designs that are suitable for use in subterranean operations are known in the art.

Although the apparatuses and structures described above can be desirably used for regulating the flow of fluids within a wellbore, there can be certain problems encountered when doing so. In the case of on/off or metering valves, significant quantities of undesired fluids can enter the wellbore pipe. If the production of undesired fluids becomes too great, this can sometimes necessitate closing the valve to shut off production from the subterranean zone in which the valve is located. In the case of apparatuses and structures that can discriminate between various types of formation fluids (*e.g.*, autonomous inflow control devices), the design of the apparatuses and structures can be such that if they are exposed to particular types of formation fluids or particulate matter (*e.g.*, sand), they can become plugged or abraided such that they no longer function as intended. Plugging of the apparatus or structure can result in incomplete production from a subterranean zone. Likewise, if the apparatus or structure becomes damaged in some way, it can sometimes permit greater access of undesired fluids to the interior of the wellbore pipe than is intended.

Although the exit port of an inflow control device can be intentionally blocked to shut off fluid flow from the device, this action most often has been performed with an added structure either within the wellbore pipe or disposed between the inflow control device and the exterior of the wellbore pipe. In either case, the accompanying volume reduction can prove detrimental for production rates. In addition, such downstream regulation of the inflow control device provides no mechanism by which the device can be protected from potentially damaging conditions.

SUMMARY OF THE INVENTION

Embodiments of t~~T~~he present invention generally relate~~s~~ to wellbore flow control devices and their use in producing a fluid from a subterranean formation, and, more specifically, to the coupling of flow regulating assemblies for improved control of fluid access to the interior of a wellbore pipe.

According to an aspect of the present invention, there is provided a wellbore flow control device comprising a gate valve assembly movably arranged within a housing coupled to a wellbore pipe and being in fluid flow communication with one or more well screens via a first flow pathway extending upstream of the gate valve assembly; and a flow restricting assembly in fluid flow communication with the gate valve assembly via a second flow pathway,

wherein the flow restricting assembly is in fluid flow communication with the interior of the wellbore pipe. The gate valve assembly is movable between a first position, where a formation fluid in the first flow pathway is blocked from accessing the second flow pathway, a second position, where the formation fluid is able to pass through the gate valve assembly and enter the interior of the wellbore pipe via the second flow pathway; and is further movable to a third position, where the fluid in the first flow pathway is diverted away from the flow restricting assembly and directly into the interior of the wellbore pipe.

According to another aspect of the present invention, there is provided a method comprising arranging a wellbore pipe in an uncompleted wellbore, the wellbore pipe comprising at least one wellbore flow control device comprising a gate valve assembly arranged within a housing coupled to the wellbore pipe and being in fluid flow communication with one or more well screens via a first flow pathway extending upstream of the gate valve assembly; and a flow restricting assembly in fluid flow communication with the gate valve assembly via a second flow pathway and the interior of the wellbore pipe. The method comprises moving the gate valve assembly from a first position, where a formation fluid in the first flow pathway is blocked from accessing the second flow pathway, to a second position, where the formation fluid is able to pass through the gate valve assembly and enter the interior of the wellbore pipe via the second flow pathway; and further moving the gate valve assembly to a third position, where the formation fluid in the first flow pathway is diverted away from the flow restricting assembly and directly into the interior of the wellbore pipe; and producing the formation fluid from the wellbore pipe.

In some embodiments, the present invention provides a wellbore flow control device comprising: a gate valve assembly that is in fluid flow communication with a flow restricting assembly, each assembly being located on

provided above that a sliding sleeve assembly should be considered an illustrative gate valve assembly, and any structure capable of similarly directing fluid flow to the flow restricting assembly and, optionally, the interior of the wellbore pipe can be used within the ~~spirit and~~ scope of the present disclosure. Thus, any embodiment specifically described herein using a sliding sleeve assembly can be similarly practiced with a different type of gate valve assembly.

As shown in FIGURES 2A and 2B, wellbore pipe **50** is operably coupled to housing **51**, which contains sliding sleeve assembly **60** and flow restricting assembly **70** that are in fluid flow communication with one another via flow pathway **75**. Wellbore flow control device **40** further contains sand control screen **52**, which is in fluid flow communication with sliding sleeve assembly **60** by flow pathway **80**. As shown in FIGURES 2A and 2B, the interior surface of flow pathway **80** is partially defined by wellbore pipe **50**, housing **51** and shroud **53**, which can further inhibit entry of sand and other debris into flow pathway **80**.

As shown in FIGURES 2A and 2C, when sliding sleeve assembly **60** is in the closed position, a fluid travelling through flow pathway **80** is prevented from reaching flow restricting assembly **70**, since access to flow pathway **75** is blocked. FIGURE 2C shows an expansion of sliding sleeve assembly **60** of wellbore flow control device **40** when the sliding sleeve assembly is in the closed position, and FIGURE 2D shows an expansion of sliding sleeve assembly **60** of wellbore flow control device **40** when the sliding sleeve assembly is in the open position. As shown in FIGURE 2C, when sliding sleeve assembly **60** is closed, exit **81** of flow pathway **80** is blocked by sliding sleeve assembly **60**, and fluid can progress no further through wellbore flow control device **40**. In contrast, as shown in FIGURE 2D, when sliding sleeve assembly **60** is open, exit **81** of flow pathway **80** is no longer blocked, and fluid can flow along sliding sleeve assembly **60** to entrance **76** of flow pathway **75**. That is, sliding sleeve assembly **60** establishes a flow pathway between exit **81** and entrance **76**.

Upon entering flow pathway **75**, fluid can then progress through flow restricting assembly **70** prior to entering the interior of wellbore pipe **50** through hole **90**, which is in fluid flow communication with flow restricting assembly **70**. As described previously, flow restricting assembly **70** can be configured such that it selectively restricts access of desired fluids to the interior of wellbore pipe

embodiments. Operation of the gate valve assembly can take place manually, electrically, hydraulically, or by like means in various embodiments. In some embodiments, operation of the gate valve assembly, particularly a sliding sleeve assembly, can take place using a tool inserted from the surface down the well string. Tools appropriate for conducting such operations will be familiar to one having ordinary skill in the art.

Therefore, the present invention is well adapted to attain the ends and advantages mentioned as well as those that are inherent therein. The particular embodiments disclosed above are illustrative only, as the present invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular illustrative embodiments disclosed above may be altered, combined, or modified and all such variations are considered within the scope ~~and spirit~~ of the present invention. The invention illustratively disclosed herein suitably may be practiced in the absence of any element that is not specifically disclosed herein and/or any optional element disclosed herein. While compositions and methods are described in terms of "comprising," "containing," or "including" various components or steps, the compositions and methods can also "consist essentially of" or "consist of" the various components and steps. All numbers and ranges disclosed above may vary by some amount. Whenever a numerical range with a lower limit and an upper limit is disclosed, any number and any included range falling within the range is specifically disclosed. In particular, every range of values (of the form, "from about a to about b," or, equivalently, "from approximately a to b," or, equivalently, "from approximately a-b") disclosed herein is to be understood to set forth every number and range encompassed within the broader range of values. Also, the terms in the claims have their plain, ordinary meaning unless otherwise explicitly and clearly defined by the patentee. Moreover, the indefinite articles "a" or "an," as used in the claims, are defined herein to mean one or more than one of the element that it introduces. If there is any conflict in the usages of a word or term in this specification and one or more patent or other documents that may be

CLAIMS

The invention claimed is:

1. A wellbore flow control device comprising:

a gate valve assembly that is in fluid flow communication with a flow restricting assembly, each assembly being located on the exterior of a wellbore pipe;

wherein the flow restricting assembly is in fluid flow communication with the interior of the wellbore pipe.

2. The wellbore flow control device of claim 1, wherein the gate valve assembly comprises a sliding sleeve assembly.

3. The wellbore flow control device of claim 2, wherein the flow restricting assembly comprises a structure selected from the group consisting of an autonomous inflow control device, a non-autonomous inflow control device, tubing, a nozzle, a port, a tortuous path, and any combination thereof.

4. The wellbore flow control device of claim 1, further comprising:

a housing for the gate valve assembly and the flow restricting assembly that is operatively coupled to the wellbore pipe.

5. The wellbore flow control device of claim 1, further comprising:

a well screen that is in fluid flow communication with the gate valve assembly via a first flow pathway that is upstream of the gate valve assembly.

6. The wellbore flow control device of claim 5, wherein the gate valve assembly and the flow restricting assembly are in fluid flow communication with one another via a second flow pathway.

7. The wellbore flow control device of claim 6, wherein the gate valve assembly, when open, bridges between the first flow pathway and the second flow pathway.

8. The wellbore flow control device of claim 1, wherein the gate valve assembly is further configured to divert fluid flow away from the flow restricting assembly and directly into the interior of the wellbore pipe.

9. A wellbore flow control device comprising:

a sliding sleeve assembly that is in fluid flow communication with a first flow pathway upstream of the sliding sleeve assembly, the sliding sleeve assembly and the first fluid flow pathway being located on the exterior of a wellbore pipe; and

a flow restricting assembly that is in fluid flow communication with the sliding sleeve assembly via a second flow pathway, the flow restricting assembly and the second flow pathway being located on the exterior of the wellbore pipe;

wherein the flow restricting assembly is in fluid flow communication with the interior of the wellbore pipe.

10. The wellbore flow control device of claim 9, wherein the flow restricting assembly comprises a structure selected from the group consisting of an autonomous inflow control device, a non-autonomous inflow control device, tubing, a nozzle, a port, a tortuous path, and any combination thereof.

11. The wellbore flow control device of claim 9, further comprising:

a well screen that is in fluid flow communication with the sliding sleeve assembly via the first flow pathway.

12. The wellbore flow control device of claim 9, wherein the sliding sleeve assembly is further configured to divert fluid flow away from the flow restricting assembly and directly into the interior of the wellbore pipe.

13. The wellbore flow control device of claim 9, further comprising:

a housing for the sliding sleeve assembly and the flow restricting assembly that is operatively coupled to the wellbore pipe.

14. A method comprising:

installing a wellbore pipe in an uncompleted wellbore;

wherein the wellbore pipe comprises at least one wellbore flow control device on its exterior, each wellbore flow control device comprising a sliding sleeve assembly that is in fluid flow communication with a flow restricting assembly, and the flow restricting assembly being in fluid flow communication with the interior of the wellbore pipe.

15. The method of claim 14, further comprising:

opening the sliding sleeve assembly of at least some of the wellbore flow control devices, such that a formation fluid flows through each flow restricting assembly that is in fluid flow communication with each opened sliding sleeve assembly and into the interior of the wellbore pipe; and

producing the formation fluid from the wellbore pipe.

16. The method of claim 14, further comprising:

closing the sliding sleeve assembly of at least some of the wellbore flow control devices to isolate a subterranean zone.

17. The method of claim 16, further comprising:

opening the sliding sleeve assembly of the wellbore flow control devices in at least some of the subterranean zones that were not isolated, such that a formation fluid flows through the flow restricting assembly that is in fluid flow communication with each opened sliding sleeve assembly and into the interior of the wellbore pipe; and

producing the formation fluid from the wellbore pipe.

18. The method of claim 14, wherein the flow restricting assembly comprises a structure selected from the group consisting of an autonomous inflow control device, a non-autonomous inflow control device, tubing, a nozzle, a port, a tortuous path, and any combination thereof.

19. The method of claim 14, wherein each wellbore flow control device further comprises a well screen that is in fluid flow communication with the sliding sleeve assembly via a first flow pathway.

20. The method of claim 19, wherein the sliding sleeve assembly, when open, bridges between the first flow pathway and a second flow pathway leading to the flow restricting assembly.

21. The method of claim 14, wherein the sliding sleeve assembly is further configured to divert fluid flow away from the flow restricting assembly and directly into the interior of the wellbore pipe.

22. The method of claim 14, further comprising:

producing a formation fluid from the subterranean formation.

CLAIMS

1. A wellbore flow control device comprising:

a gate valve assembly movably arranged within a housing coupled to a wellbore pipe and being in fluid flow communication with one or more well screens via a first flow pathway extending upstream of the gate valve assembly; and

a flow restricting assembly in fluid flow communication with the gate valve assembly via a second flow pathway, wherein the flow restricting assembly is in fluid flow communication with the interior of the wellbore pipe,

wherein the gate valve assembly is movable between a first position, where a formation fluid in the first flow pathway is blocked from accessing the second flow pathway, a second position, where the formation fluid is able to pass through the gate valve assembly and enter the interior of the wellbore pipe via the second flow pathway; and

is further movable to a third position, where the fluid in the first flow pathway is diverted away from the flow restricting assembly and directly into the interior of the wellbore pipe.

2. The wellbore flow control device of claim 1, wherein the gate valve assembly comprises a sliding sleeve assembly.

3. The wellbore flow control device of claim 1 or 2, wherein the flow restricting assembly comprises a structure selected from the group consisting of an autonomous inflow control device, a non-autonomous inflow control device, tubing, a nozzle, a port, a tortuous path, and any combination thereof.

4. The wellbore flow control device of any one of claims 1 to 3, wherein the gate valve assembly is actuated to move either hydraulically or electrically.

5. The wellbore flow control device of any one of claims 1 to 4, wherein the gate valve assembly is actuated to move using a tool inserted from a surface into the wellbore pipe.

6. A method comprising:

arranging a wellbore pipe in an uncompleted wellbore, the wellbore pipe comprising:

at least one wellbore flow control device comprising a gate valve assembly arranged within a housing coupled to the wellbore pipe and being in fluid flow communication with one or more well screens via a first flow pathway extending upstream of the gate valve assembly; and

a flow restricting assembly in fluid flow communication with the gate valve assembly via a second flow pathway and the interior of the wellbore pipe;

moving the gate valve assembly from a first position, where a formation fluid in the first flow pathway is blocked from accessing the second flow pathway, to a second position, where the formation fluid is able to pass through the gate valve assembly and enter the interior of the wellbore pipe via the second flow pathway; and

further moving the gate valve assembly to a third position, where the formation fluid in the first flow pathway is diverted away from the flow restricting assembly and directly into the interior of the wellbore pipe; and

producing the formation fluid from the wellbore pipe.

7. The method of claim 6, further comprising:

moving the gate valve assembly back to the first position to isolate a subterranean zone.

8. The method of claim 6, further comprising injecting a fluid into a subterranean formation surrounding the wellbore using the wellbore flow control device when the gate valve assembly is in the second position.

9. The method of claim 6, further comprising injecting a fluid into a subterranean formation surrounding the wellbore using the wellbore flow control device when the gate valve assembly is in the third position.

10. The method of any of claims 6 to 9, wherein moving the gate valve assembly comprises actuating the gate valve assembly either hydraulically or electrically.

11. The method of any of claims 6 to 10, wherein moving the gate valve assembly comprises actuating the gate valve assembly with a tool inserted from a surface location into the wellbore pipe.

12. The method of claim 6, further comprising regulating the flow of the formation fluid into the interior of the wellbore pipe with the flow restricting assembly, the flow restricting assembly comprises a structure selected from the group consisting of an autonomous inflow control device, a non-autonomous inflow control device, tubing, a nozzle, a port, a tortuous path, and any combination thereof.