METHOD AND DEVICE FOR SEPARATING A LIGHTER DENSITY FLUID FROM A HEAVIER DENSITY FLUID

PRIORITY CLAIM

The present application claims the benefit of U.S. Provisional Application No. 62/733,493, entitled "Method and Device for Removing Bubbles from Liquid," filed September 19, 2018, and U.S. Provisional Application No. 62/873,748, entitled "Method and Device for Separating a Lighter Density Fluid from a Heavier Density Fluid," filed July 12, 2019, both of which are herein incorporated by reference in their entireties.

TECHNICAL FIELD

The present invention relates to separation and removal of a lighter density fluid, such as gas or oil, from a heaver density fluid, and more particularly, to a system which utilizes an impeller and/or a movable extraction pipe to separate and remove a lighter density fluid from a heavier density fluid.

SUMMARY

According to a first aspect of the present disclosure, there is provided a fluid separation apparatus for removing lighter density fluid from a liquid, the fluid separation apparatus including: an annular inlet chamber formed about a central axis and having an inlet in an outer wall of the annular inlet chamber; a first fluid chamber coaxial with the inlet chamber and extending between a first end and a second end, the first fluid chamber having a hollow conical shape with a diameter that reduces between the first end and the second end; a fixed impeller disposed between the annular inlet chamber and the first fluid chamber adjacent the first end of the first fluid chamber, wherein the fixed impeller comprises an outer impeller blade section in fluid communication with the annular inlet chamber adjacent the outer wall of the annular inlet chamber and an inner impeller blade section in fluid communication with the first fluid chamber adjacent a central axis of the first fluid chamber; and an extraction pipe extending within the first fluid chamber from adjacent the first end of the first fluid chamber.

According to a second aspect of the present disclosure, there is provided a fluid separation apparatus for removing lighter density fluid from a liquid, the fluid separation apparatus including: an annular inlet chamber formed about a central axis and having an inlet in an outer wall of the inlet chamber; a first fluid chamber coaxial with the inlet chamber and extending between a first end and a second end, with the first end of the first fluid chamber adjacent the annular inlet chamber, the first fluid chamber having a hollow conical shape with a diameter that reduces between the first end and the second end of the first fluid chamber; an impeller disposed between the inlet chamber and the first fluid chamber adjacent the first end of the first fluid chamber, wherein the impeller comprises a fixed upper shroud, a fixed lower shroud and a plurality of inwardly spiraling impeller blades enclosed by the shrouds and forming a flow path through the impeller, the flow path extending from an inlet at an outer diameter of the upper outer shroud to an outlet at an inner diameter of the lower outer shroud; and an extraction pipe extending within the first fluid chamber adjacent the axis in the first fluid chamber.

According to a third aspect of the present disclosure, there is provided a fluid separation method for removing lighter density fluid from a liquid, the fluid separation method including: introducing a fluid into an annular chamber; circulating the fluid along an inner wall of the annular chamber having a first diameter; directing the fluid circulating at the first diameter into an impeller inlet adjacent the first diameter; utilizing fixed blades of the impeller to direct the circulating fluid from the first diameter to a second diameter smaller than the first diameter; releasing the circulating fluid at the smaller diameter into an elongated and conical shaped chamber with a trapezoidal cross-section in a longitudinal direction adjacent a central axis of the chamber; forming an envelope of lighter density fluid around the central axis of the elongated and conical shaped chamber; and positioning a second end which is open of an extraction pipe within the envelope to remove lighter density fluid from the elongated and conical shaped chamber.

According to a fourth aspect of the present disclosure, there is provided a fluid liquid processing apparatus including: a first liquid storage vessel having an outlet; a second liquid storage vessel having an inlet; a first fluid separation apparatus comprising an annular inlet chamber formed about a central axis and having an inlet in an outer wall of the inlet chamber, the inlet in fluid

communication with the outlet of the first liquid storage vessel; a first fluid chamber coaxial with the inlet chamber and extending between a first end adjacent the annular inlet chamber and a second end, the first fluid chamber having a hollow conical shape with a diameter that reduces between the first end and the second end, the inlet of the second liquid storage vessel in fluid communication with the second end of the first fluid chamber; an impeller disposed between the inlet chamber and the first fluid chamber adjacent the first end of the first fluid chamber, wherein the fixed impeller comprises fixed impeller blades are enclosed between a fixed upper outer shroud and a fixed lower outer shroud to form a flow path through the impeller, the flow path extending from an inlet at an outer diameter of the upper outer shroud and in fluid communication with the annular inlet chamber adjacent the outer wall of the annular inlet chamber to an outlet at an inner diameter of the lower outer shroud and in fluid communication with the first fluid chamber adjacent a central axis of the first fluid chamber; and an extraction pipe extending within the first fluid chamber adjacent the axis in the first fluid chamber.

BRIEF DESCRIPTION OF DRAWINGS

Various embodiments of the present disclosure will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the disclosure. In the drawings, like reference numbers may indicate identical or functionally similar elements.

FIG. 1 is a view showing a fluid system into which a fluid separation apparatus for separation and removal of lighter density fluid from a heavier density fluid.

FIG. 2A is a cross-sectional side view showing an embodiment of a fluid separation apparatus such as shown in FIG. 1.

FIG. 2B is a cross-sectional side view showing another embodiment of a fluid separation apparatus.

FIGS. 3A and 3B are cross-sectional top views of embodiments of a fluid separation apparatus shown in FIG. 1.