[0011a] According to one aspect of the invention, there is provided an apparatus for controlling well fluids, comprising:

a gate valve having a body, the body having a cavity and a flow passage intersecting the cavity; a seat ring mounted to the body at the intersection of the flow passage and the cavity, the seat ring having an engaging face formed of a steel alloy;

a gate in the cavity and having an engaging face formed of a steel alloy that slidingly engages the face of the seat ring while being moved between open and closed positions; and a hardened outer layer formed on at least one of the engaging faces of the gate and seat ring; **characterized by**: a friction-resistant coating on the hardened outer layer, the friction-resistant material being made from molybdenum disulfide, tungsten disulfide or a carbon or diamond-like material with a thickness in a range of between 2 μm and 8 μm.

[0012] Also disclosed is~~Another aspect of the invention includes~~ a method of forming a coating on a metal load bearing surface. The method includes the step of providing a gate valve assembly having a valve body with a cavity and a flow passage intersecting the cavity. A seat ring is mounted to the body at the intersection of the flow passage and the cavity. The seat ring has an engaging face formed of a steel alloy. A gate is in the cavity and has an engaging face formed of a steel alloy that slidingly engages the face of the seat ring while being moved between open and closed positions. The method also includes the step of hardening at least one of the engaging faces. The method also includes the step of applying a friction-resistant coating to the hardened engaging face.

[0013] The hardening step can include hardening the engaging face through a process selected from nitriding, aluminiding, nickel aluminiding, boronizing, and carburizing. The application step can include that the friction-resistant coating is applied through a process selected from physical vapor deposition and chemical vapor deposition.

[0014] Another aspect of the invention includes another method of forming a coating on a metal load bearing surface. The method includes the step of providing a gate valve assembly having a valve body with a cavity and a flow passage intersecting the cavity. A seat ring mounted to the body at the intersection of the flow passage and the cavity. The seat ring has an engaging face formed of a steel alloy. A gate is in the cavity and has an engaging face formed of a steel alloy that slidingly engages the face of the seat ring while being moved between open and closed positions. The method also includes the step of hardening at least one of the engaging faces. The method also includes the step of applying a coating selected from a group consisting of molybdenum disulfide and tungsten disulfide to the hardened engaging face until the coating has a thickness in a range between about 2 microns and about 8 microns.

[0015] The hardening step can include that hardening the engaging face through a process selected from nitridmg, aluminiding, nickel aluminiding, boronizing, and

THAT CLAIMED IS:

1. An apparatus for controlling well fluids, comprising: a gate valve having a body, the body having a cavity and a flow passage intersecting the cavity; a seat ring mounted to the body at the intersection of the flow passage and the cavity, the seat ring having an engaging face formed of a steel alloy; a gate in the cavity and having an engaging face formed of a steel alloy that slidingly engages the face of the seat ring while being moved between open and closed positions; a hardened outer layer formed on at least one of the engaging faces of the gate and seat ring; and a friction-resistant coating on the hardened outer layer.

2. The apparatus according to claim 1, wherein the hardened outer layer is nonporous with a thickness that is at least 2 mils.

3. The apparatus according to claim 1, wherein the hardened outer layer is polymer-free and is impermeable to gas without the use of a sealant.

4. The apparatus according to claim 1, wherein the friction-resistant coating comprises molybdenum disulfide.

5. The apparatus according to claim 1, wherein the friction-resistant coating comprises tungsten disulfide.

6. The apparatus according to claim 1, wherein the friction-resistant coating comprises a carbon or diamond-like material.

7. The apparatus according to claim 1, wherein the friction-resistant coating comprises a thickness in a range of between about 2 and about 8 microns.

8. The apparatus according to claim 1, wherein the engaging face containing the friction-resistant coating has a hardened layer under the coating, the hardened layer comprising

one of the following: a nitrided layer, a nickel aluminided layer, a boronized layer, and a carburized layer.

9. The apparatus according to claim 1, wherein the friction-resistant coating has a hardness of at least about 500 on the Vickers scale.

10. The apparatus according to claim 1, wherein the friction-resistant coating has a hardness in the range of about 500 to about 5000 on the Vickers scale.

11. The apparatus according to claim 1 , wherein the friction-resistant coating has an unlubricated coefficient of friction in a range between about 0.03 and about 0.15 and a lubricated coefficient of friction in a range between about 0.01 and about 0.15.

12. A method of forming a coating on a metal load bearing surface, comprising:

(a) providing a gate valve assembly having a valve body with a cavity and a flow passage intersecting the cavity, a seat ring mounted to the body at the intersection of the flow passage and the cavity, the seat ring having an engaging face formed of a steel alloy, and a gate in the cavity and having an engaging face formed of a steel alloy that slidingly engages the face of the seat ring while being moved between open and closed positions;

(b) hardening at least one of the engaging faces; and

(c) applying a friction-resistant coating to the hardened engaging face.

13. The method according to claim 12, wherein step (b) comprises hardening the engaging face through a process selected from diffusion, thermal spraying, cladding vapor deposition coating, and electroplating.

14. The method according to claim 12, wherein step (c) wherein the friction-resistant coating is applied through a process selected from physical vapor deposition and chemical vapor deposition.

15. A method of forming a coating on a metal load bearing surface, comprising:

(a) providing a gate valve assembly having a valve body with a cavity and a flow passage intersecting the cavity, a seat ring mounted to the body at the intersection of the flow passage and the cavity, the seat ring having an engaging face formed of a steel alloy, and a gate in the cavity and having an engaging face formed of a steel alloy that slidingly engages the face of the seat ring while being moved between open and closed positions;

(b) hardening at least one of the engaging faces; and

(c) applying a coating selected from a group consisting of molybdenum disulfide and tungsten disulfide to the hardened engaging face until the coating has a thickness in a range between about 2 microns and about 8 microns.

16. The method according to claim 15, wherein step (b) comprises hardening the engaging face through a process selected from nitriding, aluminiding, nickel aluminiding, boronizing, carburizing, thermal spraying, cladding, and electroplating.

17. The method according to claim 15, wherein step (c) wherein the coating is applied through a process selected from physical vapor deposition and chemical vapor deposition.

18. The method according to claim 15, further comprising (d) applying a lubricant to the coating after the coating is applied to the hardened engaging face.

19. The method according to claim 15, further comprising the step of texturing the engaging surface being hardened in step (b) prior to step (b) to create a textured surface finish, and wherein in step (c), the coating is applied to the textured and hardened

engaging face with the textured surface enhancing the application of the coating to the hardened engaging face.

20. The method according to claim 15, wherein step (b) comprises hardening the engaging face through thermal spraying a polymer-free material onto the at least engaging faces.

Claims

1. An apparatus for controlling well fluids, comprising:
a gate valve having a body, the body having a cavity and a flow passage intersecting the cavity; a seat ring mounted to the body at the intersection of the flow passage and the cavity, the seat ring having an engaging face formed of a steel alloy;
a gate in the cavity and having an engaging face formed of a steel alloy that slidingly engages the face of the seat ring while being moved between open and closed positions; and a hardened outer layer formed on at least one of the engaging faces of the gate and seat ring; **characterized by**: a friction-resistant coating on the hardened outer layer, the friction-resistant material being made from molybdenum disulfide, tungsten disulfide or a carbon or diamond-like material with a thickness in a range of between 2 μm and 8 μm.

2. The apparatus according to claim 1, wherein the hardened outer layer is nonporous with a thickness that is at least 50 μm (2 mils).

3. The apparatus according to claim 1, wherein the hardened outer layer is polymer-free and is impermeable to gas without the use of a sealant.

4. The apparatus according to claim 1, wherein the engaging face containing the friction-resistant coating has a hardened layer under the coating, the hardened layer comprising one of the following: a nitrided layer, a nickel aluminided layer, a boronized layer, and a carburized layer.

5. A method of forming a coating on a metal load bearing surface, comprising:

(a) providing a gate valve assembly having a valve body with a cavity and a flow passage intersecting the cavity, a seat ring mounted to the body at the intersection of the flow passage and the cavity, the seat ring having an engaging face formed of a steel alloy, and a gate in the cavity and having an engaging face formed of a steel alloy that slidingly engages the face of the seat ring while being moved between open and closed positions; and
(b) hardening at least one of the engaging faces; **characterized by**:
(c) applying a coating selected from a group consisting of molybdenum disulfide and tungsten disulfide to the hardened engaging face until the coating has a thickness in a range between 2 μm and 8 μm.

6. The method according to claim 5, wherein step (b) comprises hardening the engaging face through a process selected from nitriding, aluminiding, nickel aluminiding, boronizing, carburizing, thermal spraying, cladding, and electroplating.

7. The method according to claim 5, wherein step (c) wherein the coating is applied through a process selected from physical vapor deposition and chemical vapor deposition.

8. The method according to claim 5, further comprising the step of texturing the engaging surface being hardened in step (b) prior to step (b) to create a textured surface finish, and wherein in step (c), the coating is applied to the textured and hardened engaging face with the textured surface enhancing the application of the coating to the hardened engaging face.

9. The method according to claim 5, wherein step (b) comprises hardening the engaging face through thermal spraying a polymer-free material onto the at least engaging faces.