

## **GATE VALVE WITH PNEUMATIC SYSTEM FOR SHEARING APPLICATION**

### **BACKGROUND**

**[0001]** This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the present invention, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present invention. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

**[0002]** In certain applications, a structure (e.g., a wireline or tubing) may obstruct closure of a valve, such as a gate valve. Under certain conditions, it may be desirable to cut the wireline or tubing to enable closure of the valve, while retaining the valve's sealing integrity over an extended period of use.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0003]** Various features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying figures in which like characters represent like parts throughout the figures, wherein:

**[0004]** FIG. 1 is a schematic diagram of an exemplary gate valve having an actuator with a pneumatic system;

**[0005]** FIG. 2 is a schematic diagram of another embodiment of the gate valve having the actuator with the pneumatic system;

**[0006]** FIG. 3 is a schematic diagram of an embodiment of the gate valve having the actuator with the pneumatic system;

**[0007]** FIG. 4 is a schematic diagram of an embodiment of the gate valve having the actuator with the pneumatic system;

**[0008]** FIG. 5 is a schematic diagram of an embodiment of the gate valve having the actuator with the pneumatic system; and

**[0009]** FIG. 6 is a schematic diagram of an embodiment of the gate valve having the actuator with the pneumatic system.

## **DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS**

**[0010]** One or more specific embodiments of the present invention will be described below. These described embodiments are only exemplary of the present invention. Additionally, in an effort to provide a concise description of these exemplary embodiments, all features of an actual implementation may not be described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

**[0011]** Embodiments of the present disclosure include a gate valve having an actuator with a pneumatic system. More specifically, the actuator includes a pneumatic system configured to create a supplemental force to supplement an actuation force generated by an actuation system of the actuator. For example, the pneumatic system may use a pressurized gas (e.g., air, nitrogen, or another inert gas) to create the supplemental force acting on the actuation system (e.g., spring-biased actuator, electrical actuator, magnetic actuator, or any combination thereof). In this manner, the supplemental force may cooperate with the actuation force generated by the actuation system to improve actuation of the gate valve. In certain embodiments, the pneumatic system may be added to existing gate valve designs to improve operation of the gate valves without increasing the size of existing gate valve actuators.

**[0012]** FIG. 1 illustrates an embodiment of a gate valve 10 having an actuator 12 and a pneumatic system 14. Specifically, the pneumatic system

14 of the actuator 12 may supplement another actuation system (e.g., actuation system 16) of the actuator 12. For example, the actuation system 16 of the actuator 12 may be a spring, a hydraulic piston, or other actuation system (e.g., spring-biased actuator, electrical actuator, magnetic actuator, or any combination thereof). In the manner described below, the pneumatic system 14 enables the use of the gate valves 10 (e.g., existing gate valves) with large bores and/or high pressures or any other combination of bore size and operating pressure using the actuation system 16, while reducing the amount of mechanical force or torque needed to open and close the gate valve 10. In other words, the pneumatic system 14 generates a supplemental actuation force to supplement an actuation force applied to the gate valve 10 by the actuation system 16. As a result, operation of the gate valve 10 may be improved without increasing the size of the actuation system 16.

**[0013]** The gate valve 10 is generally configured to control a flow of fluid through the gate valve 10 in various applications. For example, the gate valve 10 may be employed in applications relating to oil and gas industries, power generation industries, petrochemical industries, and the like. In oilfield applications, the gate valve 10 may be coupled to a Christmas tree (not shown) that controls the extraction of production fluid from a well. The gate valve 10 has a bore (e.g., bore 30) that may be sized for the given application. For example, the bore of the gate valve 10 may be at least approximately 3 inches in diameter. In other embodiments, the gate valve 10 includes a smaller bore that may be less than approximately 5 inches. In certain embodiments, the gate valve 10 is configured to operate at a high pressure of at least approximately 10,000 pounds per square inch (psi). In some embodiments, the gate valve 10 is configured to operate at pressure lower than approximately 10,000 psi. Additionally, in certain embodiments, the gate valve 10 may be used to shear a wireline, coil tubing, or other obstruction. That is, the gate valve 10 may be configured to apply a shearing force to break the obstruction and allow for travel of a gate 22.

**[0014]** As mentioned above, the gate valve 10 includes the actuator 12 having the pneumatic system 14 and the actuation system 16. For example, the actuation system 16 may be a spring, a hydraulic piston, or other

actuation system. The pneumatic system may include an air accumulator, a shop air source, a pressurized bladder disposed about the actuator 12, a compressor, a motorized piston, or other gas source. The actuator 12 is coupled to a body 18 of the gate valve 10. For example, the actuator 12 may be coupled to a top portion of the body 18 via a bonnet 20. Alternatively, the gate valve 10 may include a single body coupled to the actuator 12. The body 18 may be constructed of cast iron, ductile iron, cast carbon steel, gun metal, stainless steel, alloy steels, corrosion resistant alloys, and/or forged steels. The gate valve 10 includes the gate 22 disposed within a cavity 24 of the body 18, and the gate 22 is configured to move between an open position and a closed position within the cavity 24. As illustrated, the gate 22 is disposed in the open position. The body 18 of the gate valve 10 includes an inlet 26 and an outlet 28 configured for a flow of a fluid through a bore 30 of the body 18 into a passage 32 of the gate valve 10. In certain embodiments, the outlet 28 may act as an inlet allowing fluid flow into the passage 32 from either side of the gate valve 10. For example, in some embodiments, the inlet 26 may act as an outlet and the outlet 28 may act as an inlet.

**[0015]** Additionally, as mentioned above, the gate valve 10 may be configured to shear a wireline, coil tubing, or other tubular member. In the illustrated embodiment, a wireline 34 extends through the bore 30 and the passage 32 of the body 18 of the gate valve 10. In the manner described in detail below, when the gate 22 of the gate valve 10 moves from an opened position to a closed position, the gate 22 shears the wireline 34, thus allowing the gate 22 to close without removing the obstruction, here the wireline 34 .

**[0016]** The gate valve 10 is configured to open and close in response to an actuation force from the actuator 12. In particular, the actuation system 16 applies a force (e.g., a linear force) to a stem 36 coupling the gate 22 to the actuator 12. Additionally, the pneumatic system 14 applies a supplemental force (e.g., supplemental linear force) to increase the overall force of the actuator 12 acting on the stem 36. In this manner, the operation of the gate valve 10 may improve. As discussed in detail below, the actuator 12 may be controlled such that only the pneumatic system 14 is used to actuate the gate valve 10, only the actuation system 16 is used to actuate the gate valve 10, or

both the pneumatic system 14 and the actuation system 16 are used to actuate the gate valve 10. In other words, the actuator 12 may have multiple modes of operation.

**[0017]** FIG. 2 illustrates an embodiment of the gate valve 10 having the actuator 12 with the pneumatic system 14, illustrating the gate valve 10 in an opened position. In the illustrated embodiment, the actuation system 16 of the actuator 12 includes a spring 50 biased against a piston 52 within a piston chamber 54. In operation, the spring 50 biases the piston 52 in a direction 56, thereby urging the gate 22 from the opened position to the closed position shown in FIG. 3.

**[0018]** As mentioned above, the actuator 12 also includes the pneumatic system 14, which may supplement the actuation system 16. For example, the actuator 12 may have multiple modes of operation where the actuation system 16 is operated, the pneumatic system 14 is operated, or both the actuation system 16 and the pneumatic system 14 are operated to actuate the gate valve 10. In illustrated embodiment, the pneumatic system 14 includes a first gas source 58 and a second gas source 60. However, in other embodiments, the first gas source 58 may be a hydraulic or electric system configured to apply a force. The first and second gas sources 58 and 60 may include air accumulators, shop air sources, pressurized capsules or vessels, or other gas sources suitable for supplying a pressurized air. The first gas source 58 supplies a pressurized gas to the piston chamber 54 on a first side 62 of the piston 52 through a port 64 of the actuator 12. In particular, the first gas source 58 may supply a pressurized gas to the first side 62 of the piston 52 in order to bias the piston 52 in a direction 66, thereby compressing the spring 50 and urging the gate 22 into the open position shown in FIG. 2. In certain embodiments, the first gas source 50 may supply a gas to the first side 62 of the piston 52 at a pressure of approximately 10 to 10000 psi, approximately 20 to 5000 psi, approximately 30 to 1000 psi, approximately 40 to 500 psi, or approximately 50 to 100 psi.

**[0019]** FIG. 3 illustrates an embodiment of the gate valve 10 having the actuator 12 with the pneumatic system 14, illustrating the gate valve 10 in a closed position. In the illustrated embodiment, the first gas source 58 (or

hydraulic or electric power source) may be shut off. As a result, the spring 50 biased against the piston 52 force the piston 52 in the direction 56, thereby pushing the fluid (e.g., gas or hydraulic fluid) on the first side 62 of the piston chamber 54 out of the piston chamber 54 through the port 64. The gate valve 10 then moves into the closed position shown. That is, the gate 22 moves through the passage 32 of the gate valve 10 and shears the wireline 34. In the illustrated embodiment, the gate 22 shears the wireline 34 in two places, thus breaking the wireline 34 and creating a separate sheared portion 70 of the wireline 34. However, in other embodiments, the gate 22 may shear the wireline 34 in one location.

**[0020]** As mentioned above, the pneumatic system 14 of the actuator 12 may supplement the force generated by the actuation system 16. In the illustrated embodiment, the second gas source 60 of the pneumatic system 14 may supplement the force exerted on the piston 52 by the spring 50 of the actuation system 16. More specifically, the second gas source 60, which may be an air accumulator, shop air supply, or other gas source, may supply a pressurized gas into a second side 72 of the piston chamber 54 through a port 74 of the actuator 12. The pressurized gas from the second gas source 60 and the spring 50 may combine to bias the piston 52 in the direction 56, thereby urging the gate 22 into the closed position as shown. In the closed position, the gate 22 may shear the wireline 34 and block fluid flow through the passage 32 of the gate valve 10. The first gas source 58 may supply a gas to the first side 62 of the piston 52 at a pressure of approximately 10 to 10000 psi, approximately 20 to 5000 psi, approximately 30 to 1000 psi, approximately 40 to 500 psi, or approximately 50 to 100 psi. The gas pressures applied by the first gas source 58 and the second gas source 60 may be regulated to further control actuation of the gate valve 10. That is, the gas pressures applied by the first gas source 58 and the second gas source 60 may be regulated to supplement the actuation system 16 and further control the position of the gate 22 (e.g., between the opened and closed positions).

**[0021]** By supplementing the force applied to the gate 22 by the actuation system 16 with a supplemental force generated by the pneumatic system 14,

the size or strength of the actuation system 16 may be reduced. In this manner, greater forces may be applied to the gate 22 during operation of the gate valve 10 without increasing the size or design of the actuation system 14. As a result, in certain embodiments, the pneumatic system 14 may be applied to existing gate valve 10 designs, thereby improving operation of existing gate valves 10. For example, the pneumatic system 14 may improve operation of the gate valve 10 in emergency circumstances, or other circumstances when accelerated operation of the gate valve 10 is desirable.

**[0022]** FIG. 4 illustrates an embodiment of the gate valve 10 having the actuator 12 with the pneumatic system 14 having a pre-charged (e.g., pressurized) bladder 100 disposed about the actuation system 16. As shown, the bladder 100 is clamped or secured about the actuation system 16 with clamps 102. A first clamp 104 clamps one end of the bladder 100 to the bonnet 20 of the gate valve 10, and a second clamp 106 clamps another end of the bladder 100 to a collar 108 of the gate valve 10. As such, the bladder 100 defines a sealed volume 110 about the actuation mechanism 16.

**[0023]** As mentioned above, the bladder 100 may be pre-charged or pressurized with a gas 112. That is, the sealed volume 110 of the bladder 100 may be filled with the gas 112. The sealed volume 110 of the bladder 100 is exposed to the second side of the piston chamber 54 by the port 74. Accordingly, the pressurized gas 112 within the sealed volume 110 of the bladder 100 may enter the piston chamber 54 and exert a force on the piston 52 in the direction 56, thereby biasing the gate 22 towards the closed position shown in FIG. 3. The force exerted on the piston 52 by the gas 112 is combined with the force acting on the piston 52 by the spring 50. As such, the pressurized gas 112 supplements the actuation force of the spring 50, thereby increasing the overall force acting on the gate 22. In this manner, operation of the gate valve 10 may be improved. For example, the actuation system 16 and the pneumatic system 14 may combine to apply a greater shearing force to the wireline 34 with the gate 22, thereby enabling shearing of the wireline 34 and/or more easily shearing the wireline 34 and improving gate valve 10 performance.

**[0024]** In addition to the pre-charged bladder 100 disposed about the actuation system 16, the pneumatic system 14 in the illustrated embodiment also includes the first gas source 58. The first gas source 58 supplies a pressurized gas (e.g., a control pressure) to the first side 62 of the piston chamber 54 through the port 64 of the actuation system 16. In the present embodiment, the gas supplied by the first gas source 58 is supplied to the port 64 by a conduit 114 (e.g., a hose) that extends through the bladder 100. The conduit 114 and bladder 100 may be formed as a single or integrated piece. As, the first gas source 58 supplies pressurized gas to the first side 62 of the piston chamber 54, the pressurized gas exerts a force on the piston 52 in the direction 66, thereby urging the gate 22 towards the opened position. The gas pressure applied by the first gas source 58 may be regulated to control the position of the gate 22 (e.g., between the opened and closed positions).

**[0025]** FIG. 5 illustrates another embodiment of the gate valve 10 having the actuator 12 with the pneumatic system 14. In the illustrated embodiment, the pneumatic system 14 includes a charged piston system 120 added onto the collar 108 of the gate valve 10. More specifically, the charged piston system 120 includes a piston 122 coupled to a valve stem 124 of the gate valve 10. The charged piston system 120 includes a piston chamber 126 that is charged (i.e., pressurized) with a pressurized gas 128. The pressurized gas 128 biases the piston 122 of the charged piston system 120 in the direction 56. As the valve stem 124 of the gate valve 10 is coupled to the piston 52 of the actuation system 16, the pressurized gas 128 also biases the piston 52 in the direction 56, thereby urging the gate 22 towards the closed position. Additionally, the force exerted by the pressurized gas 128 on the piston 122 is combined with the force exerted on the piston 52 by the spring 50 of the actuation system 16. As such, the charged piston system 120 and the actuation system 16 cooperatively urge the gate 22 towards the closed position.

**[0026]** Furthermore, the illustrated embodiment includes the first gas source 58. As similarly described above, the first gas source 58 supplies pressurized gas (e.g., a control pressure) to the first side 62 of the piston chamber 54 to exert a force on the piston 52 in the direction 66, thereby

urging the gate 22 towards the opened position. As such, in the manner described below, the gas pressure applied by the first gas source 58 may be regulated to control the position of the gate 22 (e.g., between the opened and closed positions).

**[0027]** FIG. 6 illustrates an embodiment of the gate valve 10 having the actuator 12 with the pneumatic system 14, illustrating a controller 150 configured to regulate operation of the gate valve 10. Specifically, the controller 150 may be configured to regulate the pressure of gas supplied by the first and/or second gas sources 58 and 60 to the piston chamber 54. In this manner, the controller 150 may regulate operation of the gate valve 10. That is, the controller 150 may regulate the position of the gate 22 of the gate valve 10 (e.g., between open and closed positions). To this end, the controller 150 may be configured to regulate operation of valves or other flow control devices of the first and second gas sources 58 and 60 to regulate the pressure or flow of gas to the first and second sides 62 and 72 of the piston chamber 54. For example, to actuate the gate valve 10 in an opened position, the controller 150 may operate to increase flow and/or pressure of gas supplied to the first side 62 of the piston chamber 54 by the first gas source 58. The controller 150 may operate to reduce flow and/or pressure of gas supplied to the second side 72 of the piston chamber 54 by the second gas source 60. More specifically, the controller 150 may control the first and second gas sources 58 and 60 such that the force acting on the piston 52 generated by the gas supplied by the first gas source 58 (e.g., in the direction 66) is greater than the force acting on the piston 52 generated by the spring 50 and the gas supplied by the second gas source 60 (e.g., in the direction 56). As a result, the piston 52 will be urged in the direction 66, thereby opening the gate valve 10.

**[0028]** Similarly, to actuate the gate valve 10 in a closed position, the controller 150 may operate to increase flow and/or pressure of gas supplied to the second side 72 of the piston chamber 54 by the second gas source 60. Additionally, the controller 150 may operate to reduce flow and/or pressure of gas supplied to the first side 62 of the piston chamber 54 by the first gas source 58. The controller may control the first and second gas sources 58

and 60 such that the force acting on the piston 52 generated by the gas supplied by the first gas source 58 (e.g., in the direction 66) is less than the force acting on the piston 52 generated by the spring 50 and the gas supplied by the second gas source 60 (e.g., in the direction 56). As a result, the piston 52 will be urged in the direction 56, thereby closing the gate valve 10 and shearing the wireline 34.

**[0029]** Furthermore, in certain embodiments, the controller 150 may regulate operation of the first and/or second gas sources 58 and 60 based on feedback, such as feedback from sensors 152. For example, the sensors 152 may be temperature sensors, position sensors, pressure sensors, and so forth. In certain embodiments, one or more of the sensors 152 may be configured to measure a pressure within the first side 62 of the piston chamber 54, the second side 72 of the piston chamber 54, the first gas source 58, the second gas source 60, and so forth.

**[0030]** The controller 150 may be further configured to regulate different modes of operation of the actuator 12. For example, in certain circumstances (e.g., normal operation of the actuator 12), the controller 150 may be configured to operate only the actuation system 16 to actuate the gate valve 10. Similarly, in other circumstances (e.g., if the actuation system 16 fails), the controller 150 may operate only the pneumatic system 14 to actuate the gate valve 10. In temporary, emergency, or unusual conditions, the controller 150 may be configured to operate both the pneumatic system 14 and the actuation system 16 to actuate the gate valve 10. The controller 150 may be remotely controlled (e.g., at the surface) to operate the actuator 12 (e.g., the pneumatic system 14 and/or the actuation system 16).

**[0031]** Embodiments of the present disclosure include the gate valve 10 having the actuator 12 with the pneumatic system 14. More specifically, the actuator 12 includes the pneumatic system 14 configured to create a supplemental force to supplement an actuation force generated by the actuation system 16 of the actuator 12. For example, the pneumatic system 14 may use a pressurized gas to create the supplemental force acting on the actuation system 16. The supplemental force may cooperate with the actuation force generated by the actuation system 16 to improve actuation of

the gate valve 10. In certain embodiments, the pneumatic system 14 may be added to existing gates valve 10 designs to improve operation of the gate valves 10 without increasing the size of existing gate valve actuation systems 16.

**[0032]** While the invention may be susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and have been described in detail herein. However, it should be understood that the invention is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the following appended claims.

**CLAIMS**

1. A gate valve, comprising:  
a gate; and  
an actuator, comprising:  
a first actuator configured to apply an actuating force to move the gate; and  
a second pneumatic actuator configured to apply a supplemental force to move the gate.
2. The gate valve of claim 1, wherein the first actuator comprises a spring biased against a first side of a piston.
3. The system of claim 2, wherein the second pneumatic actuator comprises a first gas source configured to apply a first supplemental force to a second side of the piston.
4. The system of claim 3, wherein the second pneumatic actuator comprises a second gas source configured to apply a second supplemental source to the first side of the piston.
5. The system of claim 1, wherein the second pneumatic actuator comprises an air accumulator.
6. The system of claim 1, wherein the gate valve is configured to shear an obstruction.
7. The system of claim 1, wherein the second pneumatic actuator comprises a first gas source configured to apply a first force in a direction of the actuating force and a second gas source configured to apply a second force in an opposite direction of the actuating force.
8. The system of claim 7, wherein the first gas source comprises a pressurized bladder disposed about the first actuator.

9. The system of claim 8, wherein the second gas source comprises an air accumulator.
10. The system of claim 7, wherein the first gas source comprises a pressurized piston.
11. A system, comprising:  
a gate valve, comprising:  
a body comprising an opening into a cavity, wherein the opening is configured to receive a tubular member;  
a gate configured to move along the opening into the cavity between an open position and a closed position to shear the tubular member;  
a first actuator configured to bias the gate towards the closed position with a biasing force; and  
a second pneumatic actuator configured to apply a supplemental force to move the gate.
12. The system of claim 11, wherein the second pneumatic actuator is configured to apply the supplemental force in a direction of the biasing force.
13. The system of claim 11, wherein the second pneumatic actuator comprises a first gas source configured to apply a first gas pressure in a direction of the biasing force and a second gas source configured to apply a second gas pressure in an opposite direction of the biasing force.
14. The system of claim 13, wherein the first actuator comprises at least one spring.

15. The system of claim 11, wherein the tubular member is a wireline.
16. The system of claim 15, wherein the second pneumatic actuator comprises an air accumulator configured to apply the supplemental force.
17. A system, comprising:
  - a second pneumatic actuator configured to couple to a gate valve, wherein the second pneumatic actuator is configured to apply a supplemental force to move a gate of the gate valve, wherein the supplemental force supplements an actuating force of first actuator of the gate valve.
18. The system of claim 17, wherein the second pneumatic actuator comprises a first gas source configured to apply a first pressure in a direction of the actuating force and a second gas source configured to apply a second pressure in an opposite direction of the actuating force.
19. The system of claim 17, wherein the second pneumatic actuator comprises a pressurized bladder configured to be sealed about the first actuator and apply the supplemental force and a gas source configured to apply an opposing force in a direction opposite the actuating force.
20. The system of claim 17, wherein the second pneumatic actuator comprises a pressurized piston configured to apply the supplemental force and a gas source configured to apply an opposing force in a direction opposite the actuating force.