CLAIMS

What is claimed is:

1. An apparatus for separating gas from liquid in a gas-liquid flow, said apparatus comprising:

a pipe having a first end and a second end, the pipe having a plurality of curvilinear pipe loops arranged adjacent one another along an axis extending from a first axis end to a second axis end, each pipe loop characterized by an inner wall and an outer wall;

a loop outlet port disposed along the inner wall of one of the loops; and

a gas separator in fluid communication with the loop outlet port,

wherein each pipe loop is characterized by a diameter and the diameters of at least a portion of the plurality of adjacent pipe loops are different.

2. The apparatus of claim 1, wherein the diameters of the pipe loops along the axis are consecutively decreasing from the first axis end to the second axis end.

3. The apparatus of claim 1, further comprising a phase splitter, the phase splitter having a first inlet in fluid communication with the outlet of the pipe second axis end, a first outlet, a second outlet and a separation mechanism disposed between the first and second outlets.

4. The apparatus of claim 3, further comprising a sensor positioned along the pipe between the first and second ends and disposed to measure of property of fluid within the pipe, wherein the separation mechanism is adjustable based on the sensor.

5. The apparatus of claim 4, wherein the sensor is positioned along the pipe between the loop outlet port and the second end of the pipe.

6. The apparatus of claim 1, further comprising a heater positioned along the pipe between the first and second ends and disposed to heat fluid within the pipe.

7. The apparatus of claim 1, further comprising

an adjustable separation mechanism disposed adjacent the loop outlet port; and

a sensor positioned along the pipe between the first end and the loop outlet port and disposed to measure of property of fluid within the pipe, wherein the adjustable separation mechanism is adjustable based on the sensor.

8. An apparatus for separating gas from liquid in a gas-liquid flow, said apparatus comprising:

a first pipe having a first end and a second end, wherein at least a portion of the pipe between said first end and second end is curvilinear in shape so as to be characterized by an inner wall and an outer wall at said curvilinear portion of said pipe;

an outlet port disposed in said pipe along the inner wall between said first and second ends;

a gas separator in fluid communication with the outlet port; and

a phase splitter, the phase splitter having a first inlet in fluid communication with the second end of the pipe, a first outlet, a second outlet and a first separation mechanism disposed between the first and second outlets.

9. The apparatus of claim 8, wherein the first separation mechanism is adjustable, the apparatus further comprising a sensor positioned along the pipe between the first and second ends and disposed to measure of property of fluid within the pipe, wherein the first separation mechanism is adjustable based on the sensor.

10. The apparatus of claim 9, further comprising a second adjustable separation mechanism, the second separation mechanism disposed adjacent the outlet port; and

a sensor positioned along the pipe between the first end and the outlet port and disposed to measure of property of fluid within the pipe, wherein the adjustable second separation mechanism is adjustable based on the sensor.

11. The apparatus of claim 10, wherein the sensor utilized in conjunction with the first separation mechanism is also the same sensor utilized in conjunction with the second separation mechanism.

12. The apparatus of claim 8, wherein the pipe has a plurality of curvilinear pipe loops arranged adjacent one another along an axis extending from a first axis end to a second axis end.

13. An apparatus for separating gas from liquid in a gas-liquid flow, said apparatus comprising:

a first pipe having a first end and a second end, wherein at least a portion of the pipe between said first end and second end is curvilinear in shape so as to be characterized by an inner wall and an outer wall at said curvilinear portion of said first pipe;

an outlet port disposed in said first pipe along the inner wall between said first and second ends;

a gas separator in fluid communication with the outlet port; and

a heater positioned along the pipe between the first and second pipe ends and disposed to heat fluid within the pipe.

14. The apparatus of claim 13, further comprising a phase splitter, the phase splitter having a first inlet in fluid communication with the second end of the pipe, a first outlet, a second outlet and a first separation mechanism disposed between the first and second outlets.

15. The apparatus of claim 14, wherein the first separation mechanism is adjustable, the apparatus further comprising a sensor positioned along the pipe between the first and second ends and disposed to measure of property of fluid within the pipe, wherein the first separation mechanism is adjustable based on the sensor.

16. The apparatus of claim 13, further comprising an adjustable separation mechanism, the separation mechanism disposed adjacent the outlet port; and

a sensor positioned along the pipe between the first pipe end and the outlet port and disposed to measure of property of fluid within the pipe, wherein the adjustable separation mechanism is adjustable based on the sensor.

17. The apparatus of claim 13, wherein the pipe has a plurality of curvilinear pipe loops arranged adjacent one another along an axis extending from a first axis end to a second axis end.

18. An apparatus for separating gas from liquid in a gas-liquid flow, said apparatus comprising:

a first pipe having a first end and a second end, the first pipe having a plurality of curvilinear pipe loops arranged adjacent one another along an axis extending from a first axis end to a second axis end, each first pipe loop characterized by an inner wall and an outer wall;

a first loop outlet port disposed along the inner wall of one of the loops of the first pipe;

a first gas separator in fluid communication with the first loop outlet port,

a second pipe having a first end and a second end, the second pipe having a plurality of curvilinear pipe loops arranged adjacent one another along an axis extending from a first axis end to a second axis end, each second pipe loop characterized by an inner wall and an outer wall;

a second loop outlet port disposed along the inner wall of one of the loops of the second pipe;

a second gas separator in fluid communication with the second loop outlet port.

19. The apparatus of claim 18, wherein each pipe loop of the first and second pipes is characterized by a diameter and the diameters of at least a portion of the plurality of adjacent pipe loops are consecutively decreasing from the first axis end to the second axis end.

20. The apparatus of claim 18, wherein the second end of the first pipe is in fluid communication with the first end of the second pipe.

21. An apparatus for separating gas from liquid in a gas-liquid flow, said apparatus comprising:

a first pipe having a first end and a second end, wherein at least a portion of the pipe between said first end and second end is curvilinear in shape so as to be characterized by an inner wall and an outer wall at said curvilinear portion of said first pipe;

an outlet port disposed in said first pipe along the inner wall between said first and second ends;

a gas separator in fluid communication with the outlet port; and

an elongated channel formed along the inner wall of at least a portion of the curvilinear portion of the first pipe, between the first pipe end and the outlet port.

22. An apparatus for separating fluids in a multi-fluid flow stream, said apparatus comprising:

a housing having an inlet, a first outlet and a second outlet; and

a ball rotatably mounted in the housing, the ball having a first passageway with an inlet and an outlet; and a second passageway having an inlet and an outlet, wherein the inlets of the first and second passageways are adjacent one another and the outlets of the first and second passageways are spaced apart from one another, the inlets disposed adjacent housing inlet, the first passageway outlet disposed adjacent first housing outlet and the second passageway outlet disposed adjacent the second housing outlet.

23. The apparatus of claim 22, wherein the first and second passageways converge at their respective inlets to form an edge adjacent the housing inlet.

24. A fuel bunkering apparatus comprising;

a first fuel storage vessel having an outlet;

a second fuel storage vessel having an inlet;

a pipe having a first end in fluid communication with the outlet of the first fuel storage vessel and a second end in fluid communication with the inlet of the second fuel storage vessel, the pipe having a plurality of curvilinear pipe loops arranged adjacent one another along a substantially vertical axis extending from a first axis end to a second axis end, each pipe loop characterized by an inner wall and an outer wall;

a loop outlet port disposed along the inner wall of one of the loops; and

a gas separator in fluid communication with the loop outlet port,

wherein each pipe loop is characterized by a diameter and the diameters of at least a portion of the plurality of adjacent pipe loops are the same.

25. The apparatus of claim 24, wherein each of the loops is substantially horizontal.

26. A well system for separating components of a multi-phase flow from a wellbore drilled from a drilling rig, the system comprising:

a drilling rig;

a drill string extending from the drilling rig; and

a flow separation apparatus disposed adjacent the drilling rig and in fluid communication with the wellbore, the flow separation apparatus comprising:

a first pipe having a first end and a second end, wherein at least a portion of the pipe between said first end and second end is curvilinear in shape so as to be characterized by an inner wall and an outer wall at said curvilinear portion of said pipe;

an outlet port disposed in said pipe along the inner wall between said first and second ends;

a gas separator in fluid communication with the outlet port; and

a phase splitter, the phase splitter having a first inlet in fluid communication with the second end of the pipe, a first outlet, a second outlet and a first separation mechanism disposed between the first and second outlets.

27. The system of claim 26, wherein the first separation mechanism is adjustable, the apparatus further comprising a sensor positioned along the pipe between the first and second ends and disposed to measure of property of fluid within the pipe, wherein the first separation mechanism is adjustable based on the sensor.

28. The system of claim 27, further comprising a second adjustable separation mechanism, the second separation mechanism disposed adjacent the outlet port; and

a sensor positioned along the pipe between the first end and the outlet port and disposed to measure of property of fluid within the pipe, wherein the adjustable second separation mechanism is adjustable based on the sensor.

CLAIMS

What is claimed is:

1. An apparatus for separating gas from liquid in a gas-liquid flow, said apparatus comprising:

a first pipe having a first end and a second end, said first pipe comprising a curvilinear portion between said first end and said second end wherein said curvilinear portion comprises an inner wall and an outer wall;

said curvilinear portion further comprising an outlet port disposed along the inner wall of said curvilinear portion, said outlet port defining a junction between said first pipe and a separator inlet line, wherein said separator inlet line is connected to said outlet port;

said apparatus further comprising a gas separator in fluid communication with said outlet port through said separator inlet line such that fluid is capable of flowing into said gas separator through said separator inlet line; and

said apparatus further comprising a liquid-liquid phase splitter, said liquid-liquid phase splitter comprising a first horizontal inlet connected to the second end of said first pipe downstream of said junction such that fluid is capable of flowing into said liquid-liquid phase splitter through the second end of said first pipe, wherein said liquid-liquid phase splitter further comprises a first outlet, a second outlet and a first separation mechanism disposed between the first and second outlets.

2. The apparatus of claim 1, wherein said first separation mechanism is adjustable, the apparatus further comprising a first sensor positioned along said first pipe between the first and second ends and wherein said first sensor is disposed to measure a property of fluid within said first pipe, wherein said first separation mechanism is adjustable based on said first sensor.

3. The apparatus of claim 2, further comprising a second adjustable separation mechanism, said second separation mechanism disposed adjacent said outlet port; and a second sensor positioned along said first pipe between the first end and said outlet port and wherein said second sensor is disposed to measure a property of fluid within said first pipe, wherein said second separation mechanism is adjustable based on said second sensor.

4. The apparatus of claim 3, wherein said first sensor is utilized in conjunction with said first separation mechanism and the said second separation mechanism.

5. The apparatus of claim 1, wherein said first pipe comprises a plurality of curvilinear pipe loops arranged adjacent one another along an axis extending from a first axis end to a second axis end.

6. The apparatus of claim 5, wherein the diameter of at least one curvilinear pipe loop is different than the diameter of at least another curvilinear pipe loop.

7. The apparatus of claim 6, wherein the diameters of the curvilinear pipe loops along the axis consecutively decrease from the first axis end to the second axis end.

8. The apparatus of claim 1, further comprising a heater positioned along said first pipe between the first and second ends and wherein said heater is disposed to heat fluid within the pipe.

9. The apparatus of claim 1, further comprising an elongated channel formed along the inner wall of at least a portion of said curvilinear portion of said first pipe, between the first end of said first pipe and said outlet port.

10. An apparatus for separating fluids in a multi-fluid flow stream, said apparatus comprising:

a pipe comprising a first end and a second end, said pipe comprising a curvilinear portion between the first end and the second end, wherein said curvilinear portion comprises an inner wall and an outer wall;

said curvilinear portion further comprising an outlet port disposed along the inner wall of said curvilinear portion, said outlet port defining a junction between said pipe and a separator inlet line, wherein said separator inlet line is connected to said outlet port;

said apparatus further comprising a gas separator in fluid communication with said outlet port through said separator inlet line such that fluid is capable of flowing into said gas separator through said separator inlet line, and

said apparatus further comprising a liquid-liquid phase splitter, said liquid-liquid phase splitter comprising:

a housing comprising a horizontal housing inlet, a first housing outlet and a second housing outlet, wherein said horizontal housing inlet is connected to the second end of said pipe downstream of said junction such that fluid is capable of flowing into said liquid-liquid phase splitter through the second end of said pipe; and

a separation mechanism disposed between said first and second housing outlets, said separation mechanism comprising a ball rotatably mounted in said housing, said ball comprising a first passageway comprising a first passageway inlet a first passageway outlet and a second passageway comprising a second passageway inlet and a second passageway outlet, wherein said first passageway inlet and said second passageway inlet are adjacent one another and said first passageway outlet and the said second passageway outlet are spaced apart from one another, said first passageway inlet and said second passageway inlet disposed adjacent said housing horizontal inlet, said first passageway outlet disposed adjacent said first housing outlet and said second passageway outlet disposed adjacent said second housing outlet.

11. The apparatus of claim 10, wherein said first and second passageways coverage at their respective inlets to form an edge adjacent said housing inlet.

12. A fuel bunkering apparatus comprising;

a first fuel storage vessel having an outlet;

a second fuel storage vessel having an inlet;

a pipe comprising a first end connected to said outlet of said first fuel storage vessel and a second end in fluid communication with said inlet of said second fuel storage vessel, said pipe comprising a plurality of curvilinear pipe loops arranged adjacent one another along a substantially vertical axis extending from a first axis end to a second axis end, at least one pipe loop comprising an inner wall; an outer wall; and a loop outlet port disposed along the inner wall of one of said at least one curvilinear pipe loop, said loop outlet port defining a junction between said pipe and a separator inlet line, wherein said separator inlet line is connected to said loop outlet port;

a gas separator in fluid communication with said loop outlet port through said separator inlet line such that fluid is capable of flowing into said gas separator through said separator inlet line, wherein the diameter of at least one curvilinear pipe loop is the same as the diameter of at least another adjacent curvilinear pipe loop; and

a liquid-liquid phase splitter, said liquid-liquid phase splitter comprising a first horizontal inlet connected to the second end of said pipe downstream of said junction such that fluid is capable of flowing into said liquid-liquid phase splitter through the second end of said pipe, wherein said liquid-liquid phase splitter further comprises a first outlet connected to said fuel storage vessel, a second outlet and a first separation mechanism disposed between the first and second outlets.

13. The apparatus of claim 12, wherein each of said curvilinear pipe loops is horizontal.

14. A well system for separating components of a multi-phase flow from a wellbore drilled from a drilling rig, the system comprising:

a drilling rig;

a drill string extending from the drilling rig; and

a flow separation apparatus disposed adjacent the drilling rig and in fluid communication with said wellbore, said flow separation apparatus comprising:

a first pipe having a first end and a second end, said first pipe comprising a curvilinear portion between said first end and said second end wherein said curvilinear portion comprises an inner wall and an outer wall;

said curvilinear portion further comprising an outlet port disposed along the inner wall of said curvilinear portion, said outlet port defining a junction between said first pipe and a separator inlet line, wherein said separator inlet line is connected to said outlet port;

said apparatus further comprising a gas separator in fluid communication with said outlet port through said separator inlet line such that fluid is capable of flowing into said gas separator through said separator inlet line;

said apparatus further comprising a liquid-liquid phase splitter, said liquid-liquid phase splitter comprising a first horizontal inlet connected the second end of said first pipe downstream of the junction such that fluid is capable of flowing into said liquid-liquid phase

splitter through the second end of said first pipe, wherein said liquid-liquid phase splitter further comprises a first outlet, a second outlet and a first separation mechanism disposed between the first and second outlets.

15. The system of claim 14, wherein said first separation mechanism is adjustable, the apparatus further comprising a first sensor positioned along said first pipe between the first and second ends and wherein said first sensor is disposed to measure a property of fluid within said first pipe, wherein said first separation mechanism is adjustable based on said first sensor.

16. The system of claim 15, further comprising a second adjustable separation mechanism, said second separation mechanism disposed adjacent said outlet port; and a second sensor positioned along said first pipe between the first end and said outlet port and wherein said second sensor is disposed to measure a property of fluid within said first pipe, wherein said second separation mechanism is adjustable based on said second sensor.