Abstract: A regulation mechanism configured to automatically close off fluid flow through a line based on flow rate exceeding a predetermined level. This mechanism may be particularly beneficial when employed in conjunction with downhole chemical injection systems that are directed at well locations prone to becoming low pressure in nature. That is, in a conventional system, once the inherent pressure at the downhole end of an injection line exceeds that of the adjacent downhole environment, the flow rate of the column of fluid in the line may naturally increase as chemical is unintentionally emptied into the well. However, use of embodiments of the flow-based regulation mechanism detailed herein may near-automatically prevent such undesirable emptying of chemical into a low pressure well.

**FIG. 3A**
(72) Inventors; and

(74) Agents: SULLIVAN, Chadwick, A. et al; 10001 Richmond Avenue, IP COE, Room 4720, Houston, TX 77042 (US).


Published:
— with international search report (Art. 21(3))
— with information concerning one or more priority claims considered void (Rule 26bis.2(d))
CHEMICAL INJECTION REGULATION MECHANISM

BACKGROUND

[0001] Exploring, drilling and completing hydrocarbon wells are generally complicated, time consuming and ultimately very expensive endeavors. As a result, over the years increased attention has been paid to monitoring and maintaining the health of such wells. Significant premiums are placed on maximizing the total hydrocarbon recovery, recovery rate, and extending the overall life of the well as much as possible. Thus, logging applications for monitoring of well conditions play a significant role in the life of the well. Similarly, significant importance is placed on well intervention applications, such as clean-out techniques which may be utilized to remove debris from the well so as to ensure unobstructed hydrocarbon recovery.

[0002] In addition to interventional applications, the well is often outfitted with chemical injection equipment to enhance ongoing recovery efforts without the requirement of intervention. For example, most of the well may be defined by a smooth steel casing that is configured for the rapid uphole transfer of hydrocarbons and other fluids from a formation. However, a buildup of irregular occlusive scale, wax and other debris may occur at the inner surface of the casing or tubing and other architecture restricting flow there-through. Such debris may even form over perforations in the casing, screen, or slotted pipe thereby also hampering hydrocarbon flow into the main borehole of the well from the surrounding formation.

[0003] In order to address scale buildup as noted above, a variety of conventional interventional techniques are available. However, in order to avoid running time consuming interventional applications that may involve the delivery of footspace eating clean-out equipment, a circulating chemical injection system is often employed. This is particularly the case where the likelihood of buildup is accounted for up front, as is
often the case in deep water wells. Regardless, with such systems in place, a metered amount of chemical mixture, such as a hydrochloric acid mix, may be near continuously circulated downhole to help prevent such buildup.

[0004] The noted chemical injection equipment includes an injection line that may be run from surface and directed at different downhole points of interest such as within production tubing, at a production screen or into formation fluid prior to entering the noted tubing. Regardless, the need to halt production or run expensive interventions in order to address undesirable buildup may be largely eliminated.

[0005] Unfortunately, regulating the delivery of the chemical injection mixture to the points of interest may come with pressure related challenges over the life of the well. For example, a given downhole point of interest within the well may display a fairly high pressure at the outset of operations. In some cases, well pressures may exceed 10,000 PSI. Therefore, the chemical injection line may be pressurized from surface so as to ensure that a proper chemical injection delivery rate is maintained. Indeed, a series of check valves may also be incorporated into the line to help avoid potentially caustic production uphole through the line.

[0006] While utilizing check valves and pressurizing the line may initially ensure chemical injection delivery and avoid production through the line, pressures within the well may change over time. For example, pressurizing the line may overcome a well pressure of 10,000 PSI. However, when the pressure within the well drops over time as is often the case, the line may begin to leak chemical mixture into the well even without the application of positive pressure from surface. That is to say, depending on the depth of the line, the inherent fluid pressure therein may begin to exceed well pressure.

[0007] Aside from the expense of lost chemical mixture into the well, leakage as a result of low well pressure may have a variety of negative consequences. For example, an exceeded rate or ratio of active chemical directed at the target location may act as a
corrosive and damage the downhole tubing, screen or other equipment at the location. Once more, simply halting production by sealing off the line at surface may also be undesirable. For example, such action may result in forming a vacuum within the line that can lead to boiling of the chemical mixture. Thus, irreparable damage to the line, the production tubing and/or the casing may result.

Such low pressure wells often lead to catastrophic circumstances that require a full chemical injection system change-out, major workover or even a complete loss of the well at a cost of between several hundred thousand to perhaps millions of dollars, not to mention lost production time. Indeed, rather than take such measures, these low pressure wells may be kept on-line only so long as artificial lift and other such production aids remain viable, after which time the well may be abandoned due to failure to effectively address buildup issues.

**SUMMARY**

A chemical injection regulation mechanism is provided which includes inlet and outlet lines. A regulation device is coupled to the lines for regulating chemical flow therebetween based on a fluid flow directed thereat. For example, a method of regulating fluid flow between the lines is provided. The method includes directing a fluid downhole through the inlet line at a given rate and guiding the fluid to a regulator of the device having a pressure based on the given rate. The fluid may then be released through the outlet line and into a well where the pressure is below a predetermined level.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Fig. 1 is a side view of a downhole assembly employing an embodiment of a chemical injection regulation mechanism.

Fig. 2 is an overview of an oilfield with a well accommodating the assembly of Fig. 1 with the regulation mechanism incorporated therein.
Fig. 3A is an enlarged sectional view of the regulation mechanism of Figs. 1 and 2 in an open position to allow chemical flow therethrough.

Fig. 3B is an enlarged sectional view of the mechanism of Fig. 3A in a closed position to seal off chemical flow to the well.

Fig. 4 is an alternate embodiment of a chemical injection regulation mechanism employing multiple regulators in tandem for flexibility in flow control.

Fig. 5 is another alternate embodiment of a regulation mechanism incorporated into a downhole assembly and utilizing electric line control.

Fig. 6 is a flow-chart summarizing an embodiment of employing a chemical injection regulation mechanism is disclosed.

DETAILED DESCRIPTION

Embodiments are described with reference to certain configurations of completions hardware that make use of chemical injection assemblies. In particular, completions are depicted and described which utilize a chemical injection assembly to help prevent scale and other buildup in an adjacent production tubular. However, whether on shore or offshore, a variety of different completion architectures may benefit from utilization of regulated chemical injection as detailed herein. For example, chemical injection directed at a well annulus, casing, production screen or a variety of other locations may benefit from a regulation mechanism as detailed herein.

Referring now to Fig. 1, a side view of a downhole assembly 101 is shown. The assembly 101 utilizes an embodiment of a chemical injection regulation mechanism 100 to help manage the flow of chemical injection fluid into adjacent production tubing 180. However, in other embodiments, such a chemical injection application may be directed at a variety of different completion hardware target locations. Regardless, as detailed further below, the regulation mechanism 100 may be
particularly adept at preventing the undesirable drainage of a column of the injection fluid from a chemical injection line 120.

[0019] More specifically, a chemical injection mixture and application protocol at the depicted location of Fig. 1 may be directed by an operator positioned a significant distance away at an oilfield 200 of Fig. 2. As detailed below, this results in a pressure exerted by the column of fluid in the line 120 which, depending on downhole conditions, may exceed pressure within the tubing 180. Thus, the regulation mechanism 100 may be of significant benefit in deterring chemical fluid leakage into the depicted tubing 180.

[0020] In the embodiment shown, the assembly 101 is configured to support production in an uphole direction (see arrow 110). At the same time, the assembly 101 is outfitted with the chemical injection features such as the referenced line 120. Thus, an ongoing metered amount of chemical injection fluid may be delivered to the tubing 180 so as to help minimize scale 190 or other production inhibiting buildup.

[0021] With added reference to Fig. 2, and by way of example only, early in the life of the well 285, downhole pressures may be quite dramatic, perhaps exceeding 10,000 PSI. Therefore, the assembly 101 may be outfitted with one way check valves 175 to ensure that production does not enter the tubing port 177 of the chemical injection system. These valves 175 may be located near the port 177 to protect as much of the line 120, regulation mechanism 100, and other chemical injection hardware from exposure to downhole fluids as possible. Additionally, in order to achieve chemical injection into the tubing 180 through the port 177, a pump unit 227 may be utilized to drive up pressure and deliver a metered rate of injection.

[0022] However, in other situations, for example, later in the life of the well, downhole pressures may drop dramatically, perhaps well under 500 PSI. Nevertheless,
artificial lift and other measures may be taken to help ensure continued production viability of the well 285.

[0023] Continuing with reference to Figs. 1 and 2 and with such possible low pressure conditions of the well 285 in mind, the role of the regulation mechanism 100 is again considered. The mechanism 100 is shown with a coupling 140 for securing to the chemical injection line 120 which originates at the surface of the oilfield 200 as alluded to above. As a practical matter, this means that the noted column of fluid in the line 120 may span a distance of several thousand feet in vertical height. Thus, with a conventional line diameter of between 0.25 inches and 1.25, the fluid pressure at the coupling 140 and mechanism 100 may be far in excess of about 500 PSI (depending on the fluid type).

[0024] By the same token, however, the tubing pressure at the location 179 adjacent the depicted tubing port 177 may be well under 500 PSI as in the example above. Indeed, this is often the case for wells that are offshore, substantially depleted, of extended life, or some combination thereof. Whatever the case, as noted above, the disposal of the regulation mechanism 100 between the noted location 179 and the line 120 may be utilized to help avoid the undesirable chemical injection leakage into the tubing 180.

[0025] Referring directly now to Fig. 2, an overview of an oilfield 200 is shown which accommodates the assembly 101 of Fig. 1 within a well 285. More specifically, the assembly 101 is isolated with a packer 275 adjacent a perforated production region 297. So, for example, the interior of the production tubing 180 is exposed to the region 297 for production but isolated from the remaining annulus 250 of the well 285. Once more, as detailed above, debris such as scale and other buildup in the tubing 180 are kept at a minimum by the use of a chemical injection system that incorporates a regulation mechanism 100, among other features.
In the embodiment shown, the noted injection system is directed at delivery through a port 177 and into the tubing 180 as described above. The location of the delivery is such that uphole fluid flow via production may be utilized to distribute chemical injection mix through the tubing 180 keeping buildup therein at a minimum. However, depending on the nature of operations, such chemical injection may be directed at hardware directly adjacent the production region 297, within the annulus 250, or anywhere downhole that may be of operational benefit. Once more, there may be circumstances where downhole pressure (e.g. in the tubing 180) is of a level that's below the line-based injection fluid pressure at the downhole end of the line 120 (near the injection point). Nevertheless, the regulation mechanism 100 may help prevent uncontrolled injection fluid drainage, thereby avoiding any potential catastrophic results from such leakage.

Continuing with reference to Fig. 2, the well 285 is outfitted with a casing 280 and traverses various formation layers 290, 295 in reaching the noted production region 297. Thus, the chemical injection line 120 of the assembly 101 may traverse several thousand feet from surface before reaching the regulation mechanism 100. As such, the significance of the mechanism 100 in holding back a column of injection fluid mixture may be appreciated, for example, where the corresponding downhole pressure is of a negligible level.

Additionally, a host of equipment 220 is positioned at the oilfield 200 for running production, chemical injection, and other operations. In the embodiment shown, this includes a conventional well head 225 with production line 223 emerging therefrom along with a rig 221 for supporting a host of potential interventional tools. Further, pump 227 and control 229 units are also positioned adjacent the well head 225 for directing operations. For example, at the outset of operations, the pump unit 227
may be supplied by chemical tanks and utilized to circulate a tailored chemical fluid mixture down through the injection line 120.

[0029] The pump unit 227 may be configured to effect a pressure and rate sufficient for overcoming any high pressure downhole conditions. By the same token, changes to this rate, the ratio of constituents of the fluid mixture, or responsiveness to changing downhole pressures may be accounted for and directed by the control unit 229. As described above, this may even include directing the pump unit 227 to halt positive pressure applied to the line 120 when downhole pressure becomes sufficiently low. In fact, at this time, the effectiveness of the regulation mechanism 100 in preventing chemical loss from the line 120 may be appreciated as noted above and detailed further below.

[0030] Continuing with reference to Fig. 2, another advantage of utilizing the regulation mechanism 100 relates to testing of the injection system as a whole. That is, upon outfitting hardware within the well 285 as shown, a series of functional tests may be performed. For example, this may include testing seals and other features of the chemical line 120. With the regulation mechanism 100 incorporated into the line 120, such tests may now be performed at reasonably low pressures and without significant loss of chemical fluid. That is, flow rate and pressure may be introduced into the line 120 in order to close off the mechanism 100 as described and test fluid sealing thereof.

[0031] Referring now to Figs. 3A and 3B, enlarged sectional views depicting internal features of the regulation mechanism 100 of Figs. 1 and 2 are shown. More specifically, Fig. 3A is a view of the mechanism 100 in an open position to allow chemical flow therethrough, whereas 3B depicts the mechanism 100 closed to seal off the chemical flow.

[0032] With particular reference to Fig. 3A, the mechanism 100 is depicted with the coupling 140 at one end for securing to the chemical line 120 and an outlet 360 leading
to check valves 175 and other injection features (see Figs. 1 and 2). However, between this coupling 140 and outlet 360, the flow rate of the noted chemical fluid mix 300 may determine whether or not the regulation mechanism 100 is left open or is closed.

[0033] By way of a specific example, and continuing with reference to Fig. 3A, the fluid mix 300 may be directed to the regulation mechanism 100 at a rate of about 0.1 gallons per minute. With added reference to Fig. 2, this may be achieved by operation of the pump 227 and control 229 units which may direct and monitor flow on an ongoing basis as well as account for factors such as the length and dimensions of the line 120. Regardless, in the embodiment shown, and by way of example only, a flow rate of 0.1 gal./min. may translate into about a 150 lbs. of force applied to a valve 325 of within the mechanism 100. Thus, where a biasing device 330, in this case, a spring, is rated at about 200 lbs., such a flow of the fluid 300 would fail to overcome the spring. As such, the valve 325 would remain open and allow the fluid 300 to continue to flow through the regulation mechanism 100.

[0034] However, with added reference to Fig. 3B (and Fig. 2), circumstances may dictate that the valve 325 be closed so as to stop the flow of chemical mix 300. For example, as well noted above, low pressure conditions in the well 280 may constitute such circumstances. Indeed, where this is the case, the column of chemical mix 300 in the line 120 may naturally begin to flow at a greater rate due to a reduced pressure differential. For example, the flow rate may be increased, whether naturally or as directed by surface equipment 220. For exemplary purposes only, consider that a rate increase to 0.2 gallons per minute might raise the forces exerted on the valve 325 to a predetermined 300 lbs., thereby overcoming the biasing device 330 and closing off flow through the mechanism 100. More specifically, the valve 325 is equipped with a piston 350 and sealing head 355 which extends toward an exit channel 365 of the outlet
360. Thus, when the force of the spring is overcome by the forces imparted on the valve 325, the mechanism 100 is closed and flow from the line 120 is halted.

[0035] Continuing with reference to Figs. 3A and 3B, with some added reference to Fig. 2, the manner by which forces imparted on the valve 325 and device 330 as a result of changing flow rate is described in greater detail. Namely, in the embodiment depicted, the valve 325 is a shuttle valve disposed in a chamber 320 defined by a body 301 of the mechanism 100 and outfitted with a seal ring 329 and flow restrictor 327. Thus, the flow of fluid 300 into this chamber 320 from the line 120 translates into a force on the valve 325 that is enhanced primarily based on the dimensions of the restrictor 327. That is, the smaller the restrictor 327, the greater the magnification of the force. Regardless, with the restrictor 327 inherently of smaller dimension than the chamber 320 and the line 120, some degree of force amplification results.

[0036] The particular degree of force amplification may be tailored to the particular operational parameters in which the regulation mechanism 100 is to be utilized. So, for example, in certain embodiments a wide range and high rate of chemical injection delivery protocols may be utilized. Therefore, the amount of flow rate increase necessary to close off the regulation mechanism and injection may be greater than in applications where tighter tolerances or more precision is to be displayed in chemical injection delivery. Such design choices may be implemented through the use of flow restrictors 327 of varying sizes as noted above or through dimensional variations in the body of the valve 325 itself. Indeed, for added variability a manifold 400 of differently tailored regulator mechanisms may be utilized simultaneously (see Fig. 4).

[0037] In the embodiment shown, the diameter of the body of the piston head 355 is notably less than that of the spring and interfacing support structure. Thus, the effective diameter of the seal is limited in a manner that may allow for an equilibrium to develop between the pressure in the chamber 320 and pressure surrounding the
spring. Therefore, to ensure that the valve 325 remains closed, continuous flow of fluid 300 may be maintained. Of course, in other embodiments, the effective diameter of the seal may be increased by enlarging the piston head 355 to a degree that continuous flow of fluid 300 may not be necessary.

[0038] Referring now to Fig. 4, an alternate embodiment of a manifold 400 of chemical injection regulation mechanisms 410, 420, 430 operating in tandem to provide for flexibility in flow control. That is, each regulator 410, 420, 430 may be set to close off at a different flow rate threshold as determined by spring, restrictor and other internal component factors as noted above. For example, in one embodiment, a first regulator 430 may be configured for sealing upon exposure to a flow rate of 0.3 gallons per minute, a second regulator 420 for sealing upon exposure to 0.2 gallons per minute and a third regulator 410 to close off at 0.1 gallons per minute. Thus, as flow is introduced into the line 120 and driven up, the regulators 430, 420, 410 would be sequentially closed off.

[0039] As a practical matter, the sequential closing off of the regulators 430, 420, 410 as described above provides a system in which an overall wider range of flow rates and pressures may be utilized to achieve injection before completely shutting down an injection application. For example, such a manifold 400 may be configured to govern a metered rate of injection where flow rate from the line 120 ranges up to about 0.3 gallons per minute and imparts up to several thousand PSI on any of the individual regulators 430, 420, 410.

[0040] Referring now to Fig. 5, another alternate embodiment of a regulation mechanism 500 is shown. In this embodiment, the mechanism 500 operates to regulate a flow of chemical injection fluid 300 with the aid of a control line 510, most likely of an electric variety, although other signaling platforms may be utilized. Regardless, in the embodiment shown, the mechanism 500 regulates or meters the delivery of the
injection fluid 300 by way of a valve 525, in this case shifted open or closed via
signaling over the noted line 510. That is, in this embodiment, electric signaling may be utilized in place of flow control for regulating the chemical injection application.

Regardless, this technique helps avoid undesired release of injection fluid 300 in circumstances where downhole pressures are substantially low.

[0041] In the embodiment of Fig. 5, the valve 525 may be directed to release the chemical injection fluid 300 through a port 579 as shown. However, this ported release may again be directed at a variety of locations. This may include directing the fluid 300 to flow upstream with production fluid 110 before release into the tubing 180 so as to help prevent buildup at a port 577 thereat. Indeed, in the embodiment shown, the fluid 300 is actually routed toward a flow control valve 527 that more directly meters the release of fluid 300 into the production tubing 180. For example, in one embodiment, this valve 527 may be further guided by input from a viscosity 560, flow 540 or other sensor for tighter precision over the chemical injection release into the tubing 180 via a release port 577.

[0042] Continuing with reference to Fig. 5, a regulation mechanism 500 may be utilized at a variety of site specific locations. For example, in the embodiment of Fig. 5, the mechanism 500 is utilized to guide and regulate chemical injection at a specific isolated zone of a downhole assembly. That is, the mechanism 500 is disposed in a region of the well 285 that is cased 280 and isolated by packers, 275, 575 in a manner targeting production from the specific production region 297. Indeed, a variety of different such production zones may be a part of the overall well architecture, each with its own discrete hardware and independently operating regulation mechanism 500 tailored to the production and conditions thereat. Thus, a more site specific and overall tailored injection profile for the entire well 285 may be developed.
Referring now to Fig. 6, a flow-chart summarizing an embodiment of employing a chemical injection regulation mechanism is disclosed. Namely, an injection line leading through a well may be supplied with a chemical fluid mixture as indicated at 610. Thus, a column of fluid with its own column-based pressure at its downhole end is provided. Thus, the mix may be flowed through the line to a downhole target location as indicated at 630. Where downhole pressure is less than the column-based pressure, the potential exists for this to be achieved without the use of surface pumps or the like. Alternatively, as noted at 650, positive pressure may also be utilized as needed.

Regardless, once the flow is begun, the system is equipped with a regulation mechanism that provides for the sealing off of the flow when desired by exceeding the rate to above a predetermined level (see 670). Thus, undesirable leakage of chemical flow may be avoided. As referenced above, this sealing may take place sole based on the flow resulting from a column-based pressure differential (see 610 proceeding directly to 670) or by intentionally pumping at a higher rate from surface. Additionally, as indicated at 690, the presence of the mechanism allows for early stage seal testing of the injection line and/or periodic testing during the life of the well without significant risk of such chemical fluid losses.

Embodiments described hereinabove include a chemical injection regulation mechanism that may be utilized to avoid expenses associated with the loss of chemical injection fluid into a well as a result of low downhole pressures. Once more, more dramatic consequences related to chemical fluid leakage and/or corresponding vacuum induced line closure may also be avoided. Such regulation is achieved in a manner which avoids any undesired downtime in injection capacity and even allows for early stage testing of chemical injection line sealing capacity.
The preceding description has been presented with reference to presently preferred embodiments. Persons skilled in the art and technology to which these embodiments pertain will appreciate that alterations and changes in the described structures and methods of operation may be practiced without meaningfully departing from the principle, and scope of these embodiments. Regardless, the foregoing description should not be read as pertaining only to the precise structures described and shown in the accompanying drawings, but rather should be read as consistent with and as support for the following claims, which are to have their fullest and fairest scope.
CLAIMS

We Claim:

1. A chemical injection regulation mechanism comprising:
   a valve disposed in a chamber for exposure to a column of injection fluid; and
   a biasing device coupled to said valve and configured to allow sealing of the
   chamber upon a flow rate of the fluid thereinto reaching a predetermined level.

2. The mechanism of claim 1 wherein said biasing device is a spring configured to
   collapse upon exposure to forces determined based on the flow rate reaching the
   predetermined level.

3. The mechanism of claim 1 wherein said valve includes a piston with a sealing
   head at the end thereof to provide the sealing in response to the reaching of the
   predetermined level.

4. The mechanism of claim 1 wherein said valve is a shuttle valve with a flow
   restrictor therethrough.

5. The mechanism of claim 4 wherein the predetermined level is based at least in
   part on dimensions of the chamber, the valve and the flow restrictor.

6. The mechanism of claim 1 wherein said biasing device is coupled to an
   electrical control line to direct the sealing.
7. The mechanism of claim 1 wherein said valve is a first valve for the exposure to the injection fluid, the mechanism further comprising a second valve in fluid communication with said first valve for flow control release of the injection fluid from the mechanism.

8. The mechanism of claim 7 wherein the flow control release is governed at least in part by input from an adjacent sensor configured to provide data of a variety selected from a group consisting of flow related data and viscosity related data.

9. A valve assembly comprising:
   - an inlet line for accommodating a column of fluid;
   - a fluid flow regulation mechanism disposed in a chamber for exposure to the column of fluid; and
   - an outlet line to receive a flow of the fluid when pressure on the mechanism from the column is below a predetermined level.

10. The assembly of claim 9 wherein the fluid is a chemical injection fluid and the assembly is configured for disposal in a well, the assembly further comprising downhole hardware in fluid communication with said outlet for obtaining the flow to minimize occlusive buildup.

11. The assembly of claim 10 wherein said hardware is selected from a group consisting of well casing, a production screen, and production tubing.
The assembly of claim 10 wherein the well is selected from a group consisting of an offshore well and a substantially depleted well.

The assembly of claim 10 configured for disposal in an isolated zone within the well.

A chemical injection manifold assembly comprising:

a first regulation mechanism with a valve disposed in a chamber for regulating flow therethrough from a column of fluid in communication therewith, the regulating to allow the flow therethrough when a rate thereof is below a first predetermined level;

and

a second regulation mechanism with another valve disposed in another chamber for regulating flow therethrough from the column of fluid in communication therewith, the regulating to allow the flow therethrough when a rate thereof is below a second predetermined level different from the first predetermined level.

The assembly of claim 14 wherein the first predetermined level is substantially different from the second predetermined level to ensure sequential closure of the mechanisms as the rate is increased.

A method of regulating injection into a well, the method comprising:

supplying an injection line into the well with a column of fluid mix;

flowing the fluid through a regulation mechanism to a target location in the well at below a predetermined rate; and
sealing off said flowing with the mechanism upon the fluid reaching a flow rate that exceeds the predetermined rate.

17. The method of claim 16 wherein the reaching of the flow rate exceeding the predetermined rate is aided by application of positive pressure delivered by equipment positioned at an oilfield surface adjacent the well.

18. The method of claim 16 further comprising running a pressure test on the injection line supported by said sealing.

19. The method of claim 16 wherein said sealing further comprises maintaining a continuous flow of fluid through the line.

20. The method of claim 16 wherein said sealing comprises shifting a valve of the mechanism to a closed position, said shifting including overcoming a biasing force of the valve with a force determined based on the flow rate as the predetermined rate is exceeded.
610 Supplying an injection line into a well at an oilfield with a column of chemical fluid mix

630 Flowing the mix through the line to a target location in the well at a given rate

650 increasing the rate by application of positive pressure from the oilfield surface

670 Sealing off the flow of the mix to the location upon the rate exceeding a predetermined level

690 Running a pressure test on the line based on the sealing

FIG. 6
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

E21B 43/16(2006.01)i, E21B 43/20(2006.01)i, E21B 43/22(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21B 43/16; F16K 17/14; F16K 17/00; E21B 34/06; G05D 7/01

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic database consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: regulation valve, chemical injection, spring and pressure difference

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>US 05487405A A (SKOGLUND; PAUL K.) 30 January 1996</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>See abstract, column 3, line 48 - column 6, line 11, figures 1-3 and claim 1.</td>
<td>1-7, 10-13, 16-20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8, 14, 15</td>
</tr>
<tr>
<td></td>
<td>See abstract, paragraphs [0002], [0016H0022] and figures 2, 3.</td>
<td>1-7, 10-13, 16-20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8, 9, 14, 15</td>
</tr>
<tr>
<td></td>
<td>US 04932435A A (STROZE; MARK S. et al.) 12 June 1990</td>
<td>1-20</td>
</tr>
<tr>
<td></td>
<td>See abstract, column 3, line 15 - column 4, line 59 and figures 2-4.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>US 2009-0078428 A (ALT MOHAMMAD ATHAR) 26 March 2009</td>
<td>1-20</td>
</tr>
<tr>
<td></td>
<td>See abstract, paragraphs [0019], [0026] and figures 1-3.</td>
<td></td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"B" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search

11 SEPTEMBER 2012 (11.09.2012)

Date of mailing of the international search report

12 SEPTEMBER 2012 (12.09.2012)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-70 1, Republic of Korea
Facsimile No. 82-42-472-7140

Authorized officer

Kwak Joong Hwan
Telephone No. 82-42-481-8279

Form PCT/ISA/210 (second sheet) (July 2009)
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>US 05878777A A</td>
<td>09.03.1999</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 05971012A A</td>
<td>26.10.1999</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 96-31816 A1</td>
<td>10.10.1996</td>
</tr>
<tr>
<td>US 04932435A A</td>
<td>12.06.1990</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO 20100530 A</td>
<td>22.04.2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 7870906 B2</td>
<td>18.01.2011</td>
</tr>
</tbody>
</table>