Wireless Activatable Valve Assembly

BACKGROUND

[0001] When wellbores are prepared for oil and gas production, it is common to cement a casing string within the wellbore. Often, it may be desirable to cement the casing string within the wellbore in multiple, separate stages. The casing string may be run into the wellbore to a predetermined depth. Various "zones" in the subterranean formation may be isolated via the operation of one or more packers, which may also help to secure the casing string and stimulation equipment in place, and/or via cement.

[0002] Following the placement of the casing string, it may be desirable to provide at least one route of fluid communication out of the casing string. Conventionally, the methods and/or tools employed to provide fluid pathways out of the casing string require mechanical tools supplied by a rig and/or downhole tools needing high temperature protection, long term batteries, and/or wired surface connections. Additionally, conventional methods may not allow for individual, or at least selective, activation of a route of fluid communication from a plurality of formation zones.

SUMMARY

[0002a] According to a first aspect of the present invention, there is provided a well screen assembly for use downhole comprising: a first fluid pathway configured to provide fluid communication between an exterior of a wellbore tubular and an interior of the wellbore tubular; a flow restrictor disposed in the fluid pathway; a first actuation system comprising a first receiving antenna, wherein the first receiving antenna is configured to generate an electric current in response to receiving a first electromagnetic signal having a first frequency; and a first sliding member disposed in series with the flow restrictor in the fluid pathway, wherein the sliding member is transitional from a first position to a second position in response to the electric current; wherein the sliding member prevents fluid communication along the fluid pathway when the sliding member is in the first position, and wherein the sliding member allows fluid communication along the fluid pathway when the sliding member is in the second position.

[0002b] According to a second aspect of the present invention, there is provided a well screen assembly for use in a wellbore comprising: a plurality of fluid pathways, wherein each fluid pathway of the plurality of fluid pathways is configured to provide fluid communication between an exterior of a wellbore tubular and an interior of the wellbore tubular, wherein two or more fluid pathways of the plurality of fluid pathways comprise: an actuation system comprising a receiving antenna, wherein the receiving antenna is configured to generate an electric current in response to receiving a specific electromagnetic signal; a flow restrictor disposed in at least one of the two or more fluid pathways; and a sliding member disposed in

the corresponding fluid pathway, wherein the sliding member is transitional from a first position to a second position in response to the electric current; wherein the sliding member prevents fluid communication along the corresponding fluid pathway when the sliding member is in the first position, and wherein the sliding member allows fluid communication along the corresponding fluid pathway when the sliding member is in the second position.

[0002c] According to a third aspect of the present invention, there is provided a method comprising: preventing, by a first sliding member, fluid flow through a first fluid pathway in a well screen assembly, wherein the first fluid pathway is configured to provide fluid communication between an exterior of a wellbore tubular and an interior of the wellbore tubular; inductively coupling, by a first receiving antenna, with a first transmitting antenna that is transmitting a first signal; generating a first electric current in the first receiving antenna in response to receiving the first signal; translating the first sliding member using the first electric current; and allowing fluid flow through a flow restrictor is disposed in the first fluid pathway in response to the translating of the first sliding member.

[0003] In an embodiment, a wireless actuation system comprises a transmitter, an actuation system comprising a receiving antenna, one or more sliding members transitional from a first position to a second position and a fluid chamber disposed between the one or more sliding members and the actuation system, wherein the fluid chamber is configured to retain the one or more sliding members in the first position when fluid is sealed in the fluid chamber. The transmitter is configured to transmit an electromagnetic signal, and the sliding member prevents a route of fluid communication via one or more ports of a housing when the sliding member is in the first position. The sliding member allows fluid communication via the one or more ports of the housing when the sliding member is in the second position, and the actuation system is configured to allow the sliding member to transition from the first position to the second position.

[0004] In an embodiment, a wireless actuation system comprises a receiving antenna, an actuation mechanism coupled to the receiving antenna, a pressure chamber, and a slidable component disposed in a downhole tool. The receiving antenna is configured to generate electric power in response to receiving a signal, and the actuation mechanism is configured to selectively trigger fluid communication between the pressure chamber and the slidable component using the electric power. The slidable component is configured to transition from a first position to a second position based on a pressure differential between the pressure chamber and a pressure source.

[0005] In an embodiment, an actuation system for a downhole component comprises a

powered transmitter comprising a transmitting antenna, a downhole component comprising a central flowbore and a receiving antenna coupled to the actuation system, one or more sliding members transitional from a first position to a second position; and a fluid chamber disposed between the one or more sliding members and the actuation system. The powered transmitter is configured to be received within the central flowbore, and the transmitting antenna is configured to transmit a signal. The receiving antenna is configured to generate electric power in response to receiving the signal from the transmitting antenna, the actuation system is configured to actuate using the electric power from the receiving antenna and wherein the fluid chamber is configured to retain the one or more sliding members in the first position when fluid is sealed in the fluid chamber.

[0006] In an embodiment, a method of actuating a downhole component comprises passing a powered transmitter through a central flowbore of a downhole component; transmitting a signal from a transmitting antenna disposed in the powered transmitter; generating electric power in a receiver antenna disposed in the downhole component in response to receiving the signal from the transmitting antenna; and actuating an actuation system using the electric power, wherein the actuation system is configured to allow a sliding member to transition from a first position to a second position by selectively allowing fluid to escape from a fluid chamber. The downhole component may comprise a housing comprising the actuation system; and a sliding member slidably positioned within the housing. The sliding member may be configured to transition from a first position to a second position. When the sliding member is in the first position, the sliding member may prevent a route of fluid communication via one or more ports of the housing, and when the sliding member is in the second position, the sliding member may allow fluid communication via the one or more ports of the housing.

[0007] In an embodiment, a well screen assembly for use downhole comprises a fluid pathway configured to provide fluid communication between an exterior of a wellbore tubular and an interior of the wellbore tubular; a flow restrictor disposed in the fluid pathway; an actuation system comprising a receiving antenna, and a sliding member disposed in series with the flow restrictor in the fluid pathway. The receiving antenna is configured to generate electric power in response to receiving a first electromagnetic signal having a first frequency, and the sliding member is transitional from a first position to a second position in response to the electric power. The sliding member is configured to provide a first resistance to fluid communication along the fluid pathway when the sliding member is in the first position, and the sliding member is configured to provide a second resistance to fluid communication along the fluid pathway when the sliding member is in the second position. The first resistance and the second resistance are different.

[0008] In an embodiment, a well screen assembly for use in a wellbore comprises a plurality of fluid pathways. Each fluid pathway of the plurality of fluid pathways is configured to provide fluid communication between an exterior of a wellbore tubular and an interior of the wellbore tubular, and two or more fluid pathways of the plurality of fluid pathways comprise an actuation system comprising a receiving antenna, and a sliding member disposed in the

CLAIMS

What is claimed:

1. A wireless actuation system comprising:

a transmitter, wherein the transmitter is configured to transmit an electromagnetic signal;

an actuation system comprising a receiving antenna;

one or more sliding members transitional from a first position to a second position; and

a fluid chamber disposed between the one or more sliding members and the actuation system,

wherein the fluid chamber is configured to retain the one or more sliding members in the first position when fluid is sealed in the fluid chamber;

wherein the sliding member prevents a route of fluid communication via one or more ports of a housing when the sliding member is in the first position, and wherein the sliding member allows fluid communication via the one or more ports of the housing when the sliding member is in the second position; and

wherein the actuation system is configured to allow the sliding member to transition from the first position to the second position.

2. The wireless actuation system of claim 1, wherein the receiving antenna is tuned to receive a specific signal frequency, and wherein the actuation system is configured to allow the sliding member to transition from the first position to the second position in response to the receiving antenna receiving the specific signal frequency.

3. The wireless actuation system of claim 2, wherein the actuation system is configured to allow the sliding member to transition from the first position to the second position by selectively allowing fluid to escape from the fluid chamber in response to receiving antenna receiving the specific signal frequency.

4. The wireless actuation system of claim 2 or 3, wherein the actuation system is configured to maintain the sliding member in the first position in response to the receiving antenna receiving a signal substantially different than the specific signal frequency.

5. The wireless actuation system of any of claims 1 to 4, wherein the transmitter comprises a power source and a signal generator coupled to a transmitting antenna.

6. The wireless actuation system of any of claims 1 to 5, wherein the receiving antenna is configured to generate electric power in response to receiving the electromagnetic signal from the transmitter.

7. The wireless actuation system of claim 6, wherein the actuation system is configured to allow the sliding member to transition from the first position to the second position responsive to the electric power.

8. The wireless actuation system of any of claims 1 to 7, wherein the actuation system comprises an actuator coupled to the receiving antenna, and wherein the actuator is configured to transition the sliding member from the first position to the second position.

9. The wireless actuation system of claim 8, wherein the actuator comprises a piercing member and an actuable member.

10. The wireless actuation system of claim 8 or 9, wherein the actuator comprises an actuatable valve.

11. The wireless actuation system of any of claims 8 to 10, wherein the actuation system is configured to pierce, rupture, destroy, perforate, disintegrate, or combust the actuable member in response to the recognition of the predetermined electromagnetic signal by the receiving antenna.

12. A wireless actuation system comprising:

a receiving antenna;

an actuation mechanism coupled to the receiving antenna;

a pressure chamber; and

a slidable component disposed in a downhole tool;

wherein the receiving antenna is configured to generate electric power in response to receiving a signal, wherein the actuation mechanism is configured to selectively trigger fluid communication between the pressure chamber and the slidable component using the electric power, and wherein the slidable component is configured to transition from a first position to a second position based on a pressure differential between the pressure chamber and a pressure source.

13. The wireless actuation system of claim 12, wherein the receiving antenna is tuned to generate the electric power in response to receiving the signal.

14. The wireless actuation system of claim 12 or 13, wherein the slidable component prevents a route of fluid communication via one or more ports of a housing when the slidable component is in the first position, and wherein the slidable component allows

fluid communication via the one or more ports of the housing when the slidable component is in the second position.

15. The wireless actuation system of any of claims 12 to 14, wherein the pressure chamber comprises an atmospheric chamber.

16. The wireless actuation system of any of claims 12 to 15, further comprising a valve, wherein the actuation mechanism is configured to open the valve using the electric power to provide the fluid communication between the pressure chamber and the slidable component.

17. An actuation system for a downhole component comprising:

a powered transmitter comprising a transmitting antenna;

a downhole component comprising a central flowbore and a receiving antenna coupled to the actuation system;

one or more sliding members transitional from a first position to a second position; and

a fluid chamber disposed between the one or more sliding members and the actuation system,

wherein the powered transmitter is configured to be received within the central flowbore,

wherein the transmitting antenna is configured to transmit a signal,

wherein the receiving antenna is configured to generate electric power in response to receiving the signal from the transmitting antenna,

wherein the actuation system is configured to actuate using the electric power from the receiving antenna, and

wherein the fluid chamber is configured to retain the one or more sliding members in the first position when fluid is sealed in the fluid chamber.

18. The actuation system of claim 17, wherein the signal is configured to selectively generate the electric power in the receiver antenna.

19. The actuation system of claim 17 or 18, wherein the actuation system is configured to puncture a fluid barrier, and wherein the actuation system is configured to actuate a valve from an open position to a closed position or from a closed position to an open position in response to puncturing the fluid barrier.

20. The actuation system of any of claims 17 to 19, wherein the powered transmitter comprises a power source and a signal generator coupled to the transmitting antenna.

21. The actuation system of any of claims 17 to 20, wherein the actuation system is configured to actuate the one or more sliding members in response to receiving the electric power from the receiving antenna.

22. A method of actuating a downhole component comprising:

passing a powered transmitter through a central flowbore of a downhole component;

transmitting a signal from a transmitting antenna disposed in the powered transmitter;

generating electric power in a receiver antenna disposed in the downhole component in response to receiving the signal from the transmitting antenna; and

actuating an actuation system using the electric power, wherein the actuation system is configured to allow a sliding member to transition from a first position to a second position by selectively allowing fluid to escape from a fluid chamber.

23. The method of claim 21, wherein the downhole component comprises:

a housing comprising the actuation system; and

the sliding member slidably positioned within the housing,

wherein when the sliding member is in the first position, the sliding member prevents a route of fluid communication via one or more ports of the housing, and when the sliding member is in the second position, the sliding member allows fluid communication via the one or more ports of the housing.

24. The method of any of claims 21 to 23, wherein the signal is uniquely associated with the receiver antenna.

25. The method of any of claims 21 to 24, wherein the transmitter comprises a transmitting antenna configured to transmit the signal, and wherein the electric power is generated through inductive coupling between the transmitting antenna and the receiving antenna.

CLAIMS

1. A well screen assembly for use downhole comprising:

a first fluid pathway configured to provide fluid communication between an exterior of a wellbore tubular and an interior of the wellbore tubular;

a flow restrictor disposed in the fluid pathway;

a first actuation system comprising a first receiving antenna, wherein the first receiving antenna is configured to generate an electric current in response to receiving a first electromagnetic signal having a first frequency; and

a first sliding member disposed in series with the flow restrictor in the fluid pathway, wherein the sliding member is transitional from a first position to a second position in response to the electric current; wherein the sliding member prevents fluid communication along the fluid pathway when the sliding member is in the first position, and wherein the sliding member allows fluid communication along the fluid pathway when the sliding member is in the second position.

2. The well screen assembly of claim 1, further comprising:

a second actuation system comprising a second receiving antenna, wherein the second receiving antenna is configured to generate an electric current in response to receiving a second electromagnetic signal having a second frequency; and

a second sliding member disposed in parallel with the flow restrictor,

wherein the second sliding member is disposed in a second fluid pathway between the exterior of the wellbore tubular and the interior of the wellbore tubular,

wherein the second fluid pathway bypasses the flow restrictor, and

wherein the second sliding member prevents fluid communication along the second fluid pathway when the second sliding member is in an initial position,

wherein the second sliding member allows fluid communication along the second fluid pathway when the second sliding member is in an actuated position.

3. The well screen assembly of claim 2, wherein the first frequency and the second frequency are the same.

4. The well screen assembly of claim 2, wherein the first frequency and the second frequency are different.

5. The well screen assembly of claim 2, further comprising a transmitter, wherein the transmitter is configured to transmit the first electromagnetic signal to the first receiving antenna.

6. The well screen assembly of claim 5, wherein the transmitter is further configured to transmit the second electromagnetic signal to the second receiving antenna.

7. The well screen assembly of claim 5, further comprising a second transmitter, wherein the second transmitter is configured to transmit the second electromagnetic signal to the second receiving antenna.

8. The well screen assembly of claim 1, further comprising:

a second fluid pathway configured to provide fluid communication between an exterior of a second wellbore tubular and an interior of the second wellbore tubular, wherein the wellbore tubular and the second wellbore tubular form parts of a wellbore tubular string;

a second flow restrictor disposed in the second fluid pathway;

a second actuation system comprising a second receiving antenna, wherein the second receiving antenna is configured to generate a second electric current in response to receiving a second electromagnetic signal having a second frequency; and

a second sliding member disposed in series with the second flow restrictor in the second fluid pathway, wherein the second sliding member is transitional from a third position to a fourth position in response to the second electric current; wherein the second sliding member prevents fluid communication along the second fluid pathway when the second sliding member is in the third position, and wherein the second sliding member allows fluid communication along the second fluid pathway when the second sliding member is in the fourth position.

9. The well screen assembly of claim 8, wherein the first frequency and the second frequency are different.

10. A well screen assembly for use in a wellbore comprising:

a plurality of fluid pathways, wherein each fluid pathway of the plurality of fluid pathways is configured to provide fluid communication between an exterior of a wellbore tubular and an interior of the wellbore tubular, wherein two or more fluid pathways of the plurality of fluid pathways comprise:

an actuation system comprising a receiving antenna, wherein the receiving antenna is configured to generate an electric current in response to receiving a specific electromagnetic signal;

a flow restrictor disposed in at least one of the two or more fluid pathways; and

a sliding member disposed in the corresponding fluid pathway, wherein the sliding member is transitional from a first position to a second position in response to the electric current; wherein the sliding member prevents fluid communication along the corresponding

fluid pathway when the sliding member is in the first position, and wherein the sliding member allows fluid communication along the corresponding fluid pathway when the sliding member is in the second position.

11. The well screen assembly of claim 10, wherein the actuation systems in each of the two or more fluid pathways are configured to generate the electric current in response to specific electromagnetic signals having different frequencies.

12. The well screen assembly of claim 10, wherein the receiving antenna is physically tuned to the specific electromagnetic signal.

13. The well screen assembly of claim 10, further comprising a transmitter, wherein the transmitter is configured to transmit the specific electromagnetic signal to at least one corresponding receiving antenna.

14. The well screen assembly of claim 10, wherein at least one receiving antenna is configured to not generate an electric current in response to the transmitter transmitting the specific electromagnetic signal to the at least one corresponding receiving antenna.

15. A method comprising:

preventing, by a first sliding member, fluid flow through a first fluid pathway in a well screen assembly, wherein the first fluid pathway is configured to provide fluid communication between an exterior of a wellbore tubular and an interior of the wellbore tubular;

inductively coupling, by a first receiving antenna, with a first transmitting antenna that is transmitting a first signal;

generating a first electric current in the first receiving antenna in response to receiving the first signal;

translating the first sliding member using the first electric current; and

allowing fluid flow through a flow restrictor is disposed in the first fluid pathway in response to the translating of the first sliding member.

16. The method of claim 15, further comprising:

preventing, by a second sliding member, fluid flow through a second fluid pathway in the well screen assembly, wherein the second fluid pathway is configured to provide fluid communication between the exterior of a wellbore tubular and an interior of the wellbore tubular and wherein the second fluid pathway is disposed in parallel with the fluid pathway;

inductively coupling, by a second receiving antenna, with a second transmitting antenna that is transmitting a second signal;

generating a second electric current in the second receiving antenna in response to receiving the second signal;

translating the second sliding member using the second electric current; and

allowing fluid flow through the second fluid pathway in response to the translating of the second sliding member.

17. The method of claim 16, wherein the first transmitting antenna and the second transmitting antenna are disposed in one transmitter.

18. The method of claim 16, wherein the first signal and the second signal have different frequencies.