to begin to shatter due to turbulent effects of the stream. For this reason, application of cyclonic coalescers at practical scales outside of the lab environment has been challenged.

[0010] The incentives for deep-water subsea separation are well known, as are the challenges. Known techniques fail to meet these challenges. Existing techniques may enable separation of oil/water streams where emulsions are not likely, or where the watercut is low or high, and thus outside of the inversion range of the mixture. However many fields produce oil/water mixtures with emulsion tendencies which stabilize to a higher degree at watercuts near the inversion range. Due to the limited separation time in deepwater subsea separation and existing limitations of compact equipment, it is challenging to achieve separation of oil/water throughout the entire production life of the aforementioned fields without significantly reducing production rates during the inversion range, or accepting a lower quality oil/water separation from the subsea separation system as is normally achieved outside of the inversion range. Thus, there is a need for improvement in this field.

SUMMARY OF THE INVENTION

[0011] The present invention provides a system and method for treating a multiphase stream.

[0012] One embodiment of the present disclosure is a cyclonic coalescer for enhancing separation of a denser phase liquid from a lighter phase liquid within a multiphase stream, the coalescer comprising: a tubular housing; a plurality of coaxial flow chambers extending in the axial direction of the housing; and a swirling element associated with each of the plurality of coaxial flow chambers, the swirling elements are constructed and arranged to impart a tangential velocity of the stream flowing through the associated flow chamber.

[0013] The foregoing has broadly outlined the features of one embodiment of the present disclosure in order that the detailed description that follows may be better understood. Additional features and embodiments will also be described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The present invention and its advantages will be better understood by referring to the following detailed description and the attached drawings.

[0015] Figure 1 is a schematic drawing of a separation system according to one embodiment of the present disclosure.

CLAIMS

What is claimed is:

1. A cyclonic coalescer for enhancing separation of a denser phase liquid from a lighter phase liquid within a multiphase stream, the coalescer comprising:

a tubular housing;

a plurality of coaxial flow chambers extending in the axial direction of the housing; and

a swirling element associated with each of the plurality of coaxial flow chambers, the swirling elements are constructed and arranged to impart a tangential velocity of the stream flowing through the associated flow chamber.

2. The coalescer of claim 1, wherein the housing has a first length and the swirl elements extend a second length within the housing.

3. The coalescer of claim 2, wherein the first length is greater than the second length.

4. The coalescer of claim 2, wherein the first length is equal to the second length.

5. The coalescer of any of claims 1 to 4, wherein the swirling element is a vane.

6. The coalescer of claim 5, wherein the vane is fixed at an angle between 40° and 50° with respect to the axial direction of the associated flow chamber.

7. The coalescer of any of claims 1 to 6 further comprising an anti-swirl element associated with each of the plurality of coaxial flow chambers.

8. The coalescer of claim 7, wherein the anti-swirl elements are positioned downstream of the swirling elements.

9. The coalescer of claim 1, wherein the housing has an internal diameter of 16 inches.

10. A system for treating a multiphase fluid stream comprising:

an electrostatic coalescer; and

a cyclonic coalesce as claimed in any of claims 1 to 9.

11. The system of claim 10, wherein the cyclonic coalescer is downstream of the electrostatic coalescer.

12. The system of claim 10 or claim 11 further comprising a gravity separation vessel in fluid communication with the cyclonic coalescer, the gravity separation vessel is downstream of the cyclonic coalescer.

13. A method for treating a multiphase fluid stream to enhance separation of a denser phase liquid from a lighter phase liquid within the multiphase fluid stream, the method comprising:

flowing the stream into a plurality of coaxially extending flow chambers;

imparting a tangential velocity component on the stream flowing through each flow chamber, the tangential velocity is imparted using a swirl element; and

controlling the tangential velocity imparted on the stream to increase an average denser phase droplet size.

14. The method of claim 13, wherein controlling the tangential velocity comprises limiting the total velocity of the flow stream flowing into the flow chambers.

15. The method of claim 13 or claim 14, wherein the total velocity of the flow stream flowing into the flow chambers is less than 3 m/s.

16. The method of any of claims 13 to 15, wherein the swirl element is a vane, wherein controlling the tangential velocity comprises selecting a vane angle with respect to the axial direction of the flow chambers.

17. The method of claim 16, wherein the vane angle is between 40° and 50°.

18. The method of any of claims 13 to 17, wherein the denser phase liquid has a cut diameter of 1000-1350 microns after the tangential velocity has been imparted on the stream.

19. The method of any of claims 13 to 18, wherein the tangential velocity imparted on the stream causes an average lighter phase droplet size to increase.

20. A method of producing hydrocarbons from a subsurface reservoir, comprising:

producing hydrocarbons through a wellbore, the produced hydrocarbons exist in a liquid-dominated-by-volume multiphase stream having a denser phase liquid and a lighter phase liquid;

flowing the stream into a plurality of longitudinally extending flow chambers;

imparting a tangential velocity component on the stream flowing through each flow chamber, the tangential velocity is imparted using a swirl element; and

controlling the tangential velocity imparted on the stream to increase an average denser phase droplet size.

to begin to shatter due to turbulent effects of the stream. For this reason, application of cyclonic coalescers at practical scales outside of the lab environment has been challenged.

[0010] The incentives for deep-water subsea separation are well known, as are the challenges. Known techniques fail to meet these challenges. Existing techniques may enable separation of oil/water streams where emulsions are not likely, or where the watercut is low or high, and thus outside of the inversion range of the mixture. However many fields produce oil/water mixtures with emulsion tendencies which stabilize to a higher degree at watercuts near the inversion range. Due to the limited separation time in deepwater subsea separation and existing limitations of compact equipment, it is challenging to achieve separation of oil/water throughout the entire production life of the aforementioned fields without significantly reducing production rates during the inversion range, or accepting a lower quality oil/water separation from the subsea separation system as is normally achieved outside of the inversion range. Thus, there is a need for improvement in this field.

SUMMARY OF THE INVENTION

[0011] The present invention provides a system and method for treating a multiphase stream.

[0012] One embodiment of the present disclosure is a cyclonic coalescer for enhancing separation of a denser phase liquid from a lighter phase liquid within a multiphase stream, the coalescer including: a tubular housing; a plurality of coaxial flow chambers extending in the axial direction of the housing; and a swirling element associated with each of the plurality of coaxial flow chambers, the swirling elements are constructed and arranged to impart a tangential velocity of the stream flowing through the associated flow chamber.

[0013] The foregoing has broadly outlined the features of one embodiment of the present disclosure in order that the detailed description that follows may be better understood. Additional features and embodiments will also be described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The present invention and its advantages will be better understood by referring to the following detailed description and the attached drawings.

[0015] Figure 1 is a schematic drawing of a separation system according to one embodiment of the present disclosure.

CLAIMS

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5. The coalescer of any one of claims 1 to 4, wherein the swirling element is a vane.

6. The coalescer of claim 5, wherein the vane is fixed at an angle between 40° and 50° with respect to the axial direction of the associated flow chamber.

7. The coalescer of any one of claims 1 to 6 further including an anti-swirl element associated with each of the plurality of coaxial flow chambers.

8. The coalescer of claim 7, wherein the anti-swirl elements are positioned downstream of the swirling elements.

9. The coalescer of any one of the preceding claims, wherein the housing has an internal diameter of 16 inches.

10. A system for treating a multiphase fluid stream including:

an electrostatic coalescer; and

a cyclonic coalescer as claimed in any one of claims 1 to 9.

11. The system of claim 10, wherein the cyclonic coalescer is downstream of the electrostatic coalescer.

12. The system of claim 10 or claim 11 further including a gravity separation vessel in fluid communication with the cyclonic coalescer, the gravity separation vessel is downstream of the cyclonic coalescer.

13. A method for treating a multiphase fluid stream to enhance separation of a denser phase liquid from a lighter phase liquid within the multiphase fluid stream, the method including:

flowing the stream into a plurality of coaxially extending flow chambers;

imparting a tangential velocity component on the stream flowing through each flow chamber, the tangential velocity is imparted using a swirl element; and controlling the tangential velocity imparted on the stream to increase an average denser phase droplet size.

14. The method of claim 13, wherein controlling the tangential velocity includes limiting the total velocity of the flow stream flowing into the flow chambers.

15. The method of claim 13 or claim 14, wherein the total velocity of the flow stream flowing into the flow chambers is less than 3 m/s.

16. The method of any one of claims 13 to 15, wherein the swirl element is a vane, wherein controlling the tangential velocity includes selecting a vane angle with respect to the axial direction of the flow chambers.

17. The method of claim 16, wherein the vane angle is between 40° and 50°.

18. The method of any one of claims 13 to 17, wherein the denser phase liquid has a cut diameter of 1000-1350 microns after the tangential velocity has been imparted on the stream.

19. The method of any one of claims 13 to 18, wherein the tangential velocity imparted on the stream causes an average lighter phase droplet size to increase.

20. A method of producing hydrocarbons from a subsurface reservoir, including:

producing hydrocarbons through a wellbore, the produced hydrocarbons exist in a liquid-dominated-by-volume multiphase stream having a denser phase liquid and a lighter phase liquid;

flowing the stream into a plurality of longitudinally extending flow chambers;

imparting a tangential velocity component on the stream flowing through each flow chamber, the tangential velocity is imparted using a swirl element; and

controlling the tangential velocity imparted on the stream to increase an average denser phase droplet size.