DOWNHOLE PRESSURE MAINTENANCE SYSTEM USING A CONTROLLER

TECHNICAL FIELD

The present disclosure relates generally to a downhole pressure maintenance system, and specifically a pressure maintenance system that maintains a pressure within an isolated annulus of a wellbore within a predetermined pressure range.

BACKGROUND

After a well is drilled and a target reservoir has been encountered, completion and production operations are performed, which may include gravel packing operations. Generally, gravel packing operations include placing a lower completion assembly, which forms part of a working string, downhole within a target reservoir in a formation. In a multi-zone completion, a number of packers are located within the lower completion assembly and are activated to isolate a portion of a wellbore annulus formed between the working string and the casing (if a cased hole) or the formation (if an open hole). Each of these portions may be production zones that are subsequently packed with gravel or coarse sand. Often, after one of the packers is set but prior to the gravel packing of the production zones, each production zone is isolated from the wellbore hydrostatic pressure. As the formation absorbs drilling fluids from each production zone, the wellbore annulus pressure within each of the production zones may drop, which may cause collapse of an open hole or influx of sand in an unconsolidated cased hole installation.

The present disclosure is directed to a downhole pressure maintenance system that overcomes one or more of the shortcomings in the prior art.

SUMMARY

According to a first aspect of the present invention, there is provided a completion assembly comprising: a base pipe having an exterior surface at least partially defining an external region and an internal surface at least partially defining an internal region; and a pressure maintenance device disposed in the base pipe and comprising: a flow path that extends between the external region and the internal region; a valve that controls the flow of a fluid from the internal region to the external region through the flow path; a first pressure sensor exposed to the external region; and a controller in communication with the first pressure sensor and in communication with the valve, wherein the controller opens or partially opens the valve when the pressure measured by the first pressure sensor is less than or equal to a minimum pressure.

According to a second aspect of the present invention, there is provided a method of pressure maintenance within an isolated zone of a wellbore comprising: positioning a first pressure maintenance

device that is disposed in a completion string within a first zone of a wellbore, wherein the first pressure maintenance device comprises: a first flow path that extends between an external region of the completion string that is at least partially defined by an external surface of the completion string and an internal region of the completion string that is at least partially defined by an internal surface of the completion string; a first valve that controls the flow of a fluid from the internal region to the external region through the first flow path; a first pressure sensor exposed to the external region; and a first controller that is in communication with the first valve and the first pressure sensor; isolating the first zone from a first hydrostatic wellbore pressure that is associated with the first zone; measuring the pressure within the external region of the isolated first zone using the first pressure sensor; determining whether the pressure within the external region of the isolated first zone is less than a first zone minimum pressure using the first controller; and opening or partially opening the first valve to allow the fluid from the internal region to flow to the external region of the isolated first zone when the pressure within the external region of the isolated first zone is less than the first zone minimum pressure.

According to a third aspect of the present invention, there is provided a method of isolated wellbore pressure maintenance, the method comprising: positioning a completion string that has an internal passageway and that has an external surface that at least partially defines an external region within a wellbore; isolating a zone of the external region from a wellbore hydrostatic pressure; measuring a pressure within the external region of the isolated zone; determining whether the pressure within the external region of the isolated zone is within a predetermined pressure range; and opening or partially opening a valve that controls a flow of a fluid through a flow path from the internal region to the external region of the isolated zone when the pressure within the external region is outside of the predetermined pressure range.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments of the present disclosure will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the disclosure. In the drawings, like reference numbers may indicate identical or functionally similar elements.

FIG. 1 is a schematic illustration of an oil and gas rig operably coupled to a lower completion system, the lower completion system including a pressure maintenance device, according to an exemplary embodiment of the present disclosure;

FIG. 2 is a schematic illustration of the lower completion system of FIG. 1, according to an exemplary embodiment of the present disclosure;

FIG. 2A is an enlarged view of a portion of the lower completion system of FIG. 2, according to an exemplary embodiment of the present disclosure;

CLAIMS

1. A completion assembly comprising:

a base pipe having an exterior surface at least partially defining an external region and an internal surface at least partially defining an internal region; and

a pressure maintenance device disposed in the base pipe and comprising:

a flow path that extends between the external region and the internal region;

a valve that controls the flow of a fluid from the internal region to the external region through the flow path;

a first pressure sensor exposed to the external region; and

a controller in communication with the first pressure sensor and in communication with the valve,

wherein the controller opens or partially opens the valve when the pressure measured by the first pressure sensor is less than or equal to a minimum pressure.

2. The completion assembly of claim 1, wherein the pressure maintenance device further comprises a second pressure sensor exposed to the internal region, wherein the controller is in communication with the second pressure sensor.

3. The completion assembly of claim 2, wherein the pressure maintenance device is a remotely actuated pressure maintenance device.

4. The completion assembly of claim 1, wherein the valve comprises:

a piston coupled to a drive; and

a motor that is coupled to the drive, wherein the motor is in communication with the controller.

5. The completion assembly of claim 1, wherein the pressure maintenance device further comprises an isolation sleeve that is disposed within the internal region and slideable to a closed position such that the isolation sleeve blocks the flow path.

6. The completion assembly of claim 2, wherein the controller closes or partially closes the valve when the pressure measured by the second pressure sensor is greater than a maximum pressure.

7. The completion assembly of claim 1, wherein the pressure maintenance device further comprises at least one of a check valve and a filter located along the flow path.

8. The completion assembly of claim 1, wherein the pressure maintenance device further comprises a timer, wherein the controller is in communication with the timer.

9. A method of pressure maintenance within an isolated zone of a wellbore comprising:

positioning a first pressure maintenance device that is disposed in a completion string within a first zone of a wellbore, wherein the first pressure maintenance device comprises:

a first flow path that extends between an external region of the completion string that is at least partially defined by an external surface of the completion string and an internal region of the completion string that is at least partially defined by an internal surface of the completion string;

a first valve that controls the flow of a fluid from the internal region to the external region through the first flow path;

a first pressure sensor exposed to the external region; and

a first controller that is in communication with the first valve and the first pressure sensor;

isolating the first zone from a first hydrostatic wellbore pressure that is associated with the first zone;

measuring the pressure within the external region of the isolated first zone using the first pressure sensor;

determining whether the pressure within the external region of the isolated first zone is less than a first zone minimum pressure using the first controller; and

opening or partially opening the first valve to allow the fluid from the internal region to flow to the external region of the isolated first zone when the pressure within the external region of the isolated first zone is less than the first zone minimum pressure.

10. The method of claim 9, wherein the pressure maintenance device further comprises a second pressure sensor exposed to the internal region, the second pressure sensor in communication with the first controller.

11. The method of claim 10, wherein the method further comprises:

measuring the pressure within the internal region using the second pressure sensor;

determining whether the pressure within the internal region is greater than a first zone maximum pressure; and

closing or partially closing the first valve when the pressure within the internal region is greater than the first zone maximum pressure.

12. The method of claim 9, further comprising:

determining whether the pressure within the external region of the isolated first zone exceeds the first zone maximum pressure; and

closing or partially closing the first valve to prevent the flow of the fluid from the internal region to the external region of the isolated first zone when the pressure within the external region of the isolated first zone exceeds the first zone maximum pressure.

13. The method of claim 10, wherein the method further comprises the first controller receiving instructions from a surface assembly.

14. The method of claim 9, wherein the method further comprises the first controller sending a signal that is received at a surface assembly, the signal relating to a downhole condition.

15. The method of claim 10, further comprising the first controller receiving an updated first zone minimum pressure, the updated first zone minimum pressure being different from the first zone minimum pressure.

16. The method of claim 15, wherein the first controller receiving the updated first zone minimum pressure comprises the second pressure sensor detecting pressure pulses in the internal region.

17. The method of claim 9, further comprising:

positioning a second pressure maintenance device that is disposed in the completion string within a second zone of the wellbore, wherein the second pressure maintenance device comprises:

a second flow path that extends between the external region and the internal region;

a second valve that controls the flow of a fluid from the internal region to the external region through the second flow path;

a third pressure sensor exposed to the external region; and

a second controller that is in communication with the second valve and the second pressure sensor;

isolating the second zone from a second hydrostatic wellbore pressure that is associated with the second zone;

measuring the pressure within the external region of the isolated second zone using the third pressure sensor;

determining whether the pressure within the external region of the isolated second zone is less than a second zone minimum pressure using the second controller; and

opening the second valve to allow the fluid from the internal region to flow to the external region of the isolated second zone when the pressure within the external region of the isolated second zone is less than the second zone minimum pressure.

18. The method of claim 17, wherein the first zone minimum pressure is different from the second zone minimum pressure.

19. The method of claim 9, further comprising moving an isolation sleeve that is disposed within the internal region from an open position in which the fluid from the internal region is allowed to flow through the flow path to a closed position in which the isolation sleeve obstructs the flow path.

20. A method of isolated wellbore pressure maintenance, the method comprising:

positioning a completion string that has an internal passageway and that has an external surface that at least partially defines an external region within a wellbore;

isolating a zone of the external region from a wellbore hydrostatic pressure;

measuring a pressure within the external region of the isolated zone;

determining whether the pressure within the external region of the isolated zone is within a predetermined pressure range; and

opening or partially opening a valve that controls a flow of a fluid through a flow path from the internal region to the external region of the isolated zone when the pressure within the external region is outside of the predetermined pressure range.

21. The method of claim 20, wherein operating the valve when the pressure within the external region is outside of the predetermined pressure range comprises at least one of:

opening or partially opening the valve to increase the amount of a fluid flowing from the internal passageway to the external region; and

closing or partially closing the valve to decrease the amount of the fluid flowing from the internal passageway to the external region.

22. The method of claim 21, wherein operating the valve further comprises activating a motor that is mechanically coupled to a drive that moves the valve.

23. The method of claim 20, further comprising measuring a pressure within the internal region to receive a signal from a surface assembly.

24. The method of claim 23, further comprising operating the valve in response to the signal received from the surface assembly.

25. The method of claim 20, further comprising moving an isolation sleeve that is disposed within the internal passageway to obstruct the flow path.

26. The method of claim 20, wherein the valve is a piston valve.

27. The method of claim 20, wherein isolating the zone of the external region from a wellbore hydrostatic pressure comprises setting a packer that is disposed on the completion string.