LINER ASSEMBLY AND METHOD OF USING IN SOLUTION MINING

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FIG. 1

FIG. 2

FIG. 3

FIG. 4

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ABSTRACT OF THE DISCLOSURE

A liner conduit is attached to a resilient tube to provide a liner assembly useful to extend the effective length of a fluid-carrying conduit. The resilient tube has a relaxed diameter larger than the internal diameter of the fluid-carrying conduit. The resilient tube is stretched to reduce its diameter. The apparatus is then pushed through the fluid-carrying conduit until the “liner” conduit provides a predetermined amount beyond the downhole end of the fluid-carrying conduit. The resilient tube is then released and allowed to expand in diameter thereby sealing the annulus between the liner and fluid-carrying conduits.

This invention relates to solvent extraction techniques. It more specifically relates to precisely positioning the solvent injection and solution withdrawal points in a solution mining cavity.

In the operation of a solution mining cavity, the precise positioning of the solvent injection and solution withdrawal points within the cavity is important. In the solution mining of sodium chloride or potassium chloride, for example, the efficiency of the operation is greatly increased when the solvent is introduced near the top of the cavity and solution is withdrawn from near the bottom of the cavity. If such control is accomplished by maintaining an insoluble insulating layer, e.g., petroleum oil, floating on the top of the cavity solution, the injection point should be located beneath this layer. Disruption of the insulating layer by turbulence caused by the injected solvent is thereby reduced. The withdrawn point is preferably located substantially above the cavity floor to avoid becoming clogged with insolubles which settle to the bottom of the cavity. Under certain specific conditions, particularly if it is desired to alter or correct the shape of a solution mining cavity it may be desirable to locate the injection point at the bottom and/or the withdrawal point at the top of the cavity. For example, if the diameter of the bottom of the cavity is unduly large, it may be desirable to locate the withdrawal point nearer the top of the cavity.

In a typical solution mining operation, one or more bore holes are drilled to communicate with a subterranean formation which it is desired to extract. This formation usually contains minerals which it is desired to recover. A casing of slightly smaller external diameter than the internal diameter of the bore hole is then disposed through the bore hole. The casing normally terminates well above the depth at which extraction is initiated. The annular space between the casing and the bore hole is desirably filled with cement, grout or equivalent inert material. This inert material seals the annular space thereby protecting the formations adjacent thereto from extraction. The thus cased bore hole provides a conduit for fluid flow between the earth’s surface and the extractable formation.

When it is desired to introduce solvent and recover solution from a depth below the terminus of the casing, additional conduits may be provided in the form of internal tubing. Alternatively, a liner may be provided to extend the effective length of the conduit provided by the casing. By “tubing” is meant a conduit of smaller diameter than the casing disposed internal to the casing and extending from the earth’s surface. By “liner” is meant a conduit of smaller diameter than the casing disposed internal to the casing but extending only part way up the casing. A liner is usually suspended from the internal surface of the casing by frictional pressure. This frictional pressure is desirably provided by a packing means which also seals the annulus between the casing and the liner. While the manipulation and positioning of tubing is a simple matter, the placement, positioning and removal of liners requires specialized and sophisticated handling techniques and equipment.

Several types of liner devices are available. A number of methods of placing these liners in an emplaced casing are familiar to the art. Many of these devices and techniques satisfactorily seal the liner in an emplaced casing at the desired position or elevation. These devices and methods all have certain shortcomings. According to the present practice, liners are run down casings attached to tubing. Packing cups or expandable packers are provided in association with the liners. Positioning of the liner is desirably checked by a logging tool on a wire line. After the liner is satisfactorily positioned, the tubing is detached from the liner. If an expandable packer is used, it must be expanded before the tubing can be detached from the liner. Thus, a considerable amount of time consuming manipulation is required to set a liner in a casing in accordance with present practice.

Summary of the invention

The instant invention teaches an improved liner assembly and an improved method of positioning a liner within a casing. The hereinafter described method requires significantly less time than the methods previously known to the art. The liner assembly includes a liner conduit attached to a resilient tube. The diameter of the resilient tube is chosen such that its relaxed external diameter is larger than the internal diameter of the casing or other fluid-carrying conduit in which the assembly is intended to be used. The liner assembly taught by the instant invention can be set with a wire line whereby avoiding the necessity of running tubing down the bore hole for this purpose. A logging tool is conveniently run down the bore along with the liner assembly thereby avoiding a separate logging procedure.

Detailed description

According to the instant invention, a liner is attached to one end of a resilient tube or conduit. The resilient conduit has a normal external diameter slightly larger than the internal diameter of the casing. The resilient casing is adapted to be engaged by a stretching or tension producing means. In practice, the tension producing means is caused to engage the resilient conduit. The resilient conduit is stretched until it has an external diameter somewhat less than the internal diameter of the casing in which it is to be placed. The thus stretched resilient conduit is locked into stretched position. The liner assembly, i.e., the resilient conduit and the liner, is lowered down the cased bore hole. The location of the liner is determined by wire line measurement or by means of a logging tool. When the liner is properly positioned, that is, when the free or terminal end of the liner is located at the desired elevation in the cavity, an electrically or mechanically actuated mechanism releases the stretching means thereby allowing the extended resilient conduit to relax and grip the inside surface of the casing. The relaxed conduit fills the annular cross-section between the liner and the casing thereby functioning as a packer. Thus, the instant invention provides a more ex-
The instant invention will be more readily understood by reference to the accompanying drawings of which FIGURE 1 illustrates the novel liner device of this invention in its deformed position. FIGURE 2 illustrates the same device in stretched position. FIGURE 3 illustrates the use of the device in a solution mining cavity communicating with a single bore hole. FIGURE 4 illustrates an application of the device in an embodiment wherein a large solution mining cavity communicates with two bore holes.

Referring to FIGURE 1, the liner assembly comprises a resilient conduit or tube 1 and a liner 2. The resilient conduit 1 is adapted to be engageable by a stretching means. One convenient device to adapt the resilient conduit for gripping by the stretching means is a ring, 3, 4 or any equivalent which provides a shoulder or similar projection internal to the conduit. In some embodiments, the stretching means (or setting tool) is adapted to grip the internal surface of the resilient conduit. In these embodiments, no diameter reducing shoulder is required. The liner 2 may be of any convenient material such as metal, plastic or fiberglass pipe or tubing. In the drawings, the liner is shown as threaded into ring 4 at the end of the resilient conduit although any convenient method of fastening the liner to the resilient conduit is within contemplation.

A resilient extensible material of sufficient strength which is resistant to the solvent and other fluids with which it will be in contact in use may be employed. For example, in solution mining a deposit consisting essentially of sodium and potassium chlorides, ½-inch neoprene has been found to be a suitable resilient material for placing a liner in a 1 ½-inch casing. FIGURE 2 shows the same assembly as is shown in FIGURE 1 with the resilient tubing extended in preparation for insertion down a casing. To prepare the liner assembly for insertion, the resilient tube is stretched over a setting tool 10. In stretched or extended position, the external diameter of the resilient conduit is reduced to less than the internal diameter of the casing. The setting tool 10 is conveniently attached to a wire line 11. The setting tool 10 illustrated increases in length in response to tension in the wire line thereby stretching the resilient conduit. The gripping arms 13 collapse 12 in response to electrical impulses carried down the wire line. In other embodiments, the length of the setting tool is fixed and the resilient conduit is stretched by independent means to engage the tool. The tool is adapted to release the resilient conduit in response to an above ground manipulation.

Resilient conduits and stretching tools known to the art are employable in the instant invention. Any setting tool capable of being activated from the earth's surface to grip or release the resilient conduit of this invention is employable. Because such tools are well known, they are not described in detail herein. U.S. Patent 3,067,819, for example, describes a casing interliner suitable for use as a resilient conduit in the practice of the instant invention. Any of the several interliners and stretching mechanisms disclosed in U.S. Patent 3,067,819, the disclosure of which is hereby incorporated by reference, may be adapted to be useful in the practice of the instant invention.

A typical application of the novel apparatus of this invention is illustrated by FIGURES 3 and 4. Referring to FIGURE 3, bore hole 5 is established to terminate at the depth at which extraction is to commence. Casing 6 is disposed through bore hole 5 and terminates near the top of the extractable deposit, well above the bottom of the bore hole. A liner assembly, with the resilient conduit extended over a setting tool 10, is introduced down casing 6 by means of a wire line 11 (see FIGURE 2). The location of the assembly and thereby the elevation of the terminus or free end of the liner is readily determined by a logging tool or by wire line measurement. The assembly is located so that the terminus of the liner is close to the bottom of the bore hole. In this fashion, the effective length of the casing is extended to provide a continuous conduit from the bottom of the bore hole 5 to the earth's surface.

After the liner assembly is in place, tubing 7 is run down the bore hole and through the resilient tube and the liner to terminate near the bottom of the bore hole. Oil is introduced down either the tubing or the annulus along with solvent. The oil floats on top of the solvent to form a protective layer 8 at the top of the bore hole. The oil also seals any space between the liner or the casing and the bore hole. Solvent is then continuously introduced and solution withdrawn to develop a cavity 9. The oil pad prevents uncontrolled vertical extraction and encourages the cavity to develop literally. Of course, other inert fluids lighter than the solvent may be used in lieu of oil.

After a cavity has developed sufficiently in size, it is often brought into communication with a second bore hole 15, as illustrated in FIGURE 4. The internal tubing 7 is then removed from both communicating bore holes 5, 15. Liner assemblies are then introduced into each casing 6, 16. Liner 2 functions as the input conduit while liner 12 functions as the effluent conduit.

Whether a solution mining cavity communicates with a single or plurality of cased bore holes, the effective length of the emplaced conduits, e.g., the casing or bore holes, may need to be adjusted from time to time as the cavity develops in size. Thus, it is often necessary to raise the terminus of the influent conduit to provide an injection point close to the roof of the cavity. Similarly, it may be desired to shorten the effective length of the effluent or withdrawal conduit so that the withdrawal point will be sufficiently above the cavity floor to avoid becoming clogged with insolubles. It may be desired to either raise or lower the injection and/or withdrawal point to establish a preferred flow pattern of the cavity solution. The effective length of a conduit may be readily adjusted from time to time by reintroducing the setting tool 10, activating it to engage the resilient conduit, stretching the resilient conduit, relocating the liner assembly at the desired elevation and disengaging the setting tool to allow the resilient conduit to again set in the casing.

Although this invention has been described with primary reference to solution mining, it may have other applications in related areas where it is desired to precisely locate or relocate a fluid introduction or withdrawal point in a subterranean cavity. The apparatus and method herein described are useful in altering the effective length of any conduit and are not limited in application to a casing cemented or otherwise sealed to a formation. It is not intended to limit the claims to the specific details referred to in the description of this invention except insofar as those details are included in the appended claims.

I claim:

1. A method of extending the effective length of a fluid carrying conduit communicating with a subterranean cavity to terminate at a desired elevation which comprises releasably stretching with an independent stretching means a resilient conduit with normal external diameter greater than the internal diameter of said first named conduit to reduce the external diameter of said resilient conduit to less than the internal diameter of said first named conduit, said resilient conduit being attached to a liner conduit with external diameter smaller than the internal diameter of said first named conduit, locating said means and the stretched resilient conduit within said first named conduit such that the terminus of said liner conduit is located at the desired elevation and while the liner conduit is so positioned releasing the stretching means to permit the resilient conduit to return toward
its normal diameter thereby to engage the first named conduit.

2. The method of claim 1 wherein the first named fluid carrying conduit is a cased bore hole and the subterranean cavity is located in an extractable deposit.

3. The method of claim 1 wherein after the liner is first set at a desired elevation in the first named conduit a stretching means is introduced down said first named conduit, the resilient conduit is reengaged and restretched by said stretching means so that its external diameter is again reduced to be smaller than the internal diameter of said conduit casing, the liner conduit is relocated at a second desired elevation and the stretching means is again released to allow the resilient conduit to return toward its normal diameter thereby resetting the liner conduit at said second desired elevation.

4. An apparatus for extending the effective length of a fluid carrying conduit to terminate at any desired elevation in a subterranean cavity comprising a resilient tube having a normal diameter larger than the internal diameter of said conduit, means operably associated with said resilient tube and arranged to be engaged by a tension producing means, a liner conduit attached to one end of said resilient tube and oriented to extend from said resilient tube and beyond the engageable means, said resilient tube and liner conduit being constructed so that they are capable of movement up or down in said fluid carrying conduit after being set in one position therein to permit them to be set in a second position.

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