METHOD OF INJECTING TREATING LIQUIDS INTO WELL TUBING

7 Claims, 1 Drawing Fig.

ABSTRACT: This disclosure is of a method of introducing liquids into well tubing. The tubing has an injection valve and a packer located below the injection valve and expanded into contact with the casing. The liquid to be introduced into the tubing and a gas are introduced into the tubing-casing annulus. The gas pressure forces the liquid into the tubing through the injection valve against the pressure of the production within the tubing. The gas pressure may be varied to compensate for variations in tubing pressure.
BACKGROUND OF THE INVENTION

This invention relates to the production of oils and gases. More particularly this invention is a method of injecting liquids into a tubing bore from the casing under controlled conditions. Briefly, this invention is a new method for introducing liquids, for any desired purpose, into a tubing from the casing under controlled conditions. As specific examples, this invention can be used to inject corrosion inhibitors, to inject liquids to prevent the deposition of elemental sulfur on tubing walls, and to inject alcohol to prevent the formation of hydrocarbon hydrates. The invention will be described below with regard to its use in injecting corrosion inhibitors into the tubing.

It is highly important in the production of oils and gases to minimize corrosion caused by corrosive material produced along with the oils and gases. For example, hydrogen sulfide and carbon dioxide are often constituents of produced oil and gas. Unless protected against, hydrogen sulfide and carbon dioxide would soon damage equipment in well bores to such an extent that equipment would be unusable.

It is common in the oil and gas industry to use a corrosion inhibiting chemical for minimizing the corrosive effects of materials such as hydrogen sulfide and carbon dioxide. Various corrosion inhibiting chemical tools have been devised and various methods for injecting the corrosion inhibiting chemical into or on the subsurface equipment have been devised. For example, the Carlisle et al. U.S. Pat. No. 2,654,436, issued Oct. 6, 1953, discloses a method and apparatus for preventing corrosion in a well containing a well tubing and a well casing. However, an excessive volume of liquid corrosion inhibiting chemical is required in the practice of the method disclosed by Carlisle and it necessary to remove the differential pressure injection valve for resetting if the pressure in the tubing varies.

SUMMARY OF THE INVENTION

This invention may be used in a cased well containing a tubing having an injection valve and a packer below the injection valve which is expanded into contact with the casing. If desired, the injection valve may be differential pressure valve. The corrosion inhibiting chemical is introduced into the tubing-casing annulus. The level of the corrosion inhibiting chemical should preferably extend to a point above the liquid to the injection valve. Yet the level of the corrosion inhibiting chemical should also be at some point below the top of the tubing-casing annulus.

After the proper amount of corrosion inhibiting chemical has been introduced into the tubing-casing annulus, a quantity of gas is introduced into said annulus. If desired, the gas may be introduced before or after the corrosion inhibiting chemical. Then pump pressure is applied sufficiently high to force corrosion inhibiting chemical into the tubing through the injection valve against the pressure in the tubing.

It is common for the pressure due to production of oils and gases to vary within the tubing. With previous methods it is often necessary to remove the differential pressure injection valve and adjust said valve when the inside tubing pressure varies beyond a predetermined limit. An important feature of this invention is that the gas pressure exerted against the corrosion inhibiting chemical column is varied to compensate for variations in tubing pressure. Therefore, the differential pressure valve need not be removed even though variations in pressure should occur within the tubing.

The invention as well as its many advantages will be further understood by reference to the following detailed description and single FIG. which is a schematic view partly in section useful in explaining our new method for introducing liquids into well tubing.

Referring to the drawing, a well bore indicated generally by the numeral 10 is shown drilled from the earth's surface 12 and extending downwardly to some point below the earth's surface. A casing 14 has been formed within the well bore 10. Perforations 16 have been provided through the casing 14 to permit the passage of oils and/or gases from the producing subsurface formation 18.

A tubing 20 is connected to the wellhead 22. Tubing 20 extends from the wellhead 22 downwardly to a point adjacent the subsurface production formation 18.

An injection valve 24 is connected to the tubing 20 by means of a valve mounting means 26. The injection valve 24 may be a conventional injection valve readily available on the market. For example, the injection valve 24 may be a differential pressure valve similar to that disclosed in the Carlisle et al. U.S. Pat. No. 2,654,436, issued Oct. 6, 1953.

The packer 28 is mounted on the tubing 20 at a point on the tubing 20 below the injection valve 24. The oils and/or gases produced from subsurface formation 18 flow through perforations 16, upwardly through the tubing 20 to the casing head 22 and then through the production line 30 controlled by valve 32. The produced fluids usually contain highly corrosive materials such as hydrogen sulfide and carbon dioxide which badly damage the subsurface equipment such as the tubing 20 in a very short time unless checked by proper treatment.

The corrosion inhibiting chemical is introduced into the tubing-casing annulus 34 by means of line 36 and line 38 and controlled by pump 40. As can be seen from the drawing, the tubing-casing inhibiting chemical 42 has been introduced into the tubing-casing annulus 34 to provide a liquid column extending to a level 44 which is located above the inlet 46 of the differential pressure injection valve 24 but below the top of the tubing-casing annulus 34.

The gas, which is preferably an inert gas, such as nitrogen is introduced into the tubing-casing annulus 34 by way of gas line 48 and line 38 controlled by gas valve 50. It is not necessary that the gas be introduced after the corrosion inhibiting chemical. If desired the gas may be introduced before the corrosion inhibiting chemical or simultaneously.

In order to inject the liquid inhibitor 42 through the differential pressure valve 24, the gas pressure plus the weight of the fluid column (liquid and gas) must be greater than the pressure setting of the differential pressure valve 24 plus the average flowing tubing pressure. The differential pressure valve setting can be initially established in accordance with the expected average flowing tubing pressure. The pressure setting can only be changed by removing the valve, resetting it, and replacing the valve on the tubing 20. This is costly and time consuming.

If the tubing-casing annulus 34 is substantially full of liquid, the weight of the fluid column cannot be varied because liquid is incompressible. Conventional injection pumps are designed to operate within a predetermined pressure range. If the average flowing tubing pressure should vary above or below a predetermined pressure range, the required pump pressure to inject the corrosion inhibiting chemical into the tubing may be such that it is outside of the range of operation of the pump. Thus, the differential pressure valve 24 must be removed, reset, and replaced. Even more important, the average flowing tubing pressure of the well may be such that if the tubing-casing annulus 34 is substantially full of liquid, a valve setting sufficiently great to hold up the liquid column may not be physically possible to build up in the valve. Under these conditions, partial gaseous fill of the annular space is absolutely necessary.

Gas is compressible. Therefore, in practicing our new method if the average flowing tubing pressure varies above or below a predetermined pressure range, the pressure exerted by the column of liquids and gases at valve 24 in the tubing-casing annulus 34 can be varied by compressing or decompressing the gas column. The pressure of the gas column is increased by opening valve 50 and feeding more gas into the annulus 34. The pressure of the gas column may be decreased by opening
valve 50 and bleeding some of the gas from the annulus 34. It is not necessary to remove the differential pressure valve 24 to adjust the setting of the valve.

Another advantage of this invention results from the fact that the gaseous cushion is a poor heat conductor compared to liquids and solids. Therefore, the production flowing up tubing 20 loses much less heat to the surrounding areas than it would if the tubing-casing annulus were completely full of liquid. The insulating effect of the gas enveloping the tubing prevents loss of heat from the uppermost end of the tubing 20. Temperature and pressure conditions within the tubing are maintained such that hydrocarbon hydrate compounds are prevented from forming and sulfur in elemental or compound form is not deposited on the inside of the tubing.

It is to be understood that various modifications may be made to the described method without departing from the scope of the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

We claim:

1. A method of injecting treating liquids into a cased well with tubing placed therein having a normally closed injection valve which opens when the pressure in the tubing-casing annulus exceeds the pressure in the tubing by a predetermined amount and a packer below the injection valve expanded into contact with the casing comprising the steps of:
   Introducing a treating liquid into the tubing-casing annulus whereby said liquid fills said annulus to a level above said injection valve and substantially below the top of said annulus; and
   introducing a gas into said annulus whereby a portion of the liquid is forced through said valve into the tubing against the pressure in the tubing.

2. A method in accordance with claim 1 wherein the liquid includes a corrosion inhibiting chemical.

3. A method in accordance with claim 1 wherein the liquid includes an alcohol.

4. A method in accordance with claim 1 wherein the amount of liquid and gas introduced provides a liquid column extending to a level above the injection valve and substantially below the top of the tubing-casing annulus and a gas column extending from the top of said liquid column to the top of said annulus, whereby said gas column insulates said tubing and prevents heat loss in the upper portion of said tubing.

5. A method in accordance with claim 4 with the additional step of:
   varying the pressure of the gas column in response to variations in tubing pressure whereby the pressure exerted at the valve by the combined liquid and gas columns compensates for variations in tubing pressure.

6. A method in accordance with claim 1 wherein the liquid includes a solvent.

7. A method of injecting treating liquids into a cased well with tubing placed therein having a normally closed differential pressure valve which opens when the pressure in the tubing-casing annulus exceeds the pressure in the tubing by a predetermined amount and a packer below the differential pressure valve expanded into contact with the casing comprising the steps of:
   introducing sufficient liquid into the tubing-casing annulus to fill said annulus up to the level above the inlet of the differential pressure valve and substantially below the top of the tubing-casing annulus;
   thereafter introducing gas into said annulus at a pressure sufficient to force a portion of said liquid through said valve into the tubing against the pressure in the tubing; and
   varying the gas pressure in response to variations in tubing pressure to maintain the liquid pressure at the valve sufficient to force the liquid through the valve into the tubing.