What is claimed is:

1. An apparatus for separating a fluid mixture comprising:

a vessel;

a vortex generation zone having a tapered wall positioned within the vessel;

a fluid inlet extending into the vortex generation zone at an angle having a component tangential to an internal wall of the vortex generation zone at a point on the internal wall proximate to the fluid inlet;

a gas inlet extending into the vortex generation zone; and

a fluid outlet fluidly connected to the vessel.

2. The apparatus of claim 1, wherein the tapered wall comprises an angle to increase a rotational velocity of a fluid mixture flowing through the vortex generation zone.

3. The apparatus of claim 2, wherein the tapered wall comprises an angle ranging from greater than zero to about 14 degrees from a vertical axis.

4. The apparatus of claim 3, wherein the tapered wall comprises an angle ranging from about five and about ten degrees from the vertical axis.

5. The apparatus of claim 4, wherein the tapered wall comprises an angle of about nine degrees from the vertical axis.

6. The apparatus of claim 3, wherein the vortex generation zone is constructed and arranged to direct a fluid mixture upward.

7. The apparatus of claim 6, wherein the vortex generation zone is constructed and arranged to direct a gas upward.

8. The apparatus of claim 3, wherein the fluid inlet extends into the vortex generation zone at a second angle to induce an upward flow of a fluid mixture.

9. The apparatus of claim 8, wherein the fluid inlet extends into the vortex generation zone at a second angle ranging from greater than zero to about ten degrees above a horizontal plane.

10. The apparatus of claim 9, wherein the second angle ranges from greater than zero to about five degrees above the horizontal plane.

11. The apparatus of claim 10, wherein the second angle is about one degree above the horizontal plane.

12. The apparatus of claim 1, further comprising a preliminary separator positioned between a source of fluid mixture and the fluid inlet.

13. The apparatus of claim 1, wherein the vortex generation zone is defined by a wall shaped as an inverted truncated cone.

14. The apparatus of claim 1, wherein the fluid outlet is positioned above a central region of the vortex generation zone.

15. The apparatus of claim 14, wherein the fluid outlet further comprises a head-in-head outlet.

16. The apparatus of claim 1, further comprising a solids collection region positioned below the vortex generation zone and in fluid communication with the vortex generation zone.

17. The apparatus of claim 1, wherein the fluid inlet is positioned proximate to a region of the vortex generation zone having a greatest cross sectional area.

18. The apparatus of claim 1, further comprising a plurality of fluid inlets in fluid communication with the vortex generation zone.

19. The apparatus of claim 18, wherein the plurality of fluid inlets are approximately evenly spaced about a periphery of the vortex generation zone.

20. The apparatus of claim 19, wherein the plurality of fluid inlets are positioned proximate a region of the vortex generation zone having a greatest cross sectional area.

21. The apparatus of claim 18, further comprising a plurality of gas inlets in fluid communication with the vortex generation zone wherein the plurality of gas inlets and the plurality of fluid inlets are alternatingly and approximately evenly spaced about a perimeter of the vortex generation unit.

22. The apparatus of claim 1, further comprising one or more gas inlets in fluid communication with the vortex generation zone.

23. The apparatus of claim 22, wherein the one or more gas inlets are approximately evenly spaced about a perimeter of the vortex generation unit.

24. The apparatus of claim 22, wherein the one or more gas inlets are positioned proximate to a region of the vortex generation zone having a greatest cross sectional area.

25. The apparatus of claim 22, wherein the one or more gas inlets are positioned below a horizontal plane defined by the fluid inlet extending into the vortex generation zone.

26. The apparatus of claim 22, wherein the one or more gas inlets are positioned above a horizontal plane defined by the fluid inlet extending into the vortex generation zone.

27. An apparatus for separating a fluid mixture comprising:

a vessel;

a vortex generation zone having a tapered wall positioned within the vessel;

a separation zone in fluid communication with the vortex generation zone and positioned within the vessel and external to the vortex generation zone;

a gas inlet in fluid communication with the vortex generation zone; and

a fluid outlet in fluid communication with the separation zone.

28. The apparatus of claim 27, further comprising a second fluid outlet positioned below the fluid outlet.

29. The apparatus of claim 27, further comprising a plurality of gas inlets in fluid communication with the separation zone.

30. The apparatus of claim 29, wherein the plurality of gas inlets are spaced approximately evenly about a perimeter of the vessel.

31. The apparatus of claim 27, further comprising a plurality of gas inlets in fluid communication with the vortex generation zone.

32. The apparatus of claim 31, wherein the plurality of gas inlets are spaced approximately evenly about a perimeter of the vortex generation zone.

33. The apparatus of claim 32, wherein the plurality of gas inlets are positioned proximate to a region of the vortex generation zone having a greatest cross sectional area.

34. The apparatus of claim 29, further comprising a coalescing material positioned in the separation zone above at least one of the plurality of gas inlets.

35. The apparatus of claim 34, wherein the coalescing material substantially surrounds a periphery of the vortex generation zone.

36. The apparatus of claim 34, wherein the vortex generation zone is defined by a wall shaped as an inverted truncated cone.

37. The apparatus of claim 36, further comprising a fluid inlet in fluid communication with the vortex generation zone and located proximate a region of the vortex generation zone having a greatest cross sectional area.

38. The apparatus of claim 37, wherein the fluid outlet is positioned substantially above the vortex generation zone.

39. The apparatus of claim 38, further comprising a plurality of fluid inlets approximately evenly spaced about a perimeter of the vortex generation zone.

40. The apparatus of claim 39, wherein the plurality of fluid inlets are positioned proximate to a region of the vortex generation zone having a greatest cross sectional area.

41. The apparatus of claim 40, wherein at least one of the plurality of fluid inlets extends into the vortex generation zone at an angle having a component tangential to an internal wall of the vortex generation zone at a point on the internal wall proximate to the fluid inlet

42. The apparatus of claim 41, wherein the plurality of gas inlets and the plurality of fluid inlets are approximately evenly spaced about a perimeter of the vortex generation zone.

43. The apparatus of claim 42, further comprising a gas bubble generator in fluid communication with at least one of the plurality of gas inlets.

44. The apparatus of claim 43, wherein the gas bubble generator comprises a dissolved gas flotation pump.

45. The apparatus of claim 44, wherein at least one of the plurality of fluid inlets is positioned in the vortex generation zone and angled above a horizontal plane.

46. The apparatus of claim 45, wherein the fluid outlet comprises a head-in-head outlet.

47. The apparatus of claim 27, further comprising at least one additional fluid separation vessel.

48. The apparatus of claim 47, wherein the at least one additional fluid separation vessel is a hydrocyclone.

49. The apparatus of claim 27, further including a feedback sub-system configured and arranged to modulate a flow of gas from a gas bubble generator in fluid communication with the gas inlet in response to a level of a dissolved gas in the solution.

50. The apparatus of claim 27, further comprising a source of gas fluidly connected to a gas inlet of the gas bubble generator, the source of gas comprising at least one of methane, acetylene, and natural gas.

51. The apparatus of claim 50, further comprising a gas recovery sub-system in fluid communication with an interior region of the vessel

52. A method of separating a fluid mixture comprising:

providing a fluid mixture comprising a first component and a second component, the first component having a density different than a density of the second component;

introducing the fluid mixture into a vortex generation zone comprising a tapered wall positioned within a vessel;

inducing upward flow of the fluid mixture in the vortex generation zone;

imparting a confined rotational momentum to the first component and the second component in the vortex generation zone;

introducing gas into the fluid mixture in the vortex generation zone;

releasing the confined rotational momentum of the fluid mixture to form a first zone comprising the fluid mixture rich in the first component and a second zone comprising the fluid mixture rich in the second component; and

discharging at least a portion of the fluid mixture rich in the first component from a first fluid outlet of the vessel.

53. The method of claim 52, wherein the first component has a density greater than the second component.

54. The method of claim 53, wherein the first component comprises water and the second component comprises a hydrocarbon.

55. The method of claim 52, wherein introducing gas into the fluid mixture comprises introducing a fluid comprising dissolved gas into the fluid mixture.

56. The method of claim 55, wherein introducing a fluid comprising dissolved gas into the fluid mixture comprises introducing the fluid comprising dissolved gas at multiple points in the vortex generation zone.

57. The method of claim 52, wherein introducing the fluid mixture into the vortex generation zone comprises introducing the fluid mixture through at least one fluid inlet in a direction tangential to an internal wall of the vortex generation zone proximate the fluid inlet.

58. The method of claim 52, wherein introducing the fluid mixture into the vortex generation zone comprises introducing the fluid mixture through at least one fluid inlet at an upwardly angled direction.

59. The method of claim 52, further comprising sparging a coalescing material positioned in a separation zone external to the vortex generation zone with a gas.

60. The method of claim 52, further comprising reducing turbulence in a separation zone external to the vortex generation zone.

61. The method of claim 60, wherein reducing the turbulence in the separation zone comprises providing a coalescence packing in the separation zone external to the vortex generation zone.

62. The method of claim 52, further comprising increasing a velocity of a cyclonic flow of the fluid mixture in the vortex generation zone while inducing the fluid mixture to flow upward through the vortex generation zone.

63. The method of claim 52, wherein introducing the fluid mixture into the vortex generation zone comprises introducing the fluid mixture at multiple points in the vortex generation zone.

64. The method of claim 52, further comprising maintaining a level of fluid mixture in the vessel between a predetermined maximum and minimum level.

65. A method of separating a fluid mixture comprising:

providing a fluid mixture comprising a first component and a second component, the first component having a density different than a density of the second component;

introducing the fluid mixture into a vortex generation zone comprising a tapered wall positioned within a vessel;

inducing upward flow of the fluid mixture in the vortex generation zone;

imparting a confined rotational momentum to the first component and the second component in the vortex generation zone;

introducing gas into the fluid mixture in the vortex generation zone;

withdrawing at least a portion of the fluid mixture rich in the first component from a first fluid outlet of the vessel.

What is claimed is:

1. An apparatus for separating a fluid mixture comprising:

a vessel;

a vortex generation zone defined by a tapered wall positioned within the vessel; a fluid inlet extending into the vortex generation zone at an angle having a component tangential to an internal wall of the vortex generation zone at a point on the internal wall proximate to the fluid inlet;

a gas inlet extending into the vortex generation zone; and

a head-in-head fluid outlet defined by:

an upper wall internal to the vessel, the upper wall including a portion at a periphery thereof positioned proximate a side wall of the vessel and lower than an upper fluid outlet in the upper wall located proximate a central vertical axis of the vessel and above a central region of the vortex generation zone, and

an upper vessel fluid outlet defined in the side wall of the vessel above the upper wall.

2. The apparatus of claim 1, wherein the tapered wall comprises an angle to increase a rotational velocity of a fluid mixture flowing through the vortex generation zone.

3. The apparatus of claim 2, wherein the tapered wall comprises an angle ranging from greater than zero to about 14 degrees from a vertical axis.

4. The apparatus of claim 3, wherein the tapered wall comprises an angle ranging from about five to about ten degrees from the vertical axis.

5. The apparatus of claim 4, wherein the tapered wall comprises an angle of about nine degrees from the vertical axis.

6. The apparatus of claim 3, wherein the vortex generation zone is constructed and arranged to direct a fluid mixture upward.

7. The apparatus of claim 6, wherein the vortex generation zone is constructed and arranged to direct a gas upward.

8. The apparatus of claim 3, wherein the fluid inlet extends into the vortex generation zone at a second angle to induce an upward flow of a fluid mixture.

9. The apparatus of claim 8, wherein the second angle ranges from greater than zero to about ten degrees above a horizontal plane.

10. The apparatus of claim 9, wherein the second angle ranges from greater than zero to about five degrees above the horizontal plane.

11. The apparatus of claim 10, wherein the second angle is about one degree above the horizontal plane.

12. The apparatus of claim 1, further comprising a preliminary separator positioned between a source of fluid mixture and the fluid inlet.

13. The apparatus of claim 1, wherein the vortex generation zone is defined by a wall shaped as an inverted truncated cone.

14. The apparatus of claim 1, further comprising a solids collection region positioned below the vortex generation zone and in fluid communication with the vortex generation zone.

15. The apparatus of claim 1, wherein the fluid inlet is positioned proximate to a region of the vortex generation zone having a greatest cross sectional area.

16. The apparatus of claim 1, further comprising a plurality of fluid inlets in fluid communication with the vortex generation zone.

17. The apparatus of claim 16, wherein the plurality of fluid inlets are approximately evenly spaced about a periphery of the vortex generation zone.

18. The apparatus of claim 17, wherein the plurality of fluid inlets are positioned proximate a region of the vortex generation zone having a greatest cross sectional area.

19. The apparatus of claim 16, further comprising a plurality of gas inlets in fluid communication with the vortex generation zone wherein the plurality of gas inlets and the plurality of fluid inlets are alternatingly and approximately evenly spaced about a perimeter of the vortex generation unit.

20. The apparatus of claim 1, further comprising a plurality of gas inlets in fluid communication with the vortex generation zone.

21. The apparatus of claim 20, wherein the plurality of gas inlets are approximately evenly spaced about a perimeter of the vortex generation unit.

22. The apparatus of claim 20, wherein the plurality of gas inlets are positioned proximate to a region of the vortex generation zone having a greatest cross sectional area.

23. The apparatus of claim 20, wherein the plurality of gas inlets are positioned below a horizontal plane defined by the fluid inlet extending into the vortex generation zone.

24. The apparatus of claim 20, wherein the plurality of gas inlets are positioned above a horizontal plane defined by the fluid inlet extending into the vortex generation zone.

25. An apparatus for separating a fluid mixture comprising:

a vessel;

a vortex generation zone defined by a tapered wall positioned within the vessel;

a separation zone in fluid communication with the vortex generation zone and positioned within the vessel and external to the vortex generation zone;

a fluid inlet in fluid communication with the vortex generation zone;

a gas inlet extending into the vortex generation zone; and

a head-in-head fluid outlet defined by:

an upper wall internal to the vessel, the upper wall including a portion at a periphery thereof positioned proximate a side wall of the vessel and lower than a fluid outlet in the upper wall located proximate a central vertical axis of the vessel and above a central region of the vortex generation zone, and

an upper vessel fluid outlet defined in the side wall of the vessel above the upper wall.

26. The apparatus of claim 25, further comprising a second fluid outlet positioned below the fluid outlet.

27. The apparatus of claim 25, further comprising a plurality of gas inlets in the separation zone.

28. The apparatus of claim 27, wherein the plurality of gas inlets are spaced approximately evenly about a perimeter of the vessel.

29. The apparatus of claim 27, further comprising a coalescing material positioned in the separation zone above at least one of the plurality of gas inlets.

30. The apparatus of claim 29, wherein the coalescing material substantially surrounds a periphery of the vortex generation zone.

31. The apparatus of claim 29, wherein the vortex generation zone is defined by a wall shaped as an inverted truncated cone.

32. The apparatus of claim 31, further comprising a second fluid inlet in fluid communication with the vortex generation zone and located proximate a region of the vortex generation zone having a greatest cross sectional area.

33. The apparatus of claim 25, further comprising a plurality of gas inlets in the vortex generation zone.

34. The apparatus of claim 33, wherein the plurality of gas inlets are spaced approximately evenly about a perimeter of the vortex generation zone.

35. The apparatus of claim 34, wherein the plurality of gas inlets are positioned proximate to a region of the vortex generation zone having a greatest cross sectional area.

36. The apparatus of claim 25, further comprising a plurality of fluid inlets approximately evenly spaced about a perimeter of the vortex generation zone.

37. The apparatus of claim 36, wherein the plurality of fluid inlets are positioned proximate to a region of the vortex generation zone having a greatest cross sectional area.

38. The apparatus of claim 37, wherein at least one of the plurality of fluid inlets extends into the vortex generation zone at an angle having a component tangential to an internal wall of the vortex generation zone at a point on the internal wall proximate to the fluid inlet.

39. The apparatus of claim 38, wherein the plurality of gas inlets and the plurality of fluid inlets are approximately evenly spaced about a perimeter of the vortex generation zone.

40. The apparatus of claim 25, further comprising a gas bubble generator in fluid communication with the gas inlet.

41. The apparatus of claim 40, wherein the gas bubble generator comprises a dissolved gas flotation pump.

42. The apparatus of claim 41, wherein at least one of the plurality of fluid inlets is positioned in the vortex generation zone and angled above a horizontal plane.

43. The apparatus of claim 25, further comprising at least one additional fluid separation vessel.

44. The apparatus of claim 43, wherein the at least one additional fluid separation vessel is a hydrocyclone.

45. The apparatus of claim 25, further including a feedback sub-system configured and arranged to modulate a flow of gas from a gas bubble generator in fluid communication with the gas inlet in response to a level of a dissolved gas in the solution.

46. The apparatus of claim 25, further comprising a source of gas fluidly connected to a gas inlet of the gas bubble generator, the source of gas comprising at least one of methane, acetylene, and natural gas.

47. The apparatus of claim 46, further comprising a gas recovery sub-system in fluid communication with an interior region of the vessel.

48. A method of separating a fluid mixture comprising:

providing a fluid mixture comprising a first component and a second component, the first component having a density different than a density of the second component;

introducing the fluid mixture into a vortex generation zone defined by a frustoconical tapered wall having a cross sectional diameter at base thereof which is larger than a cross sectional area at an upper end thereof positioned within a vessel;

inducing upward flow of the fluid mixture in the vortex generation zone;

imparting a confined rotational momentum to the first component and the second component in the vortex generation zone;

introducing gas into the fluid mixture in the vortex generation zone; and

withdrawing at least a portion of the fluid mixture rich in the first component from a head-in-head fluid outlet defined by:

an upper wall internal to the vessel, the upper wall including a portion at a periphery thereof positioned proximate a side wall of the vessel and lower than an upper fluid outlet in the upper wall located proximate a central vertical axis of the vessel and above a central region of the vortex generation zone, and

an upper vessel fluid outlet defined in the side wall of the vessel above the upper wall.