into a spiral passage 212 extending between the fluid inlet 122 at the side wall 120 and the fluid outlet 114 at a radially inward position. Therefore, the length of the passage 212, i.e., the shortest distance of travel through the passage 212 from one end near the fluid inlet 122 to the other end near the fluid outlet 114, is much longer than the direct radial distance the inlet 122 and the outlet 114.

In this embodiment, the spiral walls of baffle 124 are equally spaced along the fluid path such that the spiral passage 212 formed by the baffle 124 is generally of the same width throughout the entire passage. The height of the baffle is determined by the cross-sectional area of the passage 212 within the baffle 124, and is related to the distance between two neighboring spiral walls, i.e., the width of the spiral passage. Generally, a larger height of the baffle is required if the width of the spiral passage is narrower to achieve the cross-sectional area corresponding to the designed flow velocity. For example, in one embodiment, the width of the spiral passage is about 6 inches, and the height of the baffle is about 18 inches.

Referring again to Fig. 2, the particulate drop out section 110 is enclosed by a conical-shaped, inclined side wall 126 coupled to the fluid separation section 108 thereabove at its top opening 128, and narrowing down to the bottom opening 130 that is coupled to the particulate collection structure 104. The slope of the side wall 126, characterized by the inclination angle β between the wall 126 and a horizontal plane, is about or larger than the angle of repose of a bank of wet particulates, to facilitate particulates and liquid to migrate towards the bottom of the vessel 102 and enter the particulate collection structure 104.

In this embodiment, the particulate collection structure 104 comprises a sand accumulation chamber 134 sandwiched between an inlet valve

near the fluid outlet 414, is much longer than the direct distance between the fluid inlet 422 and the fluid outlet 414.

The baffle 424 is fixed to the side wall 420 of the vessel 402 by supporting bars. As shown in Fig. 8C, the top of the baffle 424 is fastened, e.g., welded, to a pair of parallel supporting bars 604, which are in turned fastened to the side wall 420 of the vessel 402. The distance between the supporting bars 604 is sufficient for the shroud 419 to pass through. Also shown in Fig. 8C, the top of the shroud 419 is fastened to the fluid outlet 414 via a set of supporting bars 602.

As shown in Fig. 8D, the bottom of the baffle 424 and the bottom of the shroud 419 are flush and are fastened to a pair of crossbars 606, which are in turned fastened to the side wall 420 of the vessel 402.

Referring again to Fig. 8A, the particulate drop out section 410 is enclosed by a conical-shaped side wall 426 coupled to the fluid separation section 408 thereabove, and narrowing down to a bottom opening, forming a particular outlet 430. In this embodiment, the particulate outlet 430 is a normally closed valve that may be open to drain accumulated particulate out of the vessel 402 during periodic maintenance. In this embodiment, the particulate drop out section 410 also comprises a normally closed inspection window 431 that may be opened for vessel inspection.

Turning to Fig. 9, the operation of the desanding device 400 is now described. For the ease of illustration, details of the spiral portion of the baffle 424 are not shown.

In operation, a fluid stream F is injected into the vessel 402 from the wellhead through the fluid inlet 422, and enters the internal baffle 124. The fluid

In an example, the vessel 402 has a two (2) foot inner diameter with a fluid separation section 408 of a length of six (6) feet. The fluid inlet 422 has a diameter of 11 and 1/2 inches at the coupling end 502.The fluid outlet 414 has a diameter of 3 and 1/2 inches, and the shroud 419 has a diameter of 8 and 5/8 inches. The top of the shroud 419 is about two (2) to three (3) inches above the intake opening 418 of the fluid outlet 414, and the bottom of the shroud 419 is flush with the bottom of the baffle 424. The baffle 424 has about five (5) spiral revolutions. This example of the desanding device is designed to process a multiple-phase fluid stream F at a rate of 450 m^3/day. The vessel is capable of operating under a pressure up to 6000 psig (pounds per square inch gauge).

In another example, the vessel 402 has a four (4) foot inner diameter with a fluid separation section 408 of a length of 12 feet, with a shroud 419 of a length about 2/3 of that of the baffle 424. The baffle 424 has about 10 spiral revolutions. This example of the desanding device is designed to process a multiple-phase fluid stream F at a rate of 2225 m^3/day.

Those skilled in the art appreciate that the vessel 102 or 402 may be made of any suitable dimensions based on design requirements and known physical theories. For example, the dimensions of the vessel may be chosen to meet the requirement of desanding capability. The dimensions of the fluid inlet and the fluid outlet may be chosen to ensure that the flow rate of the fluid inlet would not exceed the maximum flow rate of the fluid outlet such that, under designed use, the liquid level would not grow above the freeboard interface of the vessel.

In above embodiment, the shroud is an elongated cylindrical conduit. In some other embodiments, the shroud may have other suitable shapes

CLAIMS

1. A vessel for removing at least particulates from a multiple-phase fluid stream containing at least gas and entrained particulates, the vessel comprising:

a fluid inlet for discharging said fluid stream generally horizontally into the vessel;

an outlet conduit comprising an intake opening at the bottom of the outlet conduit in the vessel for receiving a particulate-free, desanded gas stream and a discharge end at the top of the outlet conduit which extends out of the top of the vessel to discharge the desanded gas stream from the vessel; and

an internal, generally upright spiral plate baffle located below the top of the vessel for receiving the fluid stream from the fluid inlet and directing the fluid stream generally horizontally along an elongated flow path from the fluid inlet to the intake opening of the outlet conduit, the length of said flow path being longer than the direct distance between the fluid inlet and the intake opening of the outlet conduit, the baffle having an open top along the elongated flow path at an elevation above the fluid inlet, and an open bottom at an elevation below the fluid inlet wherein the at least particulates fall through the open bottom; wherein

the intake opening of the outlet conduit being within a central portion the baffle at an elevation below the open top of the baffle wherein the intake opening of the outlet conduit determines a horizontally extending freeboard interface, said freeboard interface separating a freeboard portion formed adjacent an upper portion of the vessel above the interface for collecting the desanded gas stream and an accumulator portion therebelow.

2. The vessel of claim 1 wherein the cross-sectional shape of the baffle is selected from the group consisting of an Archimedean spiral, a Cornu spiral, a Fermat's spiral, a hyperbolic spiral, a lituus, a logarithmic spiral, and a spiral of Theodorus.

3. The vessel of any one of claims 1 or 2 wherein the fluid inlet is oriented generally horizontally for directing the fluid stream along the baffle.

4. The vessel of any one of claims 1 to 3 wherein the vessel comprises a cylindrical side wall, and the fluid inlet is oriented for directing the fluid stream at a direction tangential to the side wall.

5. The vessel of any one of claims 1 to 4 wherein the fluid inlet directs the fluid stream away from a side wall of the vessel.

6. The vessel of any one of claims 1 to 5 wherein the fluid inlet is at an elevation above the intake opening of the fluid outlet.

7. The vessel of any one of claims 1 to 5 wherein the fluid inlet is at an elevation below the intake opening of the fluid outlet.

8. The vessel of any one of claims 1 to 7 further comprising:

a drain at a lower portion of the vessel for removal of particulates from the vessel.

9. The vessel of claim 8 wherein the lower portion of the vessel comprises at least one inclined side wall for facilitating flow entrained particulates to migrate towards the drain.

10. The vessel of claim 9 wherein the slope of the at least one inclined side wall is about or greater than the angle of repose of a bank of wet particulates.

11. The vessel of any one of claims 9 to 10 wherein the drain further comprises:

an inlet valve adjacent and fluidly connected to the drain;

a particulate accumulation chamber; and

a discharge valve, wherein

the particulate accumulation chamber is sandwiched between the inlet valve and the discharge valve.

12. The vessel of any one of claims 1 to 11 wherein the multiple-phase fluid stream further comprises liquid, and wherein entrained liquids and particulates fall through the open bottom of the baffle.

13. The vessel of any one of claims 1 to 12 wherein the horizontally extending freeboard interface is an interface between the gas and the liquid.

14. The vessel of any one of claims 1 to 13 wherein the intake opening of the fluid outlet determines a horizontally extending freeboard interface, said freeboard interface separating a freeboard portion formed adjacent an upper portion of the vessel above the interface and an accumulator portion therebelow, the freeboard portion forming a freeboard cross-sectional area for establishing a freeboard velocity of the fluid stream therein being less than a fluid stream velocity at the fluid inlet.

15. The vessel of any one of claims 1 to 14 wherein the vessel comprises a cylindrical side wall and a flat head.

16. The vessel of any one of claims 1 to 14 wherein the vessel comprises a cylindrical side wall and a hemispherical head.

17. The vessel of any one of claims 1 to 14 wherein the vessel comprises a cylindrical side wall and a semi-elliptical head.

18. The vessel of any one of claims 1 to 17 further comprising:

an elongated conduit having an upper opening and a lower opening;

wherein at least a portion of the elongated conduit is within the baffle;

wherein the intake opening of the fluid outlet is in the elongated conduit at an elevation below the upper opening of the conduit.

19. The vessel of claim 18 wherein the elongated conduit comprises a top wall, said top wall comprising an opening sealably receiving the

fluid outlet, and wherein the elongated conduit further comprises one or more openings proximate the top wall thereof, forming the upper opening thereof.

20. The vessel of any one of claims 18 or 19 wherein the upper opening of the elongated conduit is at an elevation above the top of the baffle.

21. The vessel of any one of claims 18 or 19 wherein the upper opening of the elongated conduit is at an elevation below the top of the baffle.

22. The vessel of any one of claims 18 to 21 wherein the lower opening of the elongated conduit is at an elevation about the same as the bottom of the baffle.

23. The vessel of any one of claims 18 to 21 wherein the lower opening of the elongated conduit is at an elevation above the bottom of the baffle.

24. A method of removing at least particulates from a multiple-phase fluid stream containing at least gas and entrained particulates, the method comprising:

injecting said fluid stream along a generally horizontal fluid injection direction into an internal, generally upright spiral baffle within the vessel via a fluid inlet;

directing said fluid stream along an elongated flow path of the baffle from the fluid inlet to an intake opening of a fluid outlet, the intake opening being within a central portion of the baffle, the length of said elongated flow path being

longer than a direct distance between the fluid inlet and the intake opening of the outlet conduit,

forming a horizontally extending freeboard interface at an elevation of the intake opening of the fluid outlet and located at an elevation below an open top of the baffle, said freeboard interface separating a freeboard portion formed adjacent an upper portion of the vessel above the interface and an accumulator portion therebelow;

allowing the entrained particulates fall out of the fluid stream, through an open bottom of the baffle to move into the accumulator portion below;

collecting desanded gas in the freeboard portion from along the open top of the baffle; and

receiving the desanded gas at the intake opening of the fluid outlet for discharge from the vessel.

25. The method of claim 24 wherein the multiple-phase fluid stream further comprises entrained liquid, and wherein during said directing said fluid stream along an elongated flow path in the vessel, the entrained liquid falls from the freeboard portion into the accumulator portion.

26. The method of claim 24 or 25 further comprising removing particulates accumulated in the accumulator portion.

27. The method of claim 24 or 25 further comprising periodically removing particulates accumulated in the accumulator portion.

28. A vessel for removing at least particulates from a multiple-phase fluid stream containing at least gas and entrained particulates, the vessel comprising:

a fluid inlet for receiving said fluid stream and manipulating the fluid along a generally horizontal fluid injection direction into the vessel;

a fluid outlet spaced laterally from the fluid inlet, said fluid outlet comprising an intake opening in the vessel and a discharge opening outside the vessel;

an internal baffle having an open top and an open bottom, said open top of the internal baffle receiving the intake opening of the fluid outlet, said internal baffle forming an elongated flow path generally about a vertical axis for receiving the fluid stream from the fluid inlet and directing the fluid stream therethrough to the fluid outlet, a length of the elongated flow path from the fluid inlet to fluid outlet being longer than the distance between the fluid inlet and the fluid outlet; and

an elongated conduit having an upper opening and a lower opening, at least a portion of the elongated conduit being within the internal baffle, and the intake opening of the fluid outlet being in the elongated conduit at an elevation below the upper opening of the conduit; wherein

the area of the cross section of the vessel at a location proximate to the fluid inlet is larger than that of the cross section of the fluid inlet;

the length of the elongated flow path, the cross section of the vessel and the velocity of the multiple-phase fluid stream are such that the entrained particulates fall out of the fluid stream and collect in a lower portion of the vessel; and

wherein a desanded gas stream flows out of an upper portion of the vessel through the fluid outlet and is free of a substantial portion of the particulates.

29. The vessel of claim 28 wherein the internal baffle is a generally upright spiral plate and the elongated flow path is a spiral flow path along the spiral plate.

30. The vessel of claim 28 or 29 wherein the lower opening of the elongated conduit is at an elevation about the same as the bottom of the internal baffle.

31. The vessel of claim 28 or 29 wherein the lower opening of the elongated conduit is at an elevation above the bottom of the internal baffle.

32. The vessel of any one of claims 28 to 31 wherein the intake opening of the fluid outlet has an area lager than that of other portion of the fluid outlet.

33. The vessel of any one of claims 28 to 32 wherein the fluid inlet is on the vessel at an elevation higher than the intake opening of the fluid outlet.

34. The vessel of any one of claims 28 to 33 wherein the fluid inlet is oriented for directing the fluid stream along the internal baffle.

35. The vessel of any one of claims 28 to 34 wherein the vessel comprises a cylindrical side wall, and the fluid inlet directs the fluid stream at a direction tangential to the side wall.

36. The vessel of any one of claims 28 to 35 further comprising:

a particulate outlet at the lower portion of the vessel for removing particulates from the vessel.

37. The vessel of any one of claims 28 to 36 wherein the intake opening of the fluid outlet defining a horizontally extending freeboard interface separating a freeboard portion formed adjacent an upper portion of the vessel above the interface and a accumulator portion therebelow, the freeboard portion forming a freeboard cross-sectional area for a freeboard velocity of the fluid stream less than a fluid stream velocity at the fluid inlet.

38. The vessel of any one of claims 28 to 37 wherein a lowermost portion of the vessel comprises a conical side wall tapering to a bottom having a cross section smaller than that of other portion of the vessel.

39. The vessel of claim 38 wherein the slope of the conical wall is about or greater than the angle of repose of a bank of wet particulates.