CLAIMS

We claim:

1. A flow control system to selectively regulate production of a fluid from a well, the system comprising:

a first flow control device configured to rotate when exposed to the fluid, the first flow control device having a first float of a first density, the first float positioned to allow or prevent flow of a first portion of the fluid through an outlet of the first flow control device depending on whether the fluid has a density less or greater than the first density;

a second flow control device configured to rotate when exposed to the fluid, the second flow control device having a second float of a second density, the second float positioned to allow or prevent flow of a second portion of the fluid through an outlet of the second flow control device depending on whether the fluid has a density less or greater than the second density;

the first density of the first float is between the density of oil and the density of gas, the first float positionable in a first position and a second position, the first float in the first position allowing flow of the first portion of the fluid through the outlet of the first flow control device, the first float in the second position preventing flow of the first portion of the fluid through the outlet of the first flow control device; and

the second density of the second float is between the density of oil and the density of water, the second float positionable in a first position and a second position, the second float in the first position preventing flow of the second portion of the fluid through the outlet of the second flow control device, the second float in the second position allowing flow of the second portion of the fluid through the outlet of the second flow control device; and

a regulator valve regulating production of a third portion of the fluid from the well based on the positioning of at least one of the first float and the second float.

2. The system of claim 1, wherein the regulator valve regulates production by allowing or preventing production of the third portion of the fluid from the well.

3. The system of claim 1, further comprising:

a first control line fluidly coupled to the outlet of the first flow control device; and

a second control line fluidly coupled to the outlet of the second flow control device.

4. The system of claim 1, wherein:

flow of the first portion of the fluid from the outlet of the first flow control device or flow of the second portion of the fluid from the outlet of the first flow control device closes the regulator valve to prevent production of the third portion of the fluid from the well.

5. The system of claim 4, wherein:

when the fluid is oil, the first float is in the second position, the second float is in the first position, and the regulator valve is open to allow production of the oil;

when the fluid is water, the first float is in the second position, the second float is in the second position, and the regulator valve is closed to prevent production of the water; and

when the fluid is gas, the first float is in the first position, the second float is in the first position, and the regulator valve is closed to prevent production of the gas.

6. The system of claim 1 further comprising:

a third flow control device configured to rotate when exposed to the fluid, the third flow control device having a third float of a third density, the third float positioned to allow or prevent flow of a fourth portion of the fluid through an outlet of the third flow control device depending on whether the fluid has a density less or greater than the third density.

7. The system of claim 6, wherein:

the third density of the third float is between the density of a formation brine and the density of a completion fluid, the third float positionable in a first position and a second position, the third float in the first position preventing flow of the fourth portion of the fluid through the outlet of the third flow control device, the third float in the second position allowing flow of the fourth portion of the fluid through the outlet of the third flow control device.

8. The system of claim 7 further comprising:

a pilot valve and a pilot line fluidly coupled between the pilot valve and the outlet of the third flow control device; the pilot valve being normally positioned in an open position, the pilot valve closing to a closed position when the pilot line is pressurized by the fourth portion of the fluid flowing from the outlet of the third flow control device;

wherein the outlet of the second flow control device is fluidly coupled to the pilot valve; wherein the pilot valve is fluidly coupled to the regulator valve;

wherein the outlet of the first flow control device is fluidly coupled to the regulator valve; wherein the pilot valve in the open position allows fluid communication between the outlet of the second flow control device and the regulator valve; and

wherein the pilot valve in the closed position prevents fluid communication between the outlet of the second flow control device and the regulator valve.

9. The system of claim 8, wherein:

when the fluid is oil, the first float is in the second position, the second float is in the first position, the third float is in the first position, and the regulator valve allows production of the oil;

when the fluid is completion fluid, the first float is in the second position, the second float is in the second position, the third float is in the second position, the pilot valve is in the closed position, and the regulator valve allows production of the completion fluid;

when the fluid is gas, the first float is in the first position, the second float is in the first position, the third float is in the first position, the pilot valve is in the open position, and the regulator valve prevents production of the gas;

when the fluid is formation brine, the first float is in the second position, the second float is in the second position, the third float is in the first position, the pilot valve is in the open position, and the regulator valve prevents production of the formation brine; and

when the fluid is water, the first float is in the second position, the second float is in the second position, the third float is in the first position, the pilot valve is in the open position, and the regulator valve prevents production of the water.

10. A method of regulating production of a fluid from a well, the method comprising:

directing a first portion of the fluid to a first flow control device, and based on the density of the fluid, preventing or allowing the first portion of the fluid to enter a first conduit;

moving a first float in the first flow control device into a first position or a second position depending on the density of the fluid relative to the density of the first float, the positioning of the first float determining whether the first portion of the fluid is allowed to enter the first conduit; wherein the first density of the first float is between the density of oil and the density of gas, between the density of oil and the density of water, or between the density of a formation brine and the density of a completion fluid;

directing a second portion of the fluid to a second flow control device, and based on the density of the fluid, preventing or allowing the second portion of the fluid to enter a second conduit;

moving a second float in the second flow control device into a first position or a second position depending on the density of the fluid relative to the density of the second float, the positioning of the second float determining whether the second portion of the fluid is allowed to enter the second conduit; wherein the second density of the second float is a selection of one of: between the density of oil and the density of gas, between the density of oil and the density of water, or between the density of a formation brine and the density of a completion fluid; but wherein the second density is not the same selection as the first density; and

allowing or preventing production of a remaining portion of the fluid based on the presence or absence of the first portion of fluid in a first control line and a second portion of fluid in the second control line.

11. The method of claim 10, further comprising:

rotating the first flow control device; and

rotating the second flow control device.

12. The method of claim 10, wherein allowing or preventing production of a remaining portion of the fluid further comprises:

controlling operation of a regulating valve with at least one of the first portion of the fluid in the first conduit and the second portion of the fluid in the second conduit.

13. The method of claim 10, wherein the determination of whether the first portion of the fluid enters the first conduit and the second portion of the fluid enters the second conduit depends on

the positioning of a float in each of the first and second flow control devices, the float positioned based on the density of the fluid relative to the density of the float.

14. A flow control system to selectively regulate production of a fluid from a well, the system comprising:

a first flow control device configured to rotate when exposed to the fluid, the first flow control device having a first float of a first density, the first float positioned to allow or prevent flow of a first portion of the fluid through an outlet of the first flow control device depending on whether the fluid has a density less or greater than the first density;

a second flow control device configured to rotate when exposed to the fluid, the second flow control device having a second float of a second density, the second float positioned to allow or prevent flow of a second portion of the fluid through an outlet of the second flow control device depending on whether the fluid has a density less or greater than the second density;

the first density of the first float is between the density of a formation brine and the density of a completion fluid, the first float positionable in a first position and a second position, the first float in the first position preventing flow of the first portion of the fluid through the outlet of the first flow control device, the first float in the second position allowing flow of the first portion of the fluid through the outlet of the first flow control device; and

the second density of the second float is between the density of oil and the density of water, the second float positionable in a first position and a second position, the second float in the first position preventing flow of the second portion of the fluid through the outlet of the second flow control device, the second float in the second position allowing flow of the second portion of the fluid through the outlet of the second flow control device; and

a regulator valve regulating production of a third portion of the fluid from the well based on the positioning of at least one of the first float and the second float.

15. The system of claim 14 further comprising:

a pilot valve and a pilot line fluidly coupled between the pilot valve and the outlet of the first flow control device; the pilot valve being normally positioned in an open position, the pilot valve closing to a closed position when the pilot line is pressurized by the first portion of the fluid flowing from the outlet of the first flow control device;

wherein the outlet of the second flow control device is fluidly coupled to the pilot valve;

wherein the regulator valve is fluidly coupled to the pilot valve;

wherein the pilot valve in the open position allows fluid communication between the outlet of the second flow control device and the regulator valve; and

wherein the pilot valve in the closed position prevents fluid communication between the outlet of the second flow control device and the regulator valve.

16. The system of claim 15, wherein:

when the fluid is oil, the first float is in the first position, the second float is in the first position, and the regulator valve allows production of the oil;

when the fluid is completion fluid, the first float is in the second position, the second float is in the second position, the pilot valve is in the closed position, and the regulator valve allows production of the completion fluid;

when the fluid is formation brine, the first float is in the first position, the second float is in the second position, the pilot valve is in the open position, and the regulator valve prevents production of the formation brine; and

when the fluid is water, the first float is in the first position, the second float is in the second position, the pilot valve is in the open position, and the regulator valve prevents production of the water.

17. The system of claim 14 further comprising:

a third flow control device configured to rotate when exposed to the fluid, the third flow control device having a third float of a third density, the third float positioned to allow or prevent flow of a fourth portion of the fluid through an outlet of the third flow control device depending on whether the fluid has a density less or greater than the third density.

18. The system of claim 17, wherein:

the third density of the third float is between the density of oil and the density of gas, the third float positionable in a first position and a second position, the third float in the first position preventing flow of the fourth portion of the fluid through the outlet of the third flow control device, the third

float in the second position allowing flow of the fourth portion of the fluid through the outlet of the third flow control device.

19. The system of claim 18 further comprising:

a pilot valve and a pilot line fluidly coupled between the pilot valve and the outlet of the third flow control device; the pilot valve being normally positioned in an open position, the pilot valve closing to a closed position when the pilot line is pressurized by the fourth portion of the fluid flowing from the outlet of the third flow control device;

wherein the outlet of the second flow control device is fluidly coupled to the pilot valve;

wherein the pilot valve is fluidly coupled to the regulator valve;

wherein the outlet of the first flow control device is fluidly coupled to the regulator valve;

wherein the pilot valve in the open position allows fluid communication between the outlet of the second flow control device and the regulator valve; and

wherein the pilot valve in the closed position prevents fluid communication between the outlet of the second flow control device and the regulator valve.

20. The system of claim 19, wherein:

when the fluid is oil, the first float is in the second position, the second float is in the first position, the third float is in the first position, and the regulator valve allows production of the oil;

when the fluid is completion fluid, the first float is in the second position, the second float is in the second position, the third float is in the second position, the pilot valve is in the closed position, and the regulator valve allows production of the completion fluid;

when the fluid is gas, the first float is in the first position, the second float is in the first position, the third float is in the first position, the pilot valve is in the open position, and the regulator valve prevents production of the gas;

when the fluid is formation brine, the first float is in the second position, the second float is in the second position, the third float is in the first position, the pilot valve is in the open position, and the regulator valve prevents production of the formation brine; and

when the fluid is water, the first float is in the second position, the second float is in the second position, the third float is in the first position, the pilot valve is in the open position, and the regulator valve prevents production of the water.