houses an electrical heating coil 8 which is supplied with electricity via an electrical supply circuit 9. Power supply to the heating coil is applied to heat the liner pipe to a temperature within the range 35°C to 95°C and preferably to about 50°C . On leaving the die, the swaged liner pipe is cooled by means of an annular heat exchanger 12 which is disposed around the pipe and which extracts heat from the pipe. The heat exchange medium may be carbon dioxide, air, water or any other suitable fluid.

The pipe clamp 2 is fixed to the free end of existing pipe and provides in conjunction with the existing pipe, referenced 10, an anchor against which the liner pipe 7 may be pulled. The supporting structure to which the pipe clamp is connected may be tubular in form or may consist of a plurality of arms connecting the pipe clamp 2 and swaging die 3 together.

In operation of the apparatus, a length of liner pipe 7 of polyethylene or other suitable material may be mitred at one end or pre-formed effectively to form a nose cone at that end over which an apertured metal nose cone may be fitted. A ratio of wall thickness to diameter of the liner pipe in the range 10 to 46 is preferred. Holes are punched in the mitre sections which correspond with those in the metal nose cone and through which a cable is connected to the pipe. The cable is threaded through the swaging die 3 and the existing pipeline and connected to some form of pulling device such as a winch appropriately anchored. The electrical supply is switched on to heat the die to the required temperature and the mitred end of the liner pipe is introduced into the upstream end of the die. Tension in the cable is increased to the required value (usually between 45% and 55% of the yield strength of the liner pipe in question and in particular 50%) until the liner pipe begins to move through the die and be pulled into the existing pipeline. The liner pipe is pulled in this way completely through the existing pipe. The cable is released and the memory characteristic of the material of the pipe is then permitted to expand the pipe until it

contacts the internal surface of the existing pipe.

If desired, the pipe is assisted through the existing pipe by means of a liner pipe pusher machine. Such an arrangement is illustrated in Figure 2 of the drawings. Referring to this figure, the pusher machine, which generally comprises a frame 21, hydraulic cylinder 22, clamp ring 23 and ancillaries is disposed between the swaging die 3 and pipe clamp 2. In operation, this machine pulls the liner pipe through the swaging die 3 and pushes it into the existing pipeline.

It will be appreciated that the above embodiments have been described by way of example only and that many variations are possible without departing from the invention as defined in the appended claims. For example the liner pipe may be heated prior to entry into the swaging die as in the manner described in our co-pending application No. 2186340.

CLAIMS

1. A method of lining installed pipework which includes the steps of taking a length of liner pipe made from a memory retaining plastics material of external diameter greater than the internal diameter of the pipework to be lined, and using pulling means under tension attached to the leading end of the liner pipe and threaded through the pipework, drawing the liner pipe through a swaging die attached to but spaced from the pipework to reduce the external diameter of the liner pipe, the tension applied by the pulling means being such as partially to restrain the radial expansion of the outer surface of the liner pipe after its emergence from the die, drawing the liner pipe through the installed pipework with its outer diameter reduced to and/or maintained at a dimension less than that of the inner diameter of the pipework and thereafter allowing the liner pipe to expand within the pipework by relaxation of the said tension followed by memory induced expansion at ordinary atmospheric pressure and at the ambient temperature of the pipework, and gripping the liner pipe emerging from the die within the space between the die and the pipework and urging the liner pipe towards and through the pipework.

2. A method as claimed in claim 1 in which the external diameter of the liner pipe is reduced by up to 15%.



3. A method as claimed in claim 1 or claim 2 in which the die is heated so that the liner pipe is heated before it emerges from the die.
4. A method as claimed in claim 3, in which the liner pipe is cooled within the space between the die and the pipework as it emerges from the die.
5. A method as claimed in either claim 3 or claim 4, in which the liner pipe is pre-heated before the swaging step to a temperature between 30°C and 90°C.
6. A method as claimed in claim 5, in which the liner pipe is pre-heated to a temperature of from 35°C to 65°C.
7. A method as claimed in claim 6, in which the liner pipe is pre-heated to a temperature of from 45°C to 55°C.
8. A method as claimed in claim 1 or claim 2, in which the liner pipe is drawn into the die at ambient temperature and no heat is supplied to or generated within the die save such heat as may be generated by friction between the liner pipe and the internal surfaces of the die during passage of the liner pipe through the die.
9. A method as claimed in any of the preceding claims in which the liner pipe is of polyethylene or a co-polymer of



ethylene and at least one other alphaolefin of up to ten carbon atoms.

10. A method as claimed in any of the preceding claims in which the installed pipework is ground embedded and is at least 10 metres in length.

