A system and method for monitoring and removing scale from a wellbore according to which fluid is passed through a discharge head at a pressure and flow rate so that it discharges against the inner wall of the well to remove scale from the wall, and the pressure and flow rate of the fluid are measured so that the changes in the pressure and flow rate provide an indication of scale removal.
SYSTEM AND METHOD FOR MONITORING AND REMOVING SCALE FROM A WELLBORE

BACKGROUND

[0001] This disclosure relates to a system and method for monitoring and removing scale from a wellbore.

[0002] In downhole oil and gas recovery installations, scale, in the form of salt crystal growth, mud cake, mud filtrate, etc., often accumulates on the wall of the wellbore, or on a casing in the wellbore, which can lead to lost productivity and reduced injection rate. Therefore, cleaning, or scale removal, operations are often needed to remove the buildup material.

[0003] These operations often involve lowering a cleaning tool down in the wellbore and passing cleaning fluid at a relatively high pressure through the tool so that the fluid impacts against the scale to remove it. During the cleaning operation it is desired to identify how much scale is left on the wall of the wellbore or the casing after the cleaning operation, and adjust the operation accordingly within the same running trip. However, due to the limitations of most of the cleaning tools, an inspection tool often has to be run separately from the cleaning tool in order to evaluate the cleaning results, which adds to the cost of the operation.

[0004] Therefore what is need is a single tool that functions to both clean and monitor the results of the cleaning.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. 1 is a partial elevational/partial sectional/partial schematic view, not necessarily to scale, depicting an oil and gas recovery installation incorporating a tool according to one embodiment.

[0006] FIG. 2 is an enlarged sectional view of the tool of FIG. 1.

[0007] FIG. 3 is an enlarged view of a portion of the tool of FIG. 2.

DETAILED DESCRIPTION

[0008] Referring to FIG. 1 of the drawings, the reference numeral 10 refers to the bore of a completed well penetrating a subterranean formation F for the purpose of recovering hydrocarbon fluids from the formation F. A tool 12 is lowered into the wellbore 10 to a predetermined depth by a string 14, in the form of coiled tubing, jointed tubing, or the like, which is connected to the upper end of the tool 12. The tool 12 is for the purpose of cleaning and monitoring scale in the wellbore 10 in a manner to be described.

[0009] The string 14 extends from a rig 16 that is located above ground and extends over the wellbore 10. The rig 16 is conventional and, as such, includes support structure, and other associated equipment, for receiving and supporting the tool 12 and lowering it to a predetermined depth in the wellbore 10, via the string 14, using a winch, or the like. It is also understood that other tools (not shown) can be attached to the string 14.

[0010] The upper portion of the wellbore 10 can be lined with a casing 18 which is cemented in the wellbore 10 in a conventional manner. Although not shown in the drawing, it is understood that production tubing, having an outer diameter greater than that of the tool 12 but less than that of the casing 18, can be installed in the wellbore 10 in a conventional manner and extends from the ground surface to a predetermined depth in the casing 18 to provide a passage for the recovered fluids.

[0011] Referring to FIG. 2, the tool 12 includes a discharge head 20 forming the lower portion of the tool 12, and a sensing head 22 connected to the discharge head 20 and forming the upper portion of the tool 12. The upper end of the sensing head 22 is connected to the lower end of the string 14 in any conventional manner. The lower end portion of the sensing head 22 is stepped radially inwardly to form a reduced-diameter nipple 22a, which is externally threaded. The upper end portion of the discharge head 20 is internally threaded and receives the nipple 22a in a threaded engagement, to attach the sensing head 22 to the discharge head 20. The outer diameter of the sensing head 22 is slightly larger than the outer diameter of the discharge head 20 and is less than, and a function of, the inner diameter of the casing 18.

[0012] A chamber 20a is formed in the interior of the discharge head 20, and a plurality of angularly and radially spaced discharge ports 20b are provided through the wall of the discharge head 20 and are in communication with the chamber 20a. Therefore, when pressurized cleaning fluid from the rig 16 is passed through the string 14 and into the tool 12, it passes into the chamber 20a in a manner to be described, and discharges through the ports 20b to clean the scale off the inner wall of the casing 18. It is understood that the tool 12 can be rotated in any conventional manner so that fluid discharging from the discharge head 20 in the above manner can cover the full inner circumference of the casing 18.

[0013] An axial passage 22b extends through the length of the sensing head 22, and a radial passage 22c extends through the sensing head 22 in a spaced relation to the upper end of the sensing head 22. The diameter of the passage 22c is greater than that of the passage 22b, and the passage 22c intersects with the passage 22b to place the passages in communication.

[0014] One end portion of the passage 22c has a reduced diameter portion near a wall portion of the sensing head 22, which receives a sensing element 24, in the form of a ball. The sensing element 24 is sized relative to the reduced-diameter portion so that a portion of the sensing element 24 can project outwardly from the wall while the remaining portion extends within the passage 22c. A plug 26 is disposed in an end portion of the passage 22b and defines a seat for receiving the sensing element 24. Two radial passages 26a and 26b are formed through the plug 26 for reasons to be described. A pair of wiper ring seals 28a and 28b extend between the outer surface of the plug 26 and the corresponding surface of the wall of the sensing head 22 forming the passage 22c to provide a seal.

[0015] A plug 30 is disposed in the other end portion of the passage 22c and is externally threaded to mate with threads formed in the corresponding end portion of the passage 22c, to secure the plug 26 in the passage 22c. A compression spring 32 is disposed in the passage 22c between the respective inner ends of the plugs 26 and 30.

[0016] As a result of the above, the plug 30 is fixed relative to the passage 22c and the plug 26 is adapted to slide in the
passage 22c. The plugs 26 and 30 establish a load on the spring 32, which urges the plug 26, and therefore the sensing element 24 radially outwardly, or in a direction from left-to-right as viewed in FIG. 2.

[0017] In operation, the tool 12 is lowered from the rig 16, via the string 14 to an area of the wellbore 10 to be cleaned. Fluid, such as water or cleaning fluid, is pumped into the tool 12, via a conventional pump, or the like, at the rig 16, and passes through the string 14 and into the upper end of the passage 22a.

[0018] The spring 32 normally pushes the sensing element 24 radially outwardly against the inner wall of the casing 18 to its extended position as shown in FIG. 2 and by the phantom line in FIG. 3, so that the sensing element 24 seals against the reduced diameter portion of the passage 22c, with the wiper seals 28a and 28b sealing against the ingress of dirt and other foreign materials into the passage 22c. In this situation, the fluid passes through the length of the passage 22b, enters the chamber 20a of the discharge head 20, and discharges against the inner wall of the casing 18 for removing any scale from the wall, as described above. The tool 12 is rotated and lowered gradually down the wellbore 10 as the fluid discharges from the tool 12, and it is understood that measuring devices are provided at the rig 16 for measuring the flow rate and pressure of the fluid.

[0019] During this operation, as the tool 12 is lowered in the wellbore 10, if scale is still present on the inner wall of the casing 18 after the above cleaning/removal operation, the effective inner diameter of the casing will be reduced. If this occurs, the sensing element 24, and therefore the plug 26, will be forced back, or radially inwardly in a right-to-left direction, in the passage 22c to a retracted position shown by the solid line in FIG. 3. This creates flow passages (two of which are shown in FIG. 3) extending from the passage 22b, into and through the passage 22c, through the passages 26a and 26b, and through a passage defined between the sensing element 24 and the reduced diameter portion of the passage 22c. Thus, fluid will be diverted into the latter passage and will flow into an annulus defined between the outer surface of the tool 12 and the inner wall of the casing 18.

[0020] This diversion of the fluid flow changes the flow rate of the fluid, as well as the pressure of the above pump, which is measured at the rig 16 and thus provides an indication that corresponds to the amount of scale remaining on the inner wall of the casing 18. When this occurs, an operator at the rig 16 can pull the tool 12 back up the wellbore 10 until a clean area of the wall of the casing 18 is encountered, causing the sensing element to move to its position of FIG. 2 thus closing the above diversion path. The fluid will thus be directed into the discharge head 20 and through the discharge ports 20b. Then the tool 12 is lowered in the wellbore 10 again to remove the remaining scale by the discharging fluid. It can be appreciated that the above cycle is repeated as necessary as the tool 12 is lowered down the wellbore 10 for cleaning in the above manner.

Variations

[0021] It is understood that variations may be made in the foregoing without departing from the scope of the invention. For example, additional sensing elements, identical to the sensing element 24, along with the corresponding components described above, can be provided in the sensing head 22 in an angularly and/or axially-spaced relation to the sensing element 24. Also, the size and shape of the sensing element(s) 24 can be varied. Moreover, the tool 12 can be used in installations not having a casing in which case scale accumulating on the inner wall of the well would be removed. Further, a computer, in the form of a microprocessor, or the like, can be provided to respond to the above changes in flow rate and/or pressure and control the above-described movement and operation of the tool accordingly.

[0022] The foregoing descriptions of specific embodiments of the present invention have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the invention to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teaching. The embodiments were chosen and described in order to best explain the principles of the invention and its practical application, to thereby enable others skilled in the art to best utilize the invention and various embodiments with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto and their equivalents.

What is claimed is:

1. A tool for use in a wellbore, comprising:
   a discharge head for receiving fluid having a pressure and a flow rate, wherein the fluid is dischargeable from the discharge head to remove scale from the wellbore; and
   a sensing element for engaging an inner wall in the wellbore, wherein the sensing element responds to changes in the diameter of the inner wall to change the pressure and the flow rate of the fluid.

2. The tool of claim 1 wherein the change in the pressure and the flow rate of the fluid provides an indication of the scale removal.

3. The tool of claim 1 wherein:
   the discharge head receives the fluid from the ground surface; and
   the sensing element diverts a portion of the fluid from the discharge head to change the pressure and the flow rate of the fluid.

4. The tool of claim 3 further comprising a sensing head connected to the discharge head, wherein the sensing element is mounted in the sensing head.

5. The tool of claim 4 wherein the sensing element moves from an extended position in which it engages the inner wall and a retracted position in which it engages scale on the inner wall.

6. The tool of claim 5 wherein:
   the fluid flows from the ground surface to the discharge head when the sensing element in the extended position; and
   a portion of the fluid is diverted from the discharge head to the sensing head for discharge from the tool when the sensing element is in the retracted position.

7. The tool of claim 1 wherein the changes in the diameter of the inner wall are a result of the accumulation of the scale on the inner wall.

8. The tool of claim 1 wherein:
   the discharge head receives the fluid from a string extending between the tool and the ground surface; and
the changes in the pressure and the flow rate are measurable at the ground surface.

9. The tool of claim 8 wherein:

the fluid normally flows from the string to the discharge head; and

the sensing element diverts a portion of the fluid from the discharge head to change the pressure and the flow rate of the fluid.

10. The tool of claim 1 further comprising a sensing head connected to the discharge head upstream of the sensing head, wherein the sensing element is disposed in the sensing head.

11. The tool of claim 10 wherein:

the sensing head is in fluid flow communication with the discharge head; and

the fluid from the string passes through the sensing head to the discharge head.

12. The tool of claim 11 wherein the sensing head diverts a portion of the fluid flowing to the discharge head in response to the changes in the diameter of the inner wall and passes the diverted fluid externally of the tool to change the pressure and the flow rate of the fluid.

13. The tool of claim 10 wherein the sensing element moves relative to the sensing head in response to the changes in the diameter of the inner wall to divert the fluid.

14. The tool of claim 10 wherein the changes in the diameter of the inner wall are a result of the accumulation of the scale on the inner wall.

15. The tool of claim 10 wherein movement of the sensing element in one direction opens a diversion path for the fluid and movement of the sensing element in an opposite direction closes the diversion path.

16. The tool of claim 10 wherein the changes in the diameter of the inner wall are a result of the accumulation of the scale on the inner wall.

17. The tool of claim 1 wherein a casing disposed in the wellbore defines the inner wall.

18. The tool of claim 1 wherein a wall of the wellbore defines the inner wall.

19. A method comprising the steps of:

flowing fluid at a pressure and a flow rate so that the fluid discharges against an inner wall of a wellbore to remove scale from the inner wall; and

responding to changes in the diameter of the inner wall to change the pressure and the flow rate of the fluid.

20. The method of claim 19 further comprising the step of measuring the pressure and the flow rate of the fluid so that the changes in the pressure and the flow rate provide an indication of scale removal.

21. The method of claim 19 wherein:

the fluid normally discharges from a discharge head; and

the pressure and the flow rate of the fluid is changed by diverting a portion of the fluid from the discharge head.

22. The method of claim 19 further comprising the steps of:

measuring the pressure and the flow rate of the fluid; and

controlling the operation of the tool accordingly.

23. The method of claim 19 wherein the step of responding comprises the step of engaging the inner wall with a sensing element which moves between an extended position and a retracted position in response to the changes in the diameter of the inner wall.

24. The method of claim 23 wherein:

the fluid is directed in a path so that it discharges against the inner wall to remove the scale when the sensing element is in the extended position; and

a portion of the fluid is diverted from the path to change the pressure and the flow rate of the fluid when the sensing element is in the retracted position.

25. The method of claim 24 further comprising the step of passing the diverted fluid externally of the tool.

26. The method of claim 19 wherein the changes in the diameter of the inner wall are a result of the accumulation of the scale on the inner wall.

27. The method of claim 19 further comprising the step of disposing a casing in the wellbore to define the inner wall.