

ADJUSTABLE FLOW CONTROL DEVICE

BACKGROUND

[0001] Wellbores are sometimes drilled into subterranean formations to produce one or more fluids from the subterranean formation. For example, a wellbore may be used to produce one or more hydrocarbons. Additional components such as water may also be produced with the hydrocarbons, though attempts are usually made to limit water production from a wellbore or a specific interval within the wellbore. Other components such as hydrocarbon gases may also be limited for various reasons over the life of a wellbore.

[0002] Where fluids are produced from a long interval of a formation penetrated by a wellbore, it is known that balancing the production of fluid along the interval can lead to reduced water and gas coning, and more controlled conformance, thereby increasing the proportion and overall quantity of oil or other desired fluid produced from the interval. Various devices and completion assemblies have been used to help balance the production of fluid from an interval in the wellbore. For example, inflow control devices (ICD's) have been used in conjunction with well screens to restrict the flow of produced fluid through the screens for the purpose of balancing production along an interval. For example, in a long horizontal wellbore, fluid flow near a heel of the wellbore may be more restricted as compared to fluid flow near a toe of the wellbore, to thereby balance production along the wellbore.

SUMMARY

[0003] According to a first aspect of the present invention, there is provided a flow control device comprising: a fluid pathway configured to provide fluid communication between an exterior of a wellbore tubular and an interior of the wellbore tubular; a flow restriction disposed in the fluid pathway, wherein the flow restriction is permanently installed within the fluid pathway, and wherein the flow restriction is the only flow restriction disposed in the fluid pathway; a flow blockage disposed in the fluid pathway in series with the flow restriction, wherein the flow blockage substantially prevents a fluid flow in any direction along the fluid pathway; and a retaining member configured to maintain the flow blockage within the fluid pathway and allow access to the flow blockage within the fluid pathway from the exterior of the flow control device, wherein the flow blockage is disposed in the fluid pathway between the flow restriction and the retaining member.

[0003a] In an embodiment, a flow control device 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 restriction disposed in a fluid pathway, a flow blockage disposed in the fluid pathway, and a retaining member configured to maintain the flow blockage within the fluid pathway and allow access to the flow blockage within the fluid pathway. The flow blockage substantially prevents a fluid flow through the fluid pathway.

[0004] According to a second aspect of the present invention, there is provided a method comprising: providing a flow control device comprising: a plurality of fluid pathways between an exterior of a wellbore tubular and an interior of the wellbore tubular, a plurality of flow restrictions disposed in corresponding fluid pathways of the plurality of fluid pathways, and a plurality of retaining members disposed in corresponding fluid pathways of the plurality of fluid pathways, wherein each retaining member of the plurality of retaining members is configured to maintain a corresponding flow blockage within the corresponding fluid pathway and allow access to the corresponding flow blockage within the corresponding fluid pathway from the exterior of the flow control device; accessing one or more flow blockages from the exterior of the flow control device through one or more of the plurality of retaining members; selectively installing or removing one or more flow blockages from the plurality of fluid pathways in series with one or more of the corresponding plurality of flow restrictions while leaving each of the plurality of flow restrictions in position in the corresponding fluid pathways, wherein the one or more flow blockages substantially prevent flow in any direction through the corresponding fluid pathways; and producing a fluid through one or more fluid pathways clear of the flow blockages.

[0004a] In an embodiment, a method comprises providing a flow control device comprising: a plurality of fluid pathways between an exterior of a wellbore tubular and an interior of the wellbore tubular, and a plurality of flow restrictions disposed in corresponding fluid pathways of the plurality of fluid pathways, selectively installing or removing one or more flow blockages from the plurality of fluid pathways, and producing a fluid through one or more fluid pathways clear of the flow blockages.

[0005] In an embodiment, a method of adjusting a fluid resistance to flow comprises determining a desired fluid flow resistance from an interval in a wellbore, and selectively

CLAIMS:

1. A flow control device comprising:
 - a fluid pathway configured to provide fluid communication between an exterior of a wellbore tubular and an interior of the wellbore tubular;
 - a flow restriction disposed in the fluid pathway, wherein the flow restriction is permanently installed within the fluid pathway, and wherein the flow restriction is the only flow restriction disposed in the fluid pathway;
 - a flow blockage disposed in the fluid pathway in series with the flow restriction, wherein the flow blockage substantially prevents a fluid flow in any direction along the fluid pathway; and
 - a retaining member configured to maintain the flow blockage within the fluid pathway and allow access to the flow blockage within the fluid pathway from the exterior of the flow control device, wherein the flow blockage is disposed in the fluid pathway between the flow restriction and the retaining member.
2. The flow control device of claim 1, further comprising a filter portion disposed in the fluid pathway between the exterior of the wellbore tubular and the interior of the wellbore tubular.
3. The flow control device of claim 1, wherein the flow restriction comprises a nozzle, a narrow flow tube, an annular passage, a bent tube flow restrictor, or a helical tube.
4. The flow control device of claim 1, wherein the flow blockage comprises a rod configured to be removably disposed within the fluid pathway.
5. The flow control device of claim 4, wherein the rod comprises a tapered end section, and wherein the tapered end section is configured to sealingly engage the flow restriction.
6. The flow control device of claim 1, wherein the flow blockage comprises a ball, wherein the ball is configured to engage one or more openings within the fluid pathway to substantially prevent the fluid flow through the fluid pathway.

7. The flow control device of claim 1, wherein the flow blockage comprises a plug configured to be removably disposed within the fluid pathway.
8. The flow control device of claim 7, wherein the plug comprises a thinned section, wherein the thinned section is configured to be punctured to establish fluid communication through the plug.
9. The flow control device of claim 1, wherein the plug comprises a deformable plug configured to be disposed within the fluid pathway.
10. The flow control device of claim 1, further comprising:
a plurality of flow restrictions disposed in a corresponding plurality of fluid pathways between the exterior of the wellbore tubular and the interior of the wellbore tubular, wherein the flow blockage is disposed in a first fluid pathway of the plurality of fluid pathways.
11. The flow control device of claim 10, wherein an overall resistance to flow is provided by a flow path comprising each of the plurality of fluid pathways that is clear of a flow blockage.
12. The flow control device of claim 10, further comprising:
a plurality of retaining members corresponding to the plurality of fluid pathways, wherein each retaining member of the plurality of retaining members is configured to provide direct access to each corresponding fluid pathway.
13. The flow control device of claim 10, wherein a first of the plurality of flow restrictions has a different resistance to a fluid flow than a second of the plurality of flow restrictions.
14. A method comprising:
providing a flow control device comprising: a plurality of fluid pathways between an exterior of a wellbore tubular and an interior of the wellbore tubular, a plurality of flow restrictions disposed in corresponding fluid pathways of the plurality of fluid pathways, and a plurality of retaining members disposed in corresponding fluid pathways of the plurality of fluid pathways, wherein each retaining member of the plurality of retaining members is configured to

maintain a corresponding flow blockage within the corresponding fluid pathway and allow access to the corresponding flow blockage within the corresponding fluid pathway from the exterior of the flow control device;

accessing one or more flow blockages from the exterior of the flow control device through one or more of the plurality of retaining members;

selectively installing or removing one or more flow blockages from the plurality of fluid pathways in series with one or more of the corresponding plurality of flow restrictions while leaving each of the plurality of flow restrictions in position in the corresponding fluid pathways, wherein the one or more flow blockages substantially prevent flow in any direction through the corresponding fluid pathways; and

producing a fluid through one or more fluid pathways clear of the flow blockages.

15. The method of claim 14, wherein the flow blockages comprise at least one of a rod removably disposed within one or more of the fluid pathways, a tapered rod removably disposed within one or more of the fluid pathways, a ball configured to engage one or more openings within one or more of the fluid pathways, a plug configured to be removably disposed within one or more of the fluid pathways, a plug comprising a thinned section that is configured to be punctured to establish fluid communication through the plug, or a deformable plug configured to be disposed within one or more of the fluid pathways.

16. The method of claim 14, wherein the plurality of flow restrictions are permanently installed in the corresponding fluid pathways of the plurality of fluid pathways.

17. The method of claim 14, wherein a single flow restriction of the plurality of flow restrictions is disposed in each corresponding fluid pathway of the plurality of fluid pathways.

18. The method of claim 14, wherein selectively installing or removing the one or more flow blockages from the plurality of fluid pathways comprises press fitting the one or more flow blockages within the corresponding fluid pathways through the one or more plurality of retaining members.

CLAIMS

What is claimed is:

1. A flow control device comprising:
 - a fluid pathway configured to provide fluid communication between an exterior of a wellbore tubular and an interior of the wellbore tubular;
 - a flow restriction disposed in the fluid pathway;
 - a flow blockage disposed in the fluid pathway, wherein the flow blockage substantially prevents a fluid flow through the fluid pathway; and
 - a retaining member configured to maintain the flow blockage within the fluid pathway and allow access to the flow blockage within the fluid pathway.
2. The flow control device of claim 1, further comprising a filter portion disposed in the fluid pathway between the exterior of the wellbore tubular and the interior of the wellbore tubular.
3. The flow control device of claim 1 or 2, wherein the flow restriction comprises a nozzle, a narrow flow tube, an annular passage, a bent tube flow restrictor, or a helical tube.
4. The flow control device of any of claims 1 to 3, wherein the flow restriction is permanently installed within the fluid pathway.
5. The flow control device of any of claims 1 to 4, wherein the flow blockage comprises a rod configured to be removably disposed within the fluid pathway.
6. The flow control device of claim 5, wherein the rod comprises a tapered end section, and wherein the tapered end section is configured to sealingly engage the flow restriction.
7. The flow control device of claim 1, wherein the flow blockage comprises a ball, wherein the ball is configured to engage one or more openings within the fluid pathway to substantially prevent the fluid flow through the fluid pathway.
8. The flow control device of claim 1, wherein the flow blockage comprises a plug configured to be removably disposed within the fluid pathway.
9. The flow control device of claim 8, wherein the plug comprises a thinned section, wherein the thinned section is configured to be punctured to establish fluid communication through the plug.
10. The flow control device of claim 8, wherein the plug comprises a deformable plug configured to be disposed within the fluid pathway.
11. The flow control device of any of claims 1 to 10, further comprising:
 - a plurality of flow restrictions disposed in a corresponding plurality of fluid pathways

between the exterior of the wellbore tubular and the interior of the wellbore tubular, wherein the flow blockage is disposed in a first fluid pathway of the plurality of fluid pathways.

12. The flow control device of claim 11, wherein an overall resistance to flow is provided by a flow path comprising each of the plurality of fluid pathways that is clear of a flow blockage.
13. The flow control device of claim 11 or 12, further comprising:
a plurality of retaining members corresponding to the plurality of fluid pathways,
wherein each retaining member of the plurality of retaining members is
configured to provide direct access to each corresponding fluid pathway.
14. The flow control device of any of claims 11 to 13, wherein a first of the plurality of flow restrictions has a different resistance to a fluid flow than a second of the plurality of flow restrictions.
15. A method comprising:
providing a flow control device comprising: a plurality of fluid pathways between an exterior of a wellbore tubular and an interior of the wellbore tubular, and a plurality of flow restrictions disposed in corresponding fluid pathways of the plurality of fluid pathways;
selectively installing or removing one or more flow blockages from the plurality of fluid pathways; and
producing a fluid through one or more fluid pathways clear of the flow blockages.
16. The method of claim 15, wherein the plurality of flow restrictions remain within the fluid pathways during the selective installation or removal of the one or more flow blockages.
17. The method of claim 15 or 16, wherein selectively installing or removing the one or more flow blockages comprises accessing one or more of the fluid pathways through an access port, wherein the access port provides direct access to the fluid pathway from the exterior of the wellbore tubular.
18. The method of any of claims 15 to 17, wherein the flow blockages comprise at least one of a rod removably disposed within one or more of the fluid pathways, a tapered rod removably disposed within one or more of the fluid pathways, a ball configured to engage one or more openings within one or more of the fluid pathways, a plug configured to be removably disposed within one or more of the fluid pathways, a plug comprises a thinned section that is configured to be punctured to establish fluid communication through the plug,

or a deformable plug configured to be disposed within one or more of the fluid pathways.

19. A method of adjusting a fluid resistance to flow comprising:
determining a desired fluid flow resistance from an interval in a wellbore; and
selectively blocking or unblocking one or more fluid pathways through individual
flow restrictors to provide an overall fluid pathway with the desired fluid flow
resistance.
20. The method of claim 19, further comprising:
producing a fluid from a subterranean formation through each of the unblocked
individual flow restrictors.