

Description

This invention relates to the lining of pipelines or passageways with a tubular liner and a curable synthetic resin.

There is already disclosed in EP-A-155406 (published 25.09.1985) and in US-A-4135958 that the resin is of a composition so that it is curable (or polymerisable) by means of light energy, and when the lining, which is flexible before being applied to the passageway surface, but becomes rigid when the resin cures, is subjected to light energy whilst held in position lining the passageway, the cure of the resin is commenced and/or effected.

In accordance with the invention there is provided a method of lining a pipeline or passageway comprising moving a flexible tubular lining into the pipeline or passageway and using a fluid pressure differential to shape the tubular lining to the passageway surface, there being a light curable synthetic resin sandwiched between the inner surface of the lining and the passageway surface to define a hard pipe lining the passageway surface when cured, characterised in that a means is attached to the lining tube when it is moved into the pipeline or passageway enabling curing light source means to be pulled into the passageway in order to effect curing of the resin.

The lining may comprise one or more layers of resin absorbent material such as fibrous felt which is or are impregnated with the resin, and the resin may be applied to the resin absorbent material layer or layers inside or outside the passageway.

Alternatively the resin may be applied to the passageway surface and may be held thereto by the subsequent application of the tubular liner, which may be in the form of a thin tubular membrane, inverted into the passageway immediately following the application of the resin to the passageway surface. The application of the resin to the passageway surface may be by any suitable means, such as spraying or painting.

The lining may be simply pulled into the passageway and then inflated using the fluid pressure differential or it may be inverted by said fluid pressure differential into and along the passageway.

The fluid pressure differential may be created by liquid and/or gaseous medium as required.

The said means may comprise a rope cable or the like which is attached to one end of the lining and which can be used for applying a restraining effect on the end of the lining when the lining is inverted, or in an alternative arrangement, to the end of the lining is attached a pulley forming said means, and the hold back rope trains round the pulley to provide two operative reaches of the rope. When the lining is in position with this alternative embodiment, the rope is pulled round the pulley so that one reach is removed from the passageway, and the other reach feeds round the pulley. To the said other reach there may be attached the light source means which are pulled

in so as to travel along the inside of the lining in the passageway effecting the cure.

The light source means may be kept in position essentially centrally of the passageway by means of ballast weights and/or floats or any other suitable means.

The light source means may comprise one or more light source units comprising high intensity filaments located in a vacuum casing, the casing being contained in a protective and transparent outer casing, the units being sealed permitting the light source means to be used under water. Suitably, the lights may be high pressure metal halide lamps having pinched ends and they may be a wavelength of the order of 350 to 450 nanometres.

In the majority of cases, where the lining is everted, it will be everted using water, but in some cases the lining is everted by air or a combination of air and water. Where air only is used, in accordance with another of our inventions, it is preferred that a lubricant be placed in the base of the passageway to enable the lining to slip over same.

In addition to the hold back rope, there may also be a pull through cord, tape or the like which is located in the inside of the lining prior to inversion, so that the cord emerges from the inversion face, and tension can be applied thereto in order to assist the inversion process as necessary.

The lining preferably comprises before insertion in the passageway one or more layers of fibrous felt, with the outside of the layer or the outside of the outermost layer provided with a fluid impermeable coating. The fibres of the felt and the resin are preferably selected so that they have a combined refractive index making the combined material substantially transparent to the specific wave length light which is used for the curing process whereby the light will penetrate completely through the lining in order to effect cure through the entire thickness of the lining. The lining may be any thickness but typically will be between 2 mm and 25 mm.

Various embodiments and aspects of the present invention will now be described, by way of example, with reference to the accompanying drawings, wherein:-

Fig. 1 is a sectional side view illustrating the lining process for an underground passageway and embodying an aspect of the present invention;

Fig. 2 is sectional elevation of one unit of the light source means used in the process of Fig. 1;

Fig. 3 illustrates diagrammatically and in perspective view a method of lining an underground pipeline or passageway in accordance with another aspect of the invention; and

Fig. 4 illustrates in a view similar to Fig. 3, a subsequent step in the lining process illustrated in Fig. 3.

Referring to the drawings, and firstly to Fig. 1, in this figure is shown an underground pipe 10 which is in the process of being lined with a liner

12 of flexible material. The pipe 10 is located under the ground level 14, and the liner is being inserted through a manhole 16, by means of an elbow feeding pipe 18. An end 20 of the liner is fixed to the open end of the elbow pipe 18 located in the bottom of the manhole, and then water is poured into the elbow pipe 18 as indicated by the spout 22, so as to cause the liner 12 to evert into and along the inside of the pipe 10, as illustrated at the everting region 24. The trailing end of the liner is illustrated at point 26, and the liner feed is maintained by keeping a constant head 28 of water in the elbow pipe 18.

The liner 12 is made up of a layer 30 which is of resin absorbent material such as fibrous material in woven or felted form, or in any suitable combination, and an inner membrane 32 which is impermeable to fluids. The layer 30 is impregnated with a curable resin material, such as polyester resin or the like, and it will be observed that initially the membrane 32 is to the outside of the liner before inversion as shown in the region 34, but becomes the inner layer after the lining is applied to the inside of the pipe 10, and to resin lies between the inner surface of the liner and the passageway surface. The lining which is flexible until the resin carried thereby is cured is tailored to the size of the pipe 10 to be lined, and the trailing end 26 eventually emerges in another manhole, similar to manhole 16 but spaced therefrom, and after curing the protruding end is cut off to complete the lining operation.

Two ropes or cables may be used in connection with the lining operation, these ropes or cables having different functions. A first rope or cable 36 is a "pull through" rope which can be used to help to pull through the everting portion of the liner in the event of need, whilst the other rope or cable 38 is a "hold back" rope which is attached to the point 36, and is trained round a guide roller 40 in the elbow 18, and serves to prevent the trailing end 26 of the liner from travelling along the inside of the passageway too quickly.

In accordance with an aspect of this invention, the resin which impregnates the layer 30 (and is normally applied in the factory prior to taking the lining to the site) contains a photo-initiator so that the resin system as a whole will be light curing, and in the arrangement shown in Fig. 1 a bank of illumination source assemblies 40, 42 and 44 are connected in the hold back rope 38, these sources being maintained at least approximately centrally of the pipe 10 by means of ballasting weights 46. As the lights travel through the interior of the everted lining, so the illumination radiating therefrom will initiate the curing of the resin in the layer 30. The resin system and the photo initiator are preferably chosen so that only certain wave lengths will initiate the cure, and it is also desirable to choose the layer 30 to be of fibres which, when immersed in the resin system, provide a layer which is of a refractive index so that the layer is in fact substantially transparent to the light of those wave lengths which can initiate the cure. This is to ensure that the light will penetrate

through the interior thickness of the layer 30 to give effective curing. The membrane 32 is also selected to be transparent to light up the aforesaid wave lengths.

The advantage of using photo initiated resin systems is that these systems will remain liquid for many months as long as they are not exposed to light of the appropriate wave lengths, and therefore liners can be impregnated well in advance of the time of use. Conventional resin systems which cure under the reaction of heat or at ambient temperatures will harden in a few days even if refrigerated.

The hold back rope 38 which may be a multi-core cable will incorporate all of the necessary electrical conductors and ignitors for controlling and powering the bank assemblies 40, 42 and 44. As soon as the lamps (when lit) start travelling along the inside of the pipeline, the resin systems start to cure. The speed of inversion of the lining is controlled so that full and even curing takes place.

Figures 3 and 4 illustrate an alternative method for a lining operation, but parts already described have the same reference numerals. As shown in Fig. 4, the trailing end 26 of the lining 12 is attached the pulley 50, and trained round the pulley is the pull back cable 38 defining two reaches 38A and 38B. These two reaches control the inward inversion of the lining, but at the end of the inversion, as shown in Fig. 4 the reaches are fed round the pulley 50, and attached to the end of one reach is the bank of light assemblies 40, 42 and 44, so that in fact these assemblies (when lit) are pulled through at a controlled speed after the eversion process has been completed.

It should be borne in mind that the light assemblies in the embodiments described are pulled through a body of water inside the everted lining, and therefore the light units of the assemblies must be waterproof in nature. Fig. 2 shows one arrangement which has been found suitable for each light unit, and referring to Fig. 2 a light unit is shown in sectional elevation. This is a high intensity metal halide lamp which provides a convenient light source. Because such a lamp requires a high operating temperature it is protected from the water by sealing the lamp in an outer tube of glass or quartz, and appropriate provision is made to conduct heat from the ends of the lamp as it must be kept relatively cool. In Fig. 2, the lamp is indicated by numeral 60 and is mounted by its ends within metal mounting blocks 62. These blocks are of metal such as aluminium in order to serve not only as conductors but also as heat drains to drain heat away from the lamp 60. The electric conductors 66 of the lamp 60 pass through a connector 68 which sealingly receives the screwed end of an outer transparent tube 72 which is optionally protected by a wire screen 74 and which is nitrogen filled. The screen is made up of individual strands which extend helically relative to the casing 72 in order to avoid the casting of linear shadows on the pipeline as the light assemblies pass down the

inside of the liner during the curing operation. The casing 72 is a closed end tube and the closed end may, as shown in dotted lines, be supported by a mounting 76. The mountings 68 and 76 have the shape shown to protect the lamp assembly from being impacted as it is being drawn into and out of the passageway. The mounting 68 will be filled with sealing compound to waterproof the connecting lead 66 which couple with the multi-core cable 38.

In the arrangement described with reference to the drawings, the lining comprises resin absorbent felt layers, which may be of acrylic or polypropylene fibres, and the tube is dimensioned to the size of the passageway to be lined, so that it will experience a minimum stretch. However it is within the scope of the invention to provide flexible tubes which are stretchable or non-stretchable.

Furthermore, the flexible tubes forming linings may be simply pulled into the pipeline or passageway and then inflated herein fluid pressure of air or water or a combination of air and water. The resin may be applied to the absorbent layers either before the lining is introduced into the passageway or after it has been introduced into the passageway and indeed as it is being applied to the passageway surface.

In another arrangement, a layer of the curable resin is applied to the passageway surface for example by a rotary spray or the like, and this is followed immediately by an everting flexible tubular liner which retains the resin in position lining the surface until it is cured by the lights as described herein.

A suitable light curing resin which can be used in the process of the present invention is a polyester resin including photo initiator.

It has been found that by using light energy to cure the resin, the total energy required for curing is of the order of 1% of that required when curing is achieved by inserting hot water into the inside of the everted liner.

The specific curing light arrangement illustrated in Fig. 2 is disclosed in EP-A-275924.

Claims

1. A method of lining a pipeline or passageway (10) comprising moving a flexible tubular lining (12) into the pipeline or passageway and using a fluid pressure differential to shape the tubular lining (12) to the passageway surface, there being a light curable synthetic resin sandwiched between the inner surface of the lining (10) and the passageway surface to define a hard pipe lining the passageway surface when cured, characterised in that a means (26) is attached to the lining tube (12) when it is moved into the pipeline or passageway (10) enabling curing light means (40-44) to be pulled into the passageway in order to effect curing of the resin.

2. A method according to Claim 1, wherein the flexible tubular lining (12) is inverted to the pipeline or passageway (10) to line same.

3. A method according to Claim 2, wherein the flexible tubular lining (12) comprises before inversion an outer fluid impermeable membrane (32) and an inner layer or layers (30) of resin absorbent material, and said layer or layers (32) is or are impregnated with the light curable resin, either before or after inversion.

4. A method according to Claims 2 or 3, wherein the means (26) attached to the lining tube (12) is attached to the end of the lining tube (12) which will be the trailing end and as regards inversion of the lining tube (12) into the pipeline or passageway (10).

5. A method according to Claim 4, wherein said means (26) comprises a rope (38) coupling one or more curing lights (40-44) to the tubular lining (12), so that said light or lights (40-44) will be pulled into the lined pipeline or passageway by the movement of the trailing end of the lining (12).

6. A method according to Claim 4, wherein the trailing end of the lining mounts a pulley (50) forming said means, and a rope, cable or the like (38) connected to one or more light curing source means (40-44) is trained round the pulley (50), so that after the lining has been inverted into the passageway, the lights (40-44) can be pulled into the pipeline or passageway by pulling the rope or cable (38) around the said pulley (50).

7. A method according to any preceding Claim, wherein said light source means (40-44) comprises at least one light being in the form of a high pressure metal halide lamp contained in a transparent envelope isolating the lamp from contact with a surrounding environment.

8. A method according to any preceding Claim, wherein the lining tube (12) is inserted by inversion using water and the light source means (40-44) are pulled through the water to effect the cure of the resin.

9. A light source for use in the method according to any one of the preceding Claims, comprising at least one high intensity lamp (40-44) contained in a transparent casing and sealing the lamp from contact by the surrounding environment.

10. A lamp according to Claim 9, wherein said sealing renders the lamp unit usable under water.

Patentansprüche

1. Verfahren zum Auskleiden einer Pipeline oder eines Durchlasses (10), bei dem eine flexible rohrförmige Auskleidung (12) in die Pipeline oder den Durchlaß hineinbewegt und ein Fluiddruck-Unterschied benutzt wird, um die rohrförmige Auskleidung (12) an die Durchlaßfläche anzuformen, wobei ein durch Licht aushärtbares Kunststoffharz zwischen der Innenfläche der Auskleidung (10) und der Durchlaßfläche eingeschlossen wird, um im ausgehärteten Zustand ein die Durchlaßfläche auskleidendes hartes Rohr zu bestimmen, dadurch gekennzeichnet, daß eine Einrichtung (26) an dem Auskleidungsrohr (12) bei seiner Hineinbewegung in die Pipeline oder den Durchlaß (10) angebracht wird, welche ein

inside of the liner during the curing operation. The casing 72 is a closed end tube and the closed end may, as shown in dotted lines, be supported by a mounting 76. The mountings 68 and 76 have the shape shown to protect the lamp assembly from being impacted as it is being drawn into and out of the passageway. The mounting 68 will be filled with sealing compound to waterproof the connecting lead 66 which couple with the multi-core cable 38.

In the arrangement described with reference to the drawings, the lining comprises resin absorbent felt layers, which may be of acrylic or polypropylene fibres, and the tube is dimensioned to the size of the passageway to be lined, so that it will experience a minimum stretch. However it is within the scope of the invention to provide flexible tubes which are stretchable or non-stretchable.

Furthermore, the flexible tubes forming linings may be simply pulled into the pipeline or passageway and then inflated herein fluid pressure of air or water or a combination of air and water. The resin may be applied to the absorbent layers either before the lining is introduced into the passageway or after it has been introduced into the passageway and indeed as it is being applied to the passageway surface.

In another arrangement, a layer of the curable resin is applied to the passageway surface for example by a rotary spray or the like, and this is followed immediately by an everting flexible tubular liner which retains the resin in position lining the surface until it is cured by the lights as described herein.

A suitable light curing resin which can be used in the process of the present invention is a polyester resin including photo initiator.

It has been found that by using light energy to cure the resin, the total energy required for curing is of the order of 1% of that required when curing is achieved by inserting hot water into the inside of the everted liner.

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1. A method of lining a pipeline or passageway (10) comprising moving a flexible tubular lining (12) into the pipeline or passageway and using a fluid pressure differential to shape the tubular lining (12) to the passageway surface, there being a light curable synthetic resin sandwiched between the inner surface of the lining (10) and the passageway surface to define a hard pipe lining the passageway surface when cured, characterised in that a means (26) is attached to the lining tube (12) when it is moved into the pipeline or passageway (10) enabling curing light means (40-44) to be pulled into the passageway in order to effect curing of the resin.

2. A method according to Claim 1, wherein the flexible tubular lining (12) is inverted to the pipeline or passageway (10) to line same.

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4. A method according to Claims 2 or 3, wherein the means (26) attached to the lining tube (12) is attached to the end of the lining tube (12) which will be the trailing end as regards inversion of the lining tube (12) into the pipeline or passageway (10).

5. A method according to Claim 4, wherein said means (26) comprises a rope (38) coupling one or more curing lights (40-44) to the tubular lining (12), so that said light or lights (40-44) will be pulled into the lined pipeline or passageway by the movement of the trailing end of the lining (12).

6. A method according to Claim 4, wherein the trailing end of the lining mounts a pulley (50) forming said means, and a rope, cable or the like (38) connected to one or more light curing source means (40-44) is trained round the pulley (50), so that after the lining has been inverted into the passageway, the lights (40-44) can be pulled into the pipeline or passageway by pulling the rope or cable (38) around the said pulley (50).

7. A method according to any preceding Claim, wherein said light source means (40-44) comprises at least one light being in the form of a high pressure metal halide lamp contained in a transparent envelope isolating the lamp from contact with a surrounding environment.

8. A method according to any preceding Claim, wherein the lining tube (12) is inserted by inversion using water and the light source means (40-44) are pulled through the water to effect the cure of the resin.

9. A light source for use in the method according to any one of the preceding Claims, comprising at least one high intensity lamp (40-44) contained in a transparent casing and sealing the lamp from contact by the surrounding environment.

10. A lamp according to Claim 9, wherein said sealing renders the lamp unit usable under water.

Patentansprüche

1. Verfahren zum Auskleiden einer Pipeline oder eines Durchlasses (10), bei dem eine flexible rohrförmige Auskleidung (12) in die Pipeline oder den Durchlaß hineinbewegt und ein Fluiddruck-Unterschied benutzt wird, um die rohrförmige Auskleidung (12) an die Durchlaßfläche anzuformen, wobei ein durch Licht aushärtbares Kunststoffharz zwischen der Innenfläche der Auskleidung (10) und der Durchlaßfläche eingeschlossen wird, um im ausgehärteten Zustand ein die Durchlaßfläche auskleidendes hartes Rohr zu bestimmen, dadurch gekennzeichnet, daß eine Einrichtung (26) an dem Auskleidungsrohr (12) bei seiner Hineinbewegung in die Pipeline oder den Durchlaß (10) angebracht wird, welche ein



Hineinziehen einer Aushärte-Beleuchtungseinrichtung (40-44) in den Durchlaß ermöglicht, um das Aushärten des Harzes zu bewirken.

2. Verfahren nach Anspruch 1, bei dem die flexible rohrförmige Auskleidung (12) zum Auskleiden der Pipeline oder des Durchlasses (10) zu dieser oder diesem umgestülpt wird.

3. Verfahren nach Anspruch 2, bei dem die flexible rohrförmige Auskleidung (12) vor dem Umstülpen eine äußere, für Fluid undurchdringliche Membran (32) und eine innere Schicht oder innere Schichten (30) aus Harz absorbierendem Material umfaßt, und bei dem die Schicht oder die Schichten (32) mit dem durch Licht aushärtbarem Harz entweder vor oder nach dem Umstülpen imprägniert wird bzw. werden.

4. Verfahren nach Anspruch 2 oder 3, bei dem die an dem Auskleidungsrohr (12) angebrachte Einrichtung (26) an dem Ende des Auskleidungsrohrs (12) angebracht wird, das während des Umstülpens des Auskleidungsrohres (12) in die Pipeline oder den Durchlaß (10) das nachlaufende Ende sein wird.

5. Verfahren nach Anspruch 4, bei dem die Einrichtung (26) ein Tau (38) umfaßt, welches eine oder mehrere Aushärteleuchte(n) (40-44) mit der rohrförmigen Auskleidung (12) so koppelt, daß die Leuchte(n) (40-44) durch die Bewegung des nachlaufenden Endes der Auskleidung (12) in die ausgekleidete Pipeline oder den ausgekleideten Durchlaß hineingezogen wird bzw. werden.

6. Verfahren nach Anspruch 4, bei dem das nachlaufende Ende der Auskleidung eine die Einrichtung bildende Riemen- oder Seilscheibe (50) trägt und ein Tau, Seil od. dgl. (38) an einer oder mehreren Aushärtungs-Lichtquelleneinrichtungen (40-44) um die Seil- oder Riemenscheibe (50) gezogen ist, so daß, nachdem die Auskleidung in den Durchlaß umgestülpt wurde, die Leuchte(n) (40-44) in die Pipeline oder den Durchlaß hineingezogen werden können, indem das Tau oder Seil (38) um die Riemen- oder Seilscheibe (50) gezogen wird.

7. Verfahren nach einem der vorangehenden Ansprüche, bei dem die Lichtquelleneinrichtung (40-44) mindestens eine Leuchte in Form einer Hochdruck-Metallhalogendampf-Lampe umfaßt, welche in einer transparenten, die Lampe gegen Berührung mit einer Umgebung isolierenden Hülle enthalten ist.

8. Verfahren nach einem der vorangehenden Ansprüche, bei dem das Auskleidungsrohr (12) durch Umstülpen unter Benutzung von Wasser eingesetzt wird und die Lichtquellenmittel (40-44) durch das Wasser hindurchgezogen werden, um das Aushärten des Harzes zu bewirken.

9. Lichtquelle zur Verwendung bei dem Verfahren nach einem der vorangehenden Ansprüche, die mindestens eine hochintensive Lampe (40-44) umfaßt, welche in einem transparenten Gehäuse enthalten ist, das die Lampe gegen Berührung mit der Umgebung abdichtet.

10. Lampe nach Anspruch 9, bei der die Dichtung eine Verwendung der Lampeneinheit unter Wasser zuläßt.

Revendications

1. Procédé de revêtement d'un tuyau ou d'un conduit (10), comprenant le déplacement d'un revêtement tubulaire souple (12) dans le tuyau ou le conduit et l'utilisation d'un différentiel de pression de fluide pour conformer le revêtement tubulaire (12) selon la surface du conduit, une résine synthétique durcissable à la lumière étant prise entre la surface interne du revêtement et la surface du conduit pour définir un revêtement résistant de la surface du conduit, une fois durcie, caractérisé en ce que des moyens (26) sont fixés au tube de revêtement (12) quand il est déplacé dans le tuyau ou le conduit (10), permettant de tirer des moyens lumineux de durcissement (40-44) dans le conduit de façon à effectuer le durcissement de la résine.

2. Procédé selon la revendication 1, dans lequel le revêtement tubulaire souple (12) est retourné sur le conduit ou le tuyau (10) pour le revêtir.

3. Procédé selon la revendication 2, dans lequel le revêtement tubulaire souple (12) comprend, avant retournement, une membrane externe imperméable au fluide (32) et une ou des couches internes (30) de matière absorbant la résine, la ou lesdites couches étant imprégnées de la résine durcissable à la lumière, avant ou après retournement.

4. Procédé selon les revendications 2 ou 3, dans lequel les moyens (26) fixés au tube de revêtement (12) sont fixés à l'extrémité du tube de revêtement (12) qui sera l'extrémité arrière, vis-à-vis du retournement, du tube de revêtement (12) dans le tuyau ou le conduit (10).

5. Procédé selon la revendication 4, dans lequel les moyens (26) comprennent un câble (38) couplant une ou plusieurs sources lumineuses (40-44) au revêtement tubulaire (12), de sorte que la ou lesdites sources lumineuses (40-44) seront tirées dans le tuyau ou le conduit revêtu par le déplacement de l'extrémité arrière du revêtement (12).

6. Procédé selon la revendication 4, dans lequel l'extrémité arrière du revêtement présente une poulie (50) formant lesdits moyens, et un câble, corde ou analogue (38) relié à une ou plusieurs sources lumineuses (40-44) est guidé autour de la poulie (50), de sorte que, après que le revêtement a été retourné dans le conduit, les sources lumineuses (40-44) peuvent être tirées dans le tuyau ou le conduit en tirant le câble ou la corde (38) autour de ladite poulie (50).

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel lesdites sources lumineuses (40-44) comprennent au moins une source lumineuse sous forme d'une lampe à halogénure métallique à haute pression, contenue dans une enveloppe transparente isolant la lampe de tout contact avec l'environnement immédiat.

8. Procédé selon l'une quelconque des revendications précédentes, dans lequel le tube de revêtement (12) est inséré par retournement en utilisant de l'eau et les sources lumineuses (40-44)

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sont tirées à travers l'eau pour effectuer le durcissement de la résine.

9. Source lumineuse utilisable dans le procédé selon l'une quelconque des revendications précédentes, comprenant au moins une lampe à haute intensité (40-44) contenue dans un boîtier trans-

parent et protégeant la lampe du contact avec l'environnement immédiat.

10. Lampe selon la revendication 9, dans laquelle une telle protection étanche rend la lampe utilisable sous l'eau.

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