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SUBSURFACE CHEMICAL TREATMENT OF WELLS

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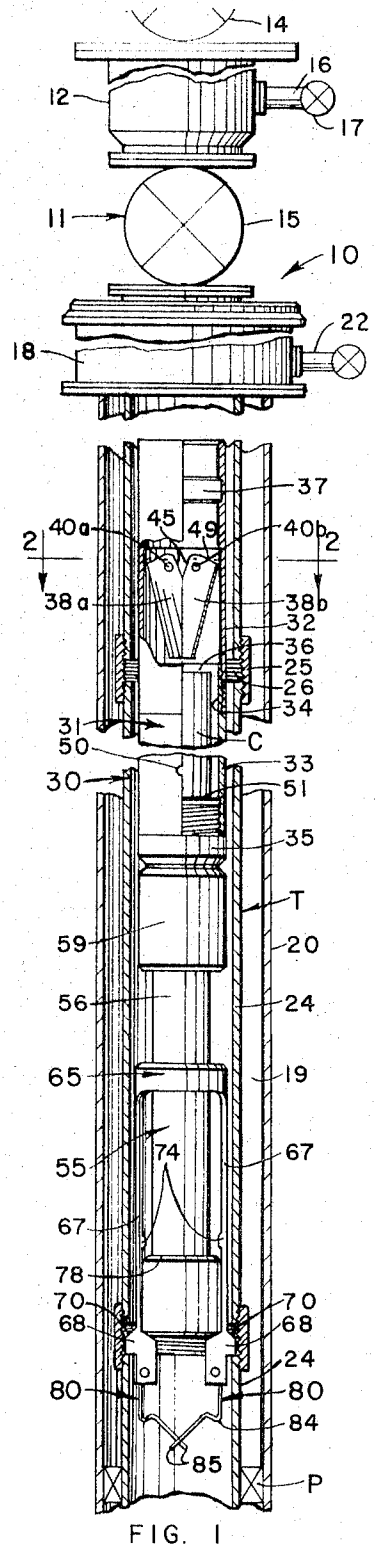


FIG. 1

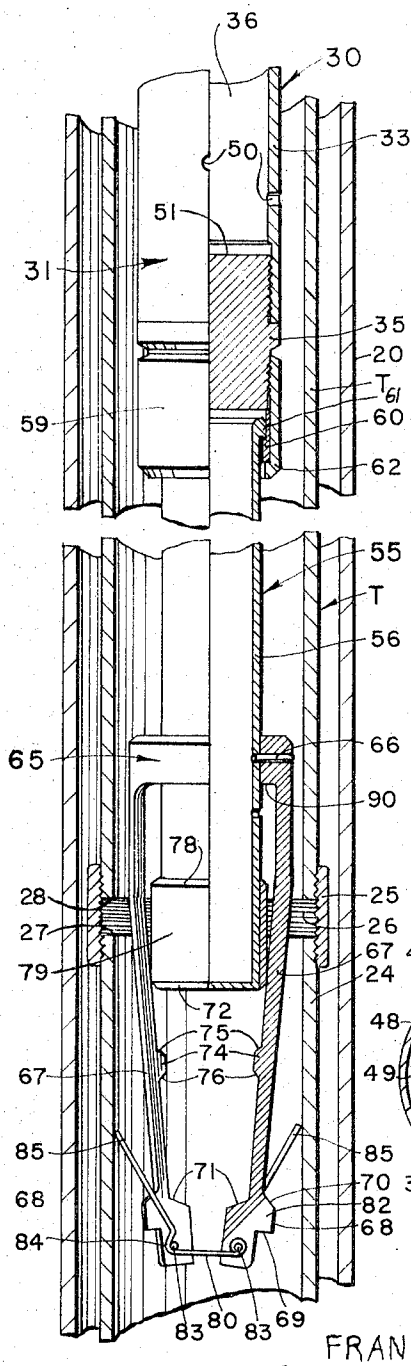


FIG. 3

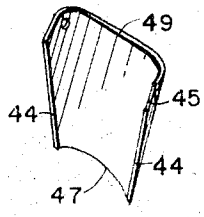


FIG. 4

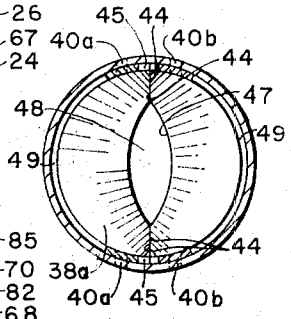


FIG. 2

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SUBSURFACE CHEMICAL TREATMENT OF WELLS

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This invention relates to well tools and methods for treating wells and more particularly to a method for treating a well flow conductor with chemicals and to a well tool for holding a chemical charge or body in the well flow conductor.

An object of this invention is to provide a new and improved method for introducing a chemical charge into a well flow conductor and holding the chemical charge in a predetermined location in the flow conductor while the well fluids flow therepast and dissolve the chemical which inhibits or prevents corrosion of the flow conductor or the deposition of paraffin on the flow conductor.

Another object is to provide a method for introducing a chemical charge into a flow conductor which does not require that the flow conductor or any well tool positioned in the flow conductor be removed from the well during such operation.

Still another object is to provide a method for introducing a chemical into a well which includes the steps of positioning a holder in the flow conductor, dropping a solid charge of the chemical into the flow conductor, while preventing the flow of well fluids therethrough, and into the holder, and opening the flow conductor to permit the flow of fluids through the holder and past the chemical which slowly dissolves in the well fluids so that the surfaces of the flow conductor downstream of the holder are treated by the chemical.

A further object of the invention is to provide a chemical holder which is releasably positionable in a predetermined location in a well flow conductor.

A still further object is to provide a holder having a body providing an upwardly opening chamber and valve means secured to the body which permits downward movement of a chemical charge into the chamber but which prevents upward movement therefrom.

A still further object is to provide a chemical holder wherein the valve means comprises a pair of arcuate cylinder segments disposed in the chamber and pivotally secured at their upper ends to the body, the segments being held by gravity in positions wherein their lower ends are adjacent one another and close the upper end of the chamber against upward movement of the solid chemical charge therefrom, the valve segments pivoting in opposite directions to move their lower ends away from each other to permit downward movement of a chemical charge therepast into the chamber.

Another object is to provide a holder whose valve segments permit flow of fluids upwardly through the chamber.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIGURE 1 is a schematic, fragmentary partly sectional view, with some parts broken away, of a well having a chemical holder of the invention anchored in an inner flow conductor thereof;

FIGURE 2 is a sectional view taken on line 2—2 of FIGURE 1;

FIGURE 3 is an enlarged fragmentary vertical partly sectional view showing the anchoring device of the holder in the position assumed thereby as the holder is being lowered into the tubing; and

FIGURE 4 is a perspective view of one of the valve segments of the holder.

Referring now to the drawings, the well 10 has the usual surface flow conductor control fittings or Christmas tree 11 which includes an elongate tubular body or housing 12 whose lower end is in alignment and communication with the inner well flow conductor or tubing T through which the well fluids flow from the well. A pair of vertically spaced valves 14 and 15 control the flow of fluids into and from the inner flow conductor and the movement of objects, such as a chemical charge C, into the inner flow conductor. The tubular housing is provided with the surface flow conductor or pipe 16 having a valve 17 so that the well fluids, when the lower valve 15 is open and the upper valve 14 is closed, may flow from the well through the flow conductor T to the tubular housing and then through the pipe surface 16 to any desired location.

The surface fittings or controls of the well also include the usual head 18 whose lower end is in communication with the upper end of the annular space or annulus 19 between the tubing T and the casing 20 of the well. The head 18 has a surface flow conductor or pipe 22 by means of which fluids such as weighted mud and the like may be pumped and introduced into or removed from the annulus 19 above the usual barrier or packer P which closes the annulus above the producing zone or earth formation of the well. The inner flow conductor T or tubing is formed of a plurality of tubing sections 24 which are connected by the usual threaded couplings 25 which provide the usual coupling recesses 26. The lower end of each of the internal annular coupling recesses 26 defined by the upper annular end shoulder 27 of a lower tubing section threaded into the lower end of the coupling and its upper end by the bottom annular end or shoulder 28 of the upper tubing section threaded into the upper end of the coupling.

The chemical holder 30 includes a tubular body 31 having upper and lower cylinder sections 32 and 33. The reduced upper end portion 34 of the lower cylindrical section is threaded into the lower end portion of the upper section. The lower end of the lower section is closed by a sub 35. The cylindrical sections and the sub of the body form an elongate chamber 36 which is closed at its bottom end and open at its top end. The upper cylindrical section 32 of the body 31 has an internal annular recess 37 in which are receivable the locking or latching means of any suitable running or pulling tool by means of which the holder may be lowered into and removed from a well.

A pair of valve elements 38*a* and 38*b*, which are segments of a cylinder whose outer radius is somewhat smaller than the radius of the enlarged lower portion 40 of the bore or passage of the upper cylindrical section 32, are pivotally secured to the upper cylindrical section below the locking recess thereof by means of the pivot pins 40*a* and 40*b*.

The inner or facing vertical lower side edges 44 of each of the segments extend downwardly and outwardly relative to the longitudinal axis of the cylinder of which they are segments and their upper edges curve upwardly and outwardly as at 45 to provide clearance for the pivotal movement of the segments relative to one another. The side edges 44 of the two segments abut when the valve segments are in closed positions illustrated in FIGURE 1. The lower arcuate edges 47 of the two segments are spaced from one another to provide an aperture or port 48 through which fluid may flow upwardly when the segments are in their closed positions. The pivot pins 40 are so positioned relative to the centers of gravity of the two segments that the lower ends of the segments tend to pivot toward one another when free to do so until their

side edges 44 abut one another. The upper edges 49 of the segments curve downwardly and outwardly so as to clear the internal surfaces of the upper cylindrical section 32 during the pivotal movement of the segments between their closed and open positions.

The lower cylindrical section 33 is provided with a plurality of apertures or ports 50 above the upper end of the sub 35 through which well fluids may enter the lower portion of the chamber and then flow upwardly therethrough and past the solid charge C of any suitable chemical which rests on the top surface 51 of the sub which defines the lower end of the holder body chamber.

A suitable anchoring device 55, such as the Otis type F collar stop illustrated on page 3911 of "The Composite Catalogue of Oil Field Equipment and Services," 1962–1963 edition, is secured to the holder body 30 for anchoring the holder in the tubing T. The anchoring device includes a tubular mandrel 56 secured to the holder body 30 by means of the annular coupling collar 59 and a split ring 60 interposed between the external annular top end flange 61 of the lock mandrel 56 and the internal annular bottom end flange 62 of the collar 59. The collar 59 is threaded on the lower end of the connector sub 35. The external diameter of the flange 61 is somewhat smaller than the internal diameter of the internal flange 62 of the coupling collar 60 in order that during the assembly of the anchoring device and the holder, the collar may be telescoped over the lock mandrel and positioned below the external flange 61. The split ring 60 is then disposed about the lock mandrel below its external top end flange by opening its split ends. The split ring moves resiliently into position about the lock mandrel when disposed thereabout. The collar is then moved upwardly until its upward movement of the lock mandrel is limited by the engagement of the flanges of lock mandrel and of the collar with the split ring. The collar is threadedly secured to the lower end of the connector sub.

The collet 65 is initially releasably secured in the upper position on the lock mandrel 56, FIGURE 3, by means of a shear pin 66 which extends through suitable aligned apertures in the collet and the lock mandrel. The collet has a pair of diametrically opposed dependent resilient collet fingers 67, each of which is provided at its lower end with an external boss 68 having a substantially horizontal downwardly facing lower stop shoulder 69 and a downwardly and outwardly extending or beveled cam shoulder 70. The collet fingers are also provided with upwardly facing internal stop shoulder 71 which engage the bottom end shoulder 72 of the lock mandrel to limit downward movement of the lock mandrel relative to the collet.

The collet fingers are also provided with intermediate internal bosses 74 having inwardly convergent upper and lower cam shoulders 75 and 76. The camming engagement of the upper shoulders 75 of the internal bosses and the lower annular end shoulder 72 of the lock mandrel moves the collet fingers resiliently outwardly as the collet mandrel is moved downwardly relative to the collet fingers from the upper position illustrated in FIGURE 3 to the lower locking position illustrated in FIGURE 1. The lower shoulders 76 of the internal bosses of the collet are engageable by the upwardly facing downwardly and outwardly beveled shoulder 78 of the mandrel when the mandrel is moved upwardly relative to the collet from its lowermost position relative thereto illustrated in FIGURE 1. The upper annular shoulder 78 of the lock mandrel is provided by the lock flange 79 formed by a ring welded to the lock mandrel.

Each of the collet fingers has a resilient spring latch 80 having one end disposed in an external slot 82 of the collet fingers and wrapped around a pin 83 which extends through the external slot and also laterally outwardly of the collet finger. Each of the spring latches 80 is provided with an intermediate hook or latch portion 84 which is adapted to engage the latch pin 83 of the opposite resilient collet finger whereby the collet fingers may be releasably held or latched thereby in the inner or retracted positions illustrated in FIGURE 3. Each spring latch has an outwardly extending straight catch portion 85 which is inclined outwardly and upwardly of the collet fingers when the latch springs are in their operative positions illustrated in FIGURE 3 holding the resilient collet fingers in their inner retracted positions.

The catch portions 85 of the latch portions bend upwardly and inwardly as they encounter obstructions in the tubing during downward movement of the well tool therethrough and are thus positively held in engagement with the pins of the collet fingers to retain the fingers in their inner retracted positions. However, upon upward movement of the anchoring device in the tubing, the ends of the catch portions engage the internal surfaces of the tubing or a downwardly facing shoulder 28 of the tubing section 24 and swing downwardly relative to the collet fingers disengaging their hook portions 84 from the pins 83 to release the collet fingers for resilient movement toward their expanded anchoring positions shown in FIGURE 1.

In use, the assembly of the holder 30 and the anchoring device 55 is lowered into the tubing, with the collet 65 releasably held in its upper position on the lock mandrel 56 by the shear pin 66 and with the collet fingers held in their inner retracted positions by the spring latches 80, by means of a wire or flexible line and the usual set of the wire line tools which include a suitable running tool, such as the Otis type G running tool illustrated on page 3934 of "The Composite Catalogue of Oil Field Equipment and Services," 1962–1963 edition. Such well tool has latch or locking means which extend into the annular internal latch groove 37 of the upper cylindrical section 32 of the body of the holder. The assembly of the holder and anchoring device is lowered in the tubing until it reaches a desired location therein. During this downward movement the spring latches hold the collet fingers in their retracted positions. Upward movement is then imparted to the assembly and causes the upper ends of the catch portions 85 of the spring latches to engage either the internal surfaces of the tubing or the bottom end shoulder of a tubing section 24 to arrest their upward movement in the tubing. As the collet and the lock mandrel, which is still secured thereto by the shear pin, continue to move upwardly, each of the spring latches pivots about its pin 83 and its hook portion moves out of engagement with the pin of the other spring latch, thus freeing the collet fingers for outward movement.

The assembly is then again lowered until the external bosses of the collet fingers move into alignment with a coupling recess whereupon the collet fingers move resiliently outwardly to position the external bosses 68 in the coupling recess. The engagement of the bottom shoulders 69 of the bosses with the top end shoulder 27 of a tubing section at such collar recess then prevents further downward movement of the collet. Downward jars then imparted to the holder and the lock mandrel by means of the wire line tools then cause the shear pin 66 to shear and free the lock mandrel for downward movement relative to the collet. The lock mandrel is then moved downwardly by jars imparted thereto by the wireline tools until its lower external lock flange 79 moves downwardly between the internal bosses 74 of the fingers and its downward movement is arrested by the engagement of its bottom end shoulder 72 with the stop shoulders 71 of the collet fingers. The external lock flange 79 is now in its lower position relative to the collet fingers and holds the lower ends of the collet fingers against inward movement thus holding the bosses 68 in the coupling recess.

The running tool is then released from the body 31 of the holder by further downward jars imparted to the running tool and is then removed from the well leaving the holder and the anchoring device locked in the tubing in the position illustrated in FIGURE 1. Upward movement

of the lock mandrel relative to the collet is resiliently resistant by the collet fingers due to the engagement of the shoulder 78 of the external lock flange of the mandrel with the downwardly facing shoulder 76 of the internal bosses 74.

Well fluids from below the packer P flow into the lower open end of the tubing and upwardly past the anchoring device and the chemical holder 30. Some of the well fluids also flow into the lower end of the holder chamber 36 through the lateral ports 50 of the body 31 and then upwardly in the chamber past the valve element or segments 38 and back to the tubing through the top open end of the chamber. Well fluids can flow upwardly in the tubing and through the surface pipe 16 only when the valves 15 and 17 are open.

Should it thereafter be desired to cause a chemical to be dissolved in the well fluids flowing upwardly through the tubing, the valves 15 and 17 are closed and the valve 14 is opened. A solid charge C of the chemical is then inserted into the tubular housing through the open valve 14. The upper valve 14 is then closed and the lower valve 15 is opened to permit the charge to fall by gravity through the valve 15 into the tubing. Since upward flow of well fluids through the tubing is now prevented because the valves 14 and 17 are closed, the charge moves downwardly, due to its greater specific density, through the well fluids in the tubing. If desired, of course, once the valve 14 is closed and the charge moves downwardly through the valve 15, the valve 17 can be opened and fluid pumped therethrough into the tubular housing 12 and thence through the valve 15 into the upper end of the tubing above the charge to facilitate the downward movement of the charge through the tubing.

The charge moves downwardly through the tubing, either by gravity or assisted by pumping, enters into the upper end of the chamber 36 of the holder and moves downwardly between the valve segments 38 whose lower end portions pivot outwardly in opposite directions due to the force exerted thereon by the downwardly moving charge until the upper end of the charge moves below the lower ends of the valve segments. The valve segments then move by gravity to their closed positions and thereafter limit upward movement of the charge in the chamber.

The valve 17 is then opened to permit flow of fluid upwardly through the tubing to the surface pipe 16. As the well fluids flow through the ports 50 into the chamber 36 and upwardly therein above the charge, the charge is slowly dissolved in the well fluids and is thus brought into contact with the internal surfaces of the tubing above the holder and with the internal surfaces of the various valves and fluid conductors through which the well fluids flow. The chemical charge may be of such composition as to provide a desired effect when dissolved in the well fluids. For example, the charge may be employed to inhibit corrosion of the tubing and of the valves and conductors through which the well fluids flow or to inhibit the deposition of paraffin on the internal surfaces of the tubing and the various flow conductors through which the well fluids are produced.

It will be apparent that upward movement of the charge C of the chamber 36 of the holder is limited by the engagement by its upper end with the bottom end edges 47 of the valve segments. The aperture or port 48 formed by the lowers ends of the valve segments is located centrally of the chamber, and tends to cause the well fluids to flow about and into contact with substantially all surfaces of the charge C thus insuring the proper dissolution of the chemical. The valve segments do not sealingly engage the internal surfaces of the upper cylindrical body section 32 so that the well fluids will flow upwardly through the holder chamber even should the charge momentarily be moved upwardly in the chamber by the force of upwardly flowing well fluids and tend to close or partially close the port 48.

Whenever one charge C of the chemical is exhausted or dissolved, another such charge is introduced into the tubing and the holder in the above described manner without the necessity of removing the holder from the tubing or of introducing any other well tool into the tubing.

Should it thereafter be desirable or necessary to remove the chemical holder from the tubing, a suitable pulling tool, such as the Otis type G pulling tool illustrated and described on page 3934 of "The Composite Catalogue of Oil Field Equipment and Services," 1962–1963 edition, may be lowered into the tubing by means of a wire line and the usual set of wire line tools in the usual well known manner until the lower end of the pulling tool telescopes into the upper cylindrical section 32 of the body 31 and its latch or locking means enter into the latch or locking recess 35 to secure the pulling tool to the holder body 31.

An upward pull imparted to the pulling tool then causes the holder 30 and the lock mandrel 56 of the anchoring device 55 to be moved upwardly relative to the collet fingers. The camming engagement of the shoulder 78 of the lock mandrel and the lower shoulders 76 of the internal bosses 74 of the collet fingers 67 move the collet fingers resiliently outwardly to permit such upward movement of the lock flange of the lock mandrel. When the shoulder 78 engages the internal annular downwardly facing shoulder 90 of the collet 65, further upward movement of the lock mandrel causes upward movement of the collet. The engagement of the upper cam shoulders 75 of the external bosses 68 of the collet fingers with any downwardly facing obstructions of the tubing, such as the lower end shoulders 28 of a tubing section 24, cams the collet fingers inwardly to permit movement of the bosses 68 out of the coupling recess 26 and thus permits upward movement of the anchoring device, and therefore of the chemical holder, for removal from the well tubing.

It will now be seen that a new and improved method of dissolving a chemical in well fluids flowing upwardly through a well flow conductor or tubing has been illustrated and described which does not require the removal or running of any tools into the flow conductor whenever a charge of the chemical must be introduced into the flow conductor to be dissolved in the well fluids.

It will further be seen that the method of dissolving a substance or chemical in a well fluid flowing through a well flow conductor includes the steps of positioning a holder having a chamber which opens downstream of the well fluid flow and valve means for preventing movement of a solid body from the chamber, closing the flow conductor to flow of fluids thereto, introducing a solid body of the substance into the downstream end of the flow conductor for movement into the flow conductor into the chamber and past the valve means, and then opening the flow conductor to flow of fluids therethrough and past the solid body in the holder to cause the substance of the solid body to be dissolved in the well fluids.

It will further be seen that the chemical holder includes a body providing an elongate upwardly opening chamber for receiving a substantially rod-shaped charge C of a chemical and valve means for permitting downward movement of the charge into the chamber and for preventing its upward movement from the chamber.

It will further be seen that the valve means of the holder comprises a pair of segments of a cylinder pivotally secured to the chamber for pivotal movement about substantially parallel spaced axes extending transversely relative to the longitudinal axes of the chamber and inwardly and above the centers of gravity of the segments whereby the lower end portions of the segments are gravity biased inwardly toward each other about the axes, are movable outwardly by the force exerted thereon by a solid body as it moves downwardly between and engages the segments, and move inwardly toward one another as the upper end of the body moves below the seg-

ments to prevent subsequent upward movement of the body from the chamber.

It will further be seen that the inner surfaces of the valve segments provide downward convergent or sloping surfaces to help guide the downward movement of the solid body therebetween and to the lower end portion of the chamber.

It will further be seen that while a particular holder valve means has been illustrated and described, the holder could be provided with valve means other than the valve elements 38*a* and 38*b*, for example, inwardly and downwardly extending leaf springs or even a single valve element 38 as long as such valve means permit downward movement of the body or charge C into the chamber and prevent its upward movement therefrom.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. The method of dissolving a substance in well fluids flowing through a well flow conductor which includes the steps of: positioning a holder having a chamber which opens downstream of the well fluid flow and valve means for preventing downstream movement of a solid body from the chamber; closing the flow conductor to prevent flow of well fluids therethrough; introducing a solid body of the substance into the downstream end of the flow conductor for movement through the flow conductor and into the chamber past the valve means; and then opening the flow conductor to flow of well fluids therethrough past the solid body in the holder to cause the substance to be dissolved in the well fluids.

2. The method of treating well fluids flowing through a flow conductor of a well which includes the steps: positioning in a desired location in the well flow conductor a holder having an upwardly opening chamber and valve means for preventing upward movement of a solid body from the chamber; closing the flow conductor at the surface of the well; introducing a solid body of a substance into the upper end of the flow conductor for downward movement through the flow conductor into the chamber and past the valve means; and then opening the flow conductor at the surface to the flow of well fluids therethrough and past the solid body in the holder to cause the substance of the solid body to be dissolved in the well fluids whereby internal surfaces of the well flow conductor downstream of the holder are contacted by well fluids having the substance dissolved therein.

3. The method of treating a well with a chemical to inhibit corrosion of internal surfaces of the flow conductor, inhibit deposition of paraffin on the internal surfaces of well flow conductor and the like, which includes the steps of: positioning a holder having an upwardly opening chamber and valve means for preventing movement of a solid body of the chemical from the chamber; closing the flow conductor at the surface to flow of fluids therethrough; introducing a solid body of the chemical into the upper end of the flow conductor for downward movement therethrough into the chamber and past the valve means; retaining said solid body of chemical in said holder; and then opening the flow conductor to flow of well fluids therethrough and through the holder past the solid body of chemical in the holder to cause the chemical to be continuously dissolved in the well fluids whereby well fluids contacting surfaces of the well flow conductor downstream of the holder containing the chemical.

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