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VALVE ASSEMBLY

Abstract

A valve assembly includes a valve body defining an upstream end, a downstream end, and an opening extending along a central axis between the upstream end and the downstream end. The valve assembly also includes a valve gate movable relative to the valve body. The valve gate defines a first side proximal to the upstream end and a second side opposite to the first side proximal to the downstream end. The second side is opposite to the first side. The valve assembly further includes a valve seat disposed within the valve body adjacent to the valve gate. The valve assembly includes a sealing element disposed between the valve body and the valve seat and contacting each of the valve body and the valve seat. The sealing element urges the valve seat towards the valve gate.

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Background/Summary

TECHNICAL FIELD

[0001] The present disclosure relates to a valve assembly.

BACKGROUND

[0002] A valve, such as a gate valve, is used in drilling and mining applications to control a flow of fluid. For example, the valve may control fluid flow between a wellbore via a well head and a frac piping system including a pump. The valve defines an opening, an upper valve cavity, and a lower valve cavity. Each of the upper valve cavity and the lower valve cavity are in communication with the opening. The valve includes a valve gate and a pair of valve seats disposed adjacent to the valve gate. The valve gate is movable between an open position and a closed position. In the open position, the valve gate allows the fluid to flow through the opening towards a downstream end of the valve or vice versa. In the closed position, the valve gate prevents the flow of fluid towards the downstream end or vice versa.

[0003] Conventionally, during drilling and mining operations, debris, such as proppant or wellbore particulate, may enter the upper valve cavity and/or the lower valve cavity via a gap between the valve gate and a corresponding valve seat, or a gap between a valve body and a corresponding valve seat. Accumulation of the debris in the upper valve cavity or the lower valve cavity is not desirable and may reduce performance of the valve. Further, the debris accumulated in the upper valve cavity, or the lower valve cavity may damage one or more components of the valve, which may increase operational costs of the valve. Lastly, the upper and lower valve cavities are initially filled with lubricating grease which may be displaced by the fluid if the fluid enters the upper and lower valve cavities.

[0004] CN1517581A describes a sealing unit and method for sealing the joint part on a valve body. The first valve seat element is fixed in the valve casing. Two sealing rings are arranged between valve casing and plug-in part of casing and one sealing ring is arranged between said plug-in part and valve seat element for providing downstream sealing. An internal flange on one of valve seat elements and the slot on another valve seat element can prevent broken pieces from coming in gap between them.

SUMMARY OF THE DISCLOSURE

[0005] In an aspect of the present disclosure, a valve assembly is provided. The valve assembly includes a valve body defining an upstream end, a downstream end, and an opening extending along a central axis between the upstream end and the downstream end. The valve assembly also includes a valve gate movable relative to the valve body. The valve gate defines a first side proximal to the upstream end and a second side proximal to the downstream end. The second side is opposite to the first side. The valve assembly further includes a valve seat disposed within the valve body adjacent to the valve gate. The valve assembly includes a sealing element disposed between the valve body and the valve seat and contacting each of the valve body and the valve seat. The sealing element urges the valve seat towards the valve gate.

[0006] In another aspect of the present disclosure, a valve assembly is provided. The valve assembly includes a valve body defining an upstream end, a downstream end, and an opening extending along a central axis between the upstream end and the downstream end. The valve body further defines a first notch extending circumferentially about the central axis. The first notch faces the opening in the valve body. The valve assembly also includes a valve gate movable relative to the valve body. The valve gate defines a first side proximal to the upstream end and a second side proximal to the downstream end. The second side is opposite to the first side. The valve assembly further includes a valve seat disposed within the valve body adjacent to the valve gate. The valve seat includes a flange extending about the central axis. The flange is received within the first notch

in the valve body. The first notch and the flange together create a flow restriction to prevent fluid flow therethrough.
[0007] In yet another aspect of the present disclosure, a valve assembly is provided. The valve assembly includes a valve body defining an upstream end, a downstream end, and an opening extending along a central axis between the upstream end and the downstream end. The valve body further defines a first notch extending circumferentially about the central axis. The first notch faces the opening in the valve body. The valve assembly also includes a valve gate movable relative to the valve body. The valve gate defines a first side proximal to the upstream end and a second side proximal to the downstream end. The second side is opposite to the first side. The valve assembly further includes a valve seat disposed within the valve body adjacent to the valve gate. The valve seat includes a flange extending about the central axis. The flange is received within the first notch in the valve body. The first notch and the flange together create a flow restriction to prevent fluid flow therethrough. The valve assembly includes a sealing element disposed between the valve body and the valve seat and contacting each of the valve body and the valve seat. The sealing element urges the valve seat towards the valve gate.
[0008] In yet another aspect of the present disclosure, a valve assembly is provided. The valve assembly includes a valve body defining a first valve cavity proximal to an upper end of the valve body and a second valve cavity proximal to a lower end of the valve body. The valve assembly also includes a valve gate movable relative to the valve body. The valve assembly further includes a valve seat disposed within the valve body and adjacent to the valve gate. The valve assembly includes a retainer plate disposed within the second valve cavity of the valve body. The retainer plate is disposed adjacent to the valve gate. The retainer plate creates a flow restriction to prevent passage of fluid towards the second valve cavity.
[0009] Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0010] FIG. **1** is a schematic perspective view illustrating an exemplary frac tree connected to a wellhead;
[0011] FIG. **2** is a schematic cross-sectional view of a valve assembly of FIG. **1** illustrating a valve gate in an open position;
[0012] FIG. **3** is a schematic cross-sectional view of the valve assembly of FIG. **2** illustrating the valve gate in a closed position;
[0013] FIG. **4** is a cross-sectional view of a portion of the valve assembly of FIG. **2**;
[0014] FIG. **5** is a schematic perspective view of an exemplary sealing element associated with the valve assembly of FIG. **2**;
[0015] FIG. **6**A is a schematic perspective view of a retainer plate associated with the valve assembly of FIG. **2**; and
[0016] FIG. **6**B is a schematic perspective view illustrating a pair of retainer plates and a pair of brackets associated with the valve assembly of FIG. **2**.
DETAILED DESCRIPTION
[0017] Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.
[0018] Referring to FIG. **1**, a schematic perspective view of an exemplary frac tree **10** connected to a wellhead **20** is illustrated. The frac tree **10** is generally used in drilling and mining applications, such as, hydraulic fracturing. The frac tree **10** directs frac fluid between the wellhead **20** and a frac piping system including a pump (not shown). In some examples, the frac fluid may be water, oil,

and the like, associated with drilling and mining applications. The frac fluid is hereinafter interchangeably referred to as “fluid”. The fluid may contain proppants, such as, sand, polymers, ceramics, and the like.

[0019] The frac tree **10** includes an adapter **30** which may also include opposing side valves **40**, **50**. In some examples, each of the side valves **40**, **50** may be a wing gate valve. The frac tree **10** also includes a pair of valve assemblies **100**. In the illustrative example of FIG. **1**, each of the valve assembly **100** from the pair of valve assemblies **100** is connected in series with each other via a conduit **80**, and therefore can be referred to as a lower valve assembly **100** disposed proximal to an upper end and an upper valve assembly **100** disposed proximal to a lower end. The adapter **30** connects the frac tree **10** with the wellhead **20**. In some examples, the adapter **30** may also facilitate connection of the wellhead **20** to a casing string (not shown) and/or a tubing string (not shown) extending within the associated wellbore. Specifically, each valve assembly **100** may selectively control fluid flow between the wellhead **20** and the frac piping system including the pump. The frac tree **10** further includes a frac cross **60** coupled to the upper valve assembly **100**. The frac cross **60** may allow connection between the frac tree **10** and alternate flow lines such as pump down lines and flowback lines.

[0020] Referring to FIG. **2**, a schematic cross-sectional view of the valve assembly **100** is illustrated. The valve assembly **100** includes a valve body **102**. The valve body **102** defines an upstream end **104**, a downstream end **106** opposite the upstream end **104**, and an opening **108** extending along a central axis A**1** between the upstream end **104** and the downstream end **106**. The opening **108** allows fluid to flow from the upstream end **104** towards the downstream end **106** in a direction D**1**. Alternatively, the opening **108** may allow the fluid to flow from the downstream end **106** towards the upstream end **104** in a direction opposite to the direction D**1**.

[0021] The valve body **102** further defines a first valve cavity **118** proximal to an upper end **120** of the valve body **102** and a second valve cavity **122** proximal to a lower end **124** of the valve body **102**. The upper and lower ends **120**, **124** are opposing ends of the valve body **102**. The valve body **102** also defines a first notch **110** (best visible in FIG. **4**) extending circumferentially about the central axis A**1**. The first notch **110** faces the opening **108** in the valve body **102**. In the illustrated example of FIG. **2**, the valve body **102** defines one first notch **110** proximal to the upstream end **104** and another first notch **110** proximal to the downstream end **106**.

[0022] The valve assembly **100** also includes a valve gate **112** movable relative to the valve body **102**. Specifically, the valve gate **112** moves between the first valve cavity **118** and the second valve cavity **122**. The valve gate **112** defines an opening **113**. The valve gate **112** is movable between an open position and a closed position. In the illustrated example of FIG. **2**, the valve gate **112** is illustrated in the open position. In the open position of the valve gate **112**, the opening **113** of the valve gate **112** is in alignment with the opening **108** such that the fluid can flow from the upstream end **104** towards the downstream end **106** or vice versa.

[0023] The valve assembly **100** further includes a gate actuator **115** (see FIG. **1**) coupled to the valve gate **112** at the upper end **120** of the valve assembly **100**. The gate actuator **115** may be used to move the valve gate **112** between the open position and the closed position. In other words, the gate actuator **115** may move the valve gate **112** along an axis A**2** perpendicular to the central axis A**1**. In some examples, the gate actuator **115** may be a manual actuator that may be operated by a user via a hand wheel. Alternatively, the gate actuator **115** may be a hydraulic actuator, pneumatic actuator, an electrical actuator, and the like, to move the valve gate **112**.

[0024] Referring to FIG. **3**, a schematic cross-sectional view of the valve assembly **100** is illustrated. The valve gate **112** is shown in the closed position in FIG. **3**. In the closed position of the valve gate **112**, the opening **113** of the valve gate **112** is not in alignment with the opening **108** such that the valve gate **112** prevents or restricts the fluid to flow from the upstream end **104** towards the downstream end **106** or vice versa.

[0025] The valve gate **112** defines a first side **114** proximal to the upstream end **104** and a second

side **116** proximal to the downstream end **106**. The second side **116** is opposite to the first side **114**.
[0026] The valve assembly **100** further includes a valve seat **126** disposed within the valve body **102** adjacent to the valve gate **112**. Particularly, the valve seat **126** is a first valve seat **126** disposed at the first side **114** of the valve gate **112**. The valve assembly **100** further includes a second valve seat **126** disposed at the second side **116** of the valve gate **112**. The first valve seat **126** and the second valve seat **126** are hereinafter interchangeably referred to as "valve seat **126**".
[0027] Referring to FIG. **4**, a cross-sectional view of a portion of the valve assembly **100** of FIGS. **1** to **3** is illustrated. It should be noted that only the valve seat **126** disposed at the first side **114** of the valve gate **112** is illustrated in FIG. **3**, however, details provided herein are equally applicable to the valve seat **126** disposed at the second side **116** (see FIGS. **2** and **3**) of the valve gate **112**. The valve seat **126** defines a second notch **128** extending circumferentially about the central axis A**1**. The valve seat **126** includes a flange **130** extending about the central axis A**1**. The flange **130** is received within the first notch **110** in the valve body **102**. The first notch **110** and the flange **130** together create a flow restriction to prevent fluid flow therethrough. In other words, the flange **130** and the first notch **110** together create a tortuous path for fluid to severely restrict the fluid from flowing towards the first valve cavity **118** and correspondingly to the second valve cavity **122**.
[0028] Fluid along with proppant may flow into gaps **148** and **150** formed between the valve body **102** and the valve seat **126** towards a face **152** of the valve seat **126**, and thereby towards the first valve cavity **118** and the second valve cavity **122** (see FIG. **3**). In order to prevent accumulation of proppant at the face **152** of the valve seat **126** and inside the first and second valve cavities **118**, **122**, the flange **130** and the first notch **110** together create the tortuous path for fluid to prevent accumulation of the proppant.
[0029] The valve assembly **100** includes a sealing element **132** disposed between the valve body **102** and the valve seat **126** and contacting each of the valve body **102** and the valve seat **126**. Particularly, the sealing element **132** is disposed within the second notch **128** of the valve seat **126**. The sealing element **132** urges the valve seat **126** towards the valve gate **112**. Particularly, the sealing element **132** is a first sealing element **132** disposed between the first valve seat **126** and the valve body **102**. The valve assembly **100** further includes a second sealing element **132** (see FIGS. **2** and **3**) disposed between the second valve seat **126** (see FIGS. **2** and **3**) and the valve body **102**.
[0030] Referring to FIG. **5**, a schematic perspective view of the sealing element **132** is illustrated. With reference to FIGS. **4** and **5**, the sealing element **132** includes an annular seal **134**. The annular seal **134** engages with each of the valve seat **126** and the valve body **102**. The annular seal **134** has a U-shaped cross section such that one portion **140** of the annular seal **134** engages with the valve body **102** and another portion **142** of the annular seal **134** engages with the valve seat **126**. Alternatively, the annular seal **134** may have a V-shaped cross section, a circular cross section, or any cross-section as desired. In some examples, the annular seal **134** may be made of a polymer. In other examples, the annular seal **134** may be made of a metallic material, an alloy, or any other material, without any limitations.
[0031] The sealing element **132** also includes a spring element **136** received within the annular seal **134**. The spring element **136** exerts a spring force on the valve seat **126** to engage the valve seat **126** with the valve gate **112**. In other words, the spring element **136** exerts the spring force on the annular seal **134** that in turn exerts a force on the valve seat **126** to reduce/eliminate a gap **146** between the valve seat **126** and the valve gate **112**, which may prevent fluid flow towards the first valve cavity **118**. In some examples, the spring element **136** may be made of a metallic material. In an example, the spring element **136** may be made of an alloy spring. In other examples, the spring element **136** may be made of a polymer or any other material, without any limitations. In some embodiments, the annular seal **134** and the spring element **136** may consist of one integral unit.
[0032] The sealing element **132** further includes an annular shim **138** received within the spring element **136**. The annular shim **138** may prevent inside surfaces of the annular seal **134** from collapsing if pressure is applied to the annular seal **134**. In some examples, the annular shim **138**

may be made of a metallic material, an alloy, a polymer, or any other material, without any limitations. In some embodiments, the annular shim **138** may be integral to the spring element **136**. In some embodiments, the annular shim **138** may also be integral to the annular seal **134**. It should be noted that a design of the sealing element **132** as described and illustrated in the present disclosure is exemplary in nature, and the sealing element **132** may include any other design and combination of components to serve the intended purpose.

[0033] Referring to FIGS. **2**, **3**, and **6**A, the valve assembly **100** includes a retainer plate **144** disposed within the second valve cavity **122** of the valve body **102**. Particularly, the retainer plate **144** is disposed adjacent to the valve gate **112**. The retainer plate **144** extends at least partially across the second valve cavity **122** in a direction D**3** (shown in FIG. **2**) parallel to a direction of movement D**2** (shown in FIG. **2**) of the valve gate **112**. The retainer plate **144** is a first retainer plate **144** disposed adjacent to the valve gate **112** at the first side **114** of the valve gate **112**. The valve assembly **100** further includes a second retainer plate **144** disposed adjacent to the valve gate **112** at the second side **116** of the valve gate **112**. The first retainer plate **144** and the second retainer plate **144** are hereinafter interchangeably referred to as "retainer plate **144**".

[0034] The retainer plate **144** may be removably disposed within the second valve cavity **122** with or without the use of any fastening means. For example, the retainer plate **144** may be simply placed within the second valve cavity **122** and held in place by adjacent components of the valve assembly **100**. In an example, the retainer plate **144** may be fixedly coupled to the valve body **102**, for example, via welding, brazing, soldering, and the like. In another example, the retainer plate **144** may be integral with the valve body **102**. For example, the retainer plate **144** and the valve body **102** may be formed as a single integral component by casting, forging, machining, and the like. In yet another example, the retainer plate **144** may be removably coupled with the valve body **102** via a bracket **156** (shown in FIG. **6**B) and one or more mechanical fasteners **158**, **160** (shown in FIG. **6**B).

[0035] The retainer plate **144** defines a cut-out **154** (shown in FIG. **6**A) that receives at least a portion of the valve seat **126** therein. Specifically, the cut-out **154** in the first retainer plate **144** receives at least a portion of the first valve seat **126** and the cut-out **154** in the second retainer plate **144** receives at least a portion of the second valve seat **126** therein. The retainer plate **144** creates a flow restriction to prevent passage of fluid towards the second valve cavity **122**. Specifically, each of the first retainer plate **144** and the second retainer plate **144** may create a tortuous path for the fluid which may severely restrict the fluid from entering the second valve cavity **122**.

[0036] As shown in FIG. **6**B, the valve assembly **100** may also include the bracket **156** disposed within the second valve cavity **122** to couple the retainer plate **144** with the valve body **102**. The bracket **156** includes a first bracket **156** to couple the first retainer plate **144** with the valve body **102** and a second bracket **156** to couple the second retainer plate **144** with the valve body **102**. It should be noted that a design of the bracket **156** as described herein is exemplary in nature, and the bracket **156** may be replaced by any other component that may facilitate coupling of the retainer plate **144** with the valve body **102**.

[0037] The valve assembly **100** also includes the one or more mechanical fasteners **158** to couple the retainer plate **144** with the bracket **156**. The valve assembly **100** further includes the one or more mechanical fasteners **160** to couple the bracket **156** with the valve body **102**. The mechanical fasteners **158**, **160** may include a bolt, a screw, a rivet, or the like.

[0038] It is to be understood that individual features shown or described for one embodiment may be combined with individual features shown or described for another embodiment. The above described implementation does not in any way limit the scope of the present disclosure. Therefore, it is to be understood although some features are shown or described to illustrate the use of the present disclosure in the context of functional segments, such features may be omitted from the scope of the present disclosure without departing from the spirit of the present disclosure as defined in the appended claims.

INDUSTRIAL APPLICABILITY

[0039] The present disclosure describes the valve assembly **100**. The valve assembly **100** includes the valve seat **126** disposed adjacent to the valve gate **112**. The valve seat **126** includes the flange **130** that engages with the first notch **110** defined by the valve body **102**. The flange **130** and the first notch **110** create a stepped profile, thereby forming the tortuous path for the fluid which may prevent/restrict the fluid to flow towards the first valve cavity **118**, via the gap **148**. The flange **130** and the first notch **110** may also trap proppant for example, debris, therein and prevent or severely restrict passage of the proppant towards the sealing element **132**.

[0040] The valve assembly also includes the sealing element **132** disposed within the second notch **128** of the valve seat **126**. The sealing element **132** includes the annular seal **134** and the spring element **136**. The spring element **136** exerts the spring force on the annular seal **134** that in turn exerts the force on the valve seat **126** to reduce/eliminate the gap **146** between the valve seat **126** and the valve gate **112**. Thus, the sealing element **132** may prevent the fluid to enter the first valve cavity **118** via the gap **146** between the valve seat **126** and the valve gate **112**. In other words, the sealing element **132** may seal the gap **146** between the valve seat **126** and the valve gate **112**, thereby preventing accumulation of proppant, such as, sand, debris, and the like inside the first valve cavity **118**.

[0041] The valve assembly **100** further includes the retainer plate **144** disposed within the second valve cavity **122**. The valve assembly **100** may include the bracket **156** that couples with the valve body **102** and the retainer plate **144**. When the valve gate **112** is in the closed position, the retainer plate **144** creates the tortuous path for the fluid, which may prevent entry of fluid towards the second valve cavity **122**, thereby preventing accumulation of proppant inside the second valve cavity **122**.

[0042] The valve assembly **100** of the present disclosure may demonstrate improved performance compared to the conventional valve assemblies. Furthermore, the valve assembly **100** may be cost-effective as the field servicing and maintenance costs associated with the valve assembly **100** may be reduced. Moreover, the valve assembly **100** described herein may have universal applicability, may be retrofitted on existing applications, and may improve efficiency of applications.

[0043] While aspects of the present disclosure have been particularly shown and described with reference to the embodiments above, it will be understood by those skilled in the art that various additional embodiments may be contemplated by the modification of the disclosed work machine, systems and methods without departing from the spirit and scope of the disclosure. Such embodiments should be understood to fall within the scope of the present disclosure as determined based upon the claims and any equivalents thereof.

Claims

1. A valve assembly comprising: a valve body defining an upstream end, a downstream end, and an opening extending along a central axis between the upstream end and the downstream end; a valve gate movable relative to the valve body, the valve gate defining a first side proximal to the upstream end and a second side proximal to the downstream end, the second side being opposite to the first side; a valve seat disposed within the valve body adjacent to the valve gate; and a sealing element disposed between the valve body and the valve seat and contacting each of the valve body and the valve seat, wherein the sealing element urges the valve seat towards the valve gate.

2. The valve assembly of claim 1, wherein the valve seat includes a flange extending about the central axis, wherein the flange is received within a first notch in the valve body, and wherein the first notch and the flange together create a flow restriction to prevent fluid flow therethrough.

3. The valve assembly of claim 1, wherein the sealing element includes an annular seal engaging with each of the valve seat and the valve body.

4. The valve assembly of claim 3, wherein the sealing element further includes a spring element

received within the annular seal, and wherein the spring element exerts a spring force on the valve seat to engage the valve seat with the valve gate.

5. The valve assembly of claim 4, wherein the spring element is made of a metallic material.

6. The valve assembly of claim 4, wherein the sealing element further includes an annular shim received within the spring element.

7. The valve assembly of claim 1, wherein the valve seat defines a second notch extending circumferentially about the central axis, and wherein the sealing element is received within the second notch of the valve seat.

8. The valve assembly of claim 1, wherein the valve seat is a first valve seat disposed at the first side of the valve gate and the sealing element is a first sealing element disposed between the first valve seat and the valve body, the valve assembly further comprising a second valve seat disposed at the second side of the valve gate and a second sealing element disposed between the second valve seat and the valve body.

9. A valve assembly comprising: a valve body defining an upstream end, a downstream end, and an opening extending along a central axis between the upstream end and the downstream end, wherein the valve body further defines a first notch extending circumferentially about the central axis, and wherein the first notch faces the opening in the valve body; a valve gate movable relative to the valve body, the valve gate defining a first side proximal to the upstream end and a second side proximal to the downstream end, the second side being opposite to the first side; and a valve seat disposed within the valve body adjacent to the valve gate, wherein the valve seat includes a flange extending about the central axis, wherein the flange is received within the first notch in the valve body, and wherein the first notch and the flange together create a flow restriction to prevent fluid flow therethrough.

10. The valve assembly of claim 9, wherein the valve seat defines a second notch extending circumferentially about the central axis.

11. The valve assembly of claim 10 further comprising a sealing element received within the second notch of the valve seat, wherein the sealing element urges the valve seat towards the valve gate.

12. The valve assembly of claim 11, wherein the sealing element includes an annular seal engaging with each of the valve seat and the valve body.

13. The valve assembly of claim 12, wherein the sealing element further includes a spring element received within the annular seal, and wherein the spring element exerts a spring force on the valve seat to engage the valve seat with the valve gate.

14. The valve assembly of claim 13, wherein the sealing element further includes an annular shim received within the spring element.

15. The valve assembly of claim 11, wherein the valve seat is a first valve seat disposed at the first side of the valve gate and the sealing element is a first sealing element disposed between the first valve seat and the valve body, the valve assembly further comprising a second valve seat disposed at the second side of the valve gate and a second sealing element disposed between the second valve seat and the valve body.

16. A valve assembly comprising: a valve body defining a first valve cavity proximal to an upper end of the valve body and a second valve cavity proximal to a lower end of the valve body; a valve gate movable relative to the valve body; a valve seat disposed within the valve body and adjacent to the valve gate; and a retainer plate disposed within the second valve cavity of the valve body, wherein the retainer plate is disposed adjacent to the valve gate, and wherein the retainer plate creates a flow restriction to prevent passage of fluid towards the second valve cavity.

17. The valve assembly of claim 16, wherein the retainer plate defines a cut-out that receives at least a portion of the valve seat therein.

18. The valve assembly of claim 16, wherein the retainer plate is a first retainer plate disposed adjacent to the valve gate at a first side of the valve gate, the valve assembly further comprising a

second retainer plate disposed adjacent to the valve gate at a second side of the valve gate, the second side being opposite to the first side.

19. The valve assembly of claim 16, wherein the retainer plate is at least one of fixedly coupled with the valve body, integral with the valve body, or removably coupled with the valve body via a bracket and one or more mechanical fasteners.

20. The valve assembly of claim 16, wherein the retainer plate extends at least partially across the second valve cavity in a direction parallel to a direction of movement of the valve gate.