SUMMARY

[0010] The present disclosure provides a subwater heat exchanger, among other things.

[0011] According to one embodiment, there is provided a subwater heat exchanger comprising:

a duct configured to receive a first fluid;

first coils inside of the duct, the first coils configured to receive a second fluid that is heated or cooled by the first fluid;

a first impeller inside of the duct that is configured to initiate flow of the first fluid around the first coils; and

a second impeller inside of the duct and substantially in line with the first impeller along a duct lateral axis of the duct wherein the duct includes:

a first duct portion configured to receive the first fluid;

a second duct portion configured to receive the first fluid; and

a third duct portion extending from the first duct portion to the second duct portion and having a center width that is smaller than a first duct portion width of the first duct portion and a second duct portion width of the second duct portion in a direction that is substantially perpendicular to the duct lateral axis, wherein the first coils are inside of the third duct portion; and

wherein the first impeller is inside of at least one of the first duct portion and the third duct portion, and

wherein the second impeller is inside of at least one of the second duct portion and the third duct portion.

[0012] 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

[0013] These and other features, aspects and advantages of the disclosed embodiments will become apparent from the following description, appending claims and the accompanying exemplary embodiments shown in the drawings, which are briefly described below.

[0014] Figure 1 is a partial schematic of a subwater heat exchanger.

[0015] Figure 2 is a partial schematic of the subwater heat exchanger of Figure 1.

[0016] Figure 3 is a partial schematic of a subwater heat exchanger.

[0017] Figure 4 is a chart comparing total heat transfer for a subwater heat exchangers according to embodiments of this disclosure that have an enhanced subwater velocity to conventional subwater heat exchangers having a conventional subwater velocity.

[0018] Figure 5a shows heat transfer properties for a conventional subwater heat exchanger.

[0019] Figure 5b shows heat transfer properties for a subwater heat exchanger according to one of the embodiments of this disclosure.

[0020] Figure 5c shows heat transfer properties for a subwater heat exchanger according to one of the embodiments of this disclosure.

CLAIMS

1. A subwater heat exchanger comprising:

a duct configured to receive a first fluid;

first coils inside of the duct, the first coils configured to receive a second fluid that is heated or cooled by the first fluid;

a first impeller inside of the duct that is configured to initiate flow of the first fluid around the first coils; and

a second impeller inside of the duct and substantially in line with the first impeller along a duct lateral axis of the duct wherein the duct includes:

a first duct portion configured to receive the first fluid;

a second duct portion configured to receive the first fluid; and

a third duct portion extending from the first duct portion to the second duct portion and having a center width that is smaller than a first duct portion width of the first duct portion and a second duct portion width of the second duct portion in a direction that is substantially perpendicular to the duct lateral axis, wherein the first coils are inside of the third duct portion; and

wherein the first impeller is inside of at least one of the first duct portion and the third duct portion, and

wherein the second impeller is inside of at least one of the second duct portion and the third duct portion.

2. The subwater heat exchanger of claim 1, wherein the duct further includes:

a first duct end and a second duct end that are permeable to the first fluid, the first duct end being at an end of the first duct portion and the second duct end being at an end of the second duct portion; and

a third duct end, a fourth duct end, a fifth duct end and a sixth duct end that form an enclosure around the first duct end and the second duct end.

3. The subwater heat exchanger of claim 2,

wherein a first duct end longitudinal axis of the first duct end is substantially parallel to a second duct end longitudinal axis of the second duct end, and

wherein the first and second duct end longitudinal axes are substantially perpendicular to third, fourth, fifth and sixth duct end longitudinal axes of the third, fourth, fifth and sixth duct ends.

4. The subwater heat exchanger of claim 2 or claim 3, wherein at least one of the third, fourth, fifth and sixth duct ends includes an opening that receives the first fluid.

5. The subwater heat exchanger of any one of claims 2 to 4, wherein at least of the third, fourth, fifth and sixth duct ends includes multiple openings that receive the first fluid.

6. The subwater heat exchanger of any one of the preceding claims, further comprising second coils inside of the duct that are separate from the first coils.

7. The subwater heat exchanger of claim 6, wherein the second coils are configured to receive a third fluid that is one of a same fluid and a different fluid from the second fluid.

8. The subwater heat exchanger of any one of the preceding claims, wherein the first fluid comprises water.

9. The subwater heat exchanger of any one of the preceding claims, wherein the second fluid and the third fluid comprise process fluid.

10. The subwater heat exchanger of any one of the preceding claims, further comprising a shaft that connects the first impeller to the second impeller.

11. The subwater heat exchanger of any one of the preceding claims, further comprising a third impeller inside the duct and between the first impeller and the second impeller.

12. The subwater heat exchanger of claim 11, wherein the shaft connects the third impeller to the first impeller and the second impeller.

13. The subwater heat exchanger of claim 11 or claim 12, wherein the third impeller comprises a plurality of third impellers.

14. The subwater heat exchanger of any one of claims 11 to 13, wherein the third impeller is at least one of within and between the first coils.

15. The subwater heat exchanger of any one of the preceding claims, further comprising a driver that drives at least one of the first impeller and the second impeller, wherein the driver directly connects to the first impeller.

16. The subwater heat exchanger of claim 15, wherein the driver comprises the second fluid and the first fluid is different from the second fluid.

17. The subwater heat exchanger of claim 16, wherein the driver comprises one of a third fluid that is different from the first fluid and the second fluid.

18. The subwater heat exchanger of claim 17, wherein the third fluid comprises one of (a) liquid pumped into an injection well, (b) gas pumped into an injection well, (c) fluid downstream of a compressor, and (d) an opposite phase from a fourth fluid used in an upstream separator.

19. The subwater heat exchanger of claim 18, wherein the liquid comprises water.

20. The subwater heat exchanger of any one of claims 15 to 19, wherein the driver comprises a magnetic hydrodynamic system.

21. The subwater heat exchanger of any one of the preceding claims, further comprising a duct inlet channel and a duct outlet channel, wherein the duct inlet channel is configured to receive the second fluid before the second fluid enters the first coils and the duct outlet channel is configured to receive the second fluid after the second fluid exits the first coils.