

CLAIMS

1. A reactor comprising:
an outer vessel having an inner surface against which a fluid being processed can be accommodated;
an inner vessel, situated within the outer vessel, and having an outer surface serving as a heat exchange surface for the fluid being processed; and
an annular space defined between the outer vessel and the inner vessel for providing a pathway along which processing of the fluid can be implemented, the annular space being designed to maintain a temperature differential between the outer vessel and the inner vessel to impart the fluid being processed with relatively high transport rates.
2. A reactor as set forth in claim 1, wherein the inner surface of the outer vessel is designed to allow fluid being processed to descend in a substantially uniform thin film.
3. A reactor as set forth in claim 2, wherein the substantially uniform thin film permits the fluid being processed to be well suited for treatment, processing, and/or separation.
4. A reactor as set forth in claim 2, wherein the substantially uniform thin film permits the fluid being processed with a relatively high rate of one of thermal transfer, mass transfer, mixing, or a combination thereof.
5. A reactor as set forth in claim 1, wherein the inner surface of the outer vessel can be provided with a profiled pattern to create additional surface area over which the fluid being processed can flow to facilitate one of treatment, processing, separation, an increase in residence time within the annular space, or a combination thereof.
6. A reactor as set forth in claim 1, wherein the inner surface of the outer vessel can be coated to facilitate treatment, processing, and/or separation of the fluid being processed.

7. A reactor as set forth in claim 1, wherein the outer vessel also includes a bottom portion designed to collect and remove the fluid being processed that has descended from the inner surface.
8. A reactor as set forth in claim 1, wherein the inner vessel includes an inner surface along which a heat exchange fluid may flow.
9. A reactor as set forth in claim 8, wherein the heat exchange fluid has a temperature different from that of the fluid being processed to impart a temperature differential between the outer surface of the inner vessel and the inner surface of the outer vessel.
10. A reactor as set forth in claim 8, wherein the inner surface of the inner vessel can be provided with a profiled pattern to increase surface tension, so as to impart and maintain a substantially thin and uniform film of the heat exchange fluid.
11. A reactor as set forth in claim 8, wherein the inner vessel also includes a bottom end designed to collect and remove the heat exchange fluid that has descended from the inner surface.
12. A reactor as set forth in claim 1, wherein the annular space is designed to permit a second fluid to be directed into the annular space for interacting with the fluid being processed.
13. A reactor as set forth in claim 12, wherein the second fluid can act to increase points of contacts at an interface between the second fluid and the fluid being processed over a relatively large surface area within the annular space to impart the fluid being processed with relatively high transport rates.

14. A reactor as set forth in claim 1, wherein the annular space is designed to permit a second fluid to be directed into the annular space in a counter-current manner relative to the fluid being processed for interacting with the fluid being processed.

15. A reactor as set forth in claim 1, wherein the annular space is provided with a relatively short distance between the inner surface of the outer vessel and the outer surface of the inner vessel in order to impart the fluid being processed with relatively high transport rates.

16. A reactor as set forth in claim 1, further including a fluid dispensing system to permit introduction of the fluid being processed onto the inner surface of the outer vessel and the inner surface of the inner vessel.

17. A reactor as set forth in claim 16, wherein the fluid dispensing system includes a rotating member within the outer vessel for generating substantially fine droplets or fiber-like elements from the fluid being processed, such that a substantially uniform thin film of the fluid being processed can be provided on to the inner surface of the outer member.

18. A reactor as set forth in claim 16, wherein the fluid dispensing system includes a rotating member within the inner vessel for generating substantially fine droplets or fiber-like elements from the heat exchange fluid, such that a substantially uniform thin film of the heat exchange fluid can be provided on to the inner surface of the inner member.

19. A reactor as set forth in claim 1, further including an energy source provided about the outer vessel to act as a source for heating or cooling the fluid being processed along the inner surface of the outer vessel.

20. A reactor as set forth in claim 1, further including a bed of packing material within the annular space to increase surface area over which a volume of the fluid being processed can come into contact to enhance its transport rates.

21. A reactor as set forth in claim 20, wherein the bed of packing material can provide a substantially uniform temperature distribution across the annular space.
22. A reactor as set forth in claim 1, further including a third vessel situated within the inner vessel, so as to provide another annular space between the third vessel and the inner vessel permit the fluid being processed multiple passes through the reactor to enhance transport rates.
23. A system for processing fluid wherein a plurality of the reactors of claim 1 are connected in series to permit the fluid being processed with multiple passes through the reactors to enhance transport rates.
24. A system as set forth in claim 23, wherein each reactor is designed to process the fluid being processed differently.
25. A method for processing a fluid, the method comprising:
introducing into an outer vessel and against its inner surface a fluid being processed;
providing, within the outer vessel, an inner vessel with a heat exchange surface at a temperature different than that of the fluid being processed; and
maintaining a temperature differential across a pathway between the outer vessel and the inner vessel to impart to the fluid being processed therein relatively high transport rates.
26. A method as set forth in claim 25, wherein the step of introducing includes generating a substantially uniform thin film flow of the fluid being processed against the inner surface of the outer vessel.
27. A method as set forth in claim 26, wherein, in the step of generating, the substantially uniform thin film flow enhances ability of the fluid to be treated, processed, and/or separated.

28. A method as set forth in claim 26, wherein the step of generating includes permitting the fluid being processed to have a relatively high rate of thermal transfer, mass transfer, mixing, or a combination thereof.

29. A method as set forth in claim 26, wherein the step of generating includes rotationally dispensing within the outer vessel substantially fine droplets or fiber-like elements of the fluid being processed.

30. A method as set forth in claim 25, wherein the step of introducing includes imparting the inner surface of the outer vessel with a profiled pattern to create additional surface area over which the fluid being processed can flow to facilitate one of treatment, processing, separation, increase in residence time of the fluid being treated within the pathway, or a combination thereof.

31. A method as set forth in claim 25, wherein the step of introducing includes coating the inner surface of the outer vessel to facilitate treatment, processing, and/or separation of the fluid being treated.

32. A method as set forth in claim 25, wherein the step of providing includes distributing against an inner surface of the inner vessel a heat exchange fluid at a temperature different than that of the fluid being processed.

33. A method as set forth in claim 32, wherein the step of distributing includes creating a temperature differential between the outer surface of the inner vessel and the inner surface of the outer vessel.

34. A method as set forth in claim 29, wherein the step of distributing includes rotationally dispensing within the inner vessel substantially fine droplets or fiber-like elements of the heat exchange fluid.

35. A method as set forth in claim 25, wherein the step of providing includes providing the inner surface of the inner vessel with a profiled pattern to increase surface tension, so as to impart and maintain a substantially thin and uniform film of the heat exchange fluid.
36. A method as set forth in claim 25, further including directing a second fluid into the pathway between the outer vessel and the inner vessel to permit interaction with the fluid being processed.
37. A method as set forth in claim 36, wherein the step of directing includes increasing points of contact at an interface between the second fluid and the fluid being processed over a relatively large surface area within the pathway to impart the fluid being processed with relatively high transport rates.
38. A method as set forth in claim 36, wherein the step of directing includes allowing the second fluid to move within the pathway in a counter-current manner relative to the fluid being processed.
39. A method as set forth in claim 25, wherein the step of maintaining includes providing the pathway with a relatively short distance between the outer surface of the inner vessel and the inner surface of the outer vessel in order to impart the fluid being processed with relatively high transport rates.
40. A method as set forth in claim 25, further including heating or cooling the fluid being processed along the inner surface of the outer vessel.
41. A method as set forth in claim 25, further placing a bed of a packing material within the pathway between the outer vessel and the inner vessel to increase surface area over which the fluid being processed can come into contact to enhance its transport rates.
42. A method as set forth in claim 41, wherein, in the step of placing, a volume of the fluid being processed is introduced into the outer vessel.

43. A method as set forth in claim 41, wherein the step of placing includes utilizing the bed of packing material to provide a substantially uniform temperature distribution across the pathway between the outer vessel and the inner vessel.
44. A method as set forth in claim 25, wherein the fluid being processed is utilized in fluid-fluid reactions in connection with organic systems.
45. A method as set forth in claim 25, wherein the fluid being processed is utilized in a distillation or an evaporation process.
46. A method as set forth in claim 25, wherein the fluid being processed is superheated steam being deheated or cooled.
47. A method as set forth in claim 25, wherein the fluid being processed is utilized in ultraviolet and/or microwave initiated reactions.
48. A method as set forth in claim 25, wherein the fluid being processed is utilized in a desalination process.
49. A method as set forth in claim 25, wherein the fluid being processed is saturated with carbon dioxide and is being utilized in a carbon dioxide removal process.

CLAIMS

1. A reactor comprising:
 - an outer vessel having an inner surface against which a fluid being processed can be accommodated;
 - an inner vessel, situated within the outer vessel, and having an outer surface serving as a heat exchange surface for the fluid being processed and an inner surface designed to permit a heat exchange fluid to flow in a substantially uniform thin film; and
 - an annular space defined between the outer vessel and the inner vessel for providing a pathway along which processing of the fluid can be implemented, the annular space being designed to maintain a temperature differential between the outer vessel and the inner vessel to impart the fluid being processed with relatively high transport rates.
2. A reactor as set forth in claim 1, wherein the inner surface of the outer vessel is designed to allow fluid being processed to descend in a substantially uniform thin film.
3. A reactor as set forth in claim 2, wherein the substantially uniform thin film of the fluid to be processed has a thickness suitable for treatment, processing, and/or separation.
4. A reactor as set forth in claim 2, wherein the substantially uniform thin film permits the fluid being processed with a relatively high rate of one of thermal transfer, mass transfer, mixing, or a combination thereof.
5. A reactor as set forth in claim 1, wherein the inner surface of the outer vessel can be provided with a profiled pattern that creates additional surface area over which the fluid being processed can flow to facilitate one of treatment, processing, separation, an increase in residence time within the annular space, or a combination thereof.

6. A reactor as set forth in claim 1, wherein the inner surface of the outer vessel includes a coating that facilitates treatment, processing, and/or separation of the fluid being processed.
7. A reactor as set forth in claim 1, wherein the outer vessel also includes a bottom portion designed to collect and remove the fluid being processed that has descended from the inner surface.
8. A reactor as set forth in claim 1, wherein the inner vessel includes an inner surface along which a heat exchange fluid may flow.
9. A reactor as set forth in claim 8, wherein the heat exchange fluid has a temperature different from that of the fluid being processed to impart a temperature differential between the outer surface of the inner vessel and the inner surface of the outer vessel.
10. A reactor as set forth in claim 8, wherein the inner surface of the inner vessel can be provided with a profiled pattern to increase surface tension, so as to impart and maintain a substantially thin and uniform film of the heat exchange fluid.
11. A reactor as set forth in claim 8, wherein the inner vessel also includes a bottom end designed to collect and remove the heat exchange fluid that has descended from the inner surface.
12. A reactor as set forth in claim 1, wherein the annular space is designed to permit a second fluid to be directed into the annular space for interacting with the fluid being processed.
13. A reactor as set forth in claim 12, wherein the second fluid can act to increase points of contacts at an interface between the second fluid and the fluid being processed over a relatively large surface area within the annular space to impart the fluid being processed with relatively high transport rates.

14. A reactor as set forth in claim 1, wherein the annular space is designed to permit a second fluid to be directed into the annular space in a counter-current manner relative to the fluid being processed for interacting with the fluid being processed.
15. A reactor as set forth in claim 1, wherein the annular space is provided with a relatively short distance between the inner surface of the outer vessel and the outer surface of the inner vessel in order to impart the fluid being processed with relatively high transport rates.
16. A reactor as set forth in claim 1, further including a fluid dispensing system to permit introduction of the fluid being processed onto the inner surface of the outer vessel and the inner surface of the inner vessel.
17. A reactor as set forth in claim 16, wherein the fluid dispensing system includes a rotating member within the outer vessel for generating substantially fine droplets or fiber- like elements from the fluid being processed, such that a substantially uniform thin film of the fluid being processed can be provided on to the inner surface of the outer member.
18. A reactor as set forth in claim 16, wherein the fluid dispensing system includes a rotating member within the inner vessel for generating substantially fine droplets or fiber- like elements from the heat exchange fluid, such that a substantially uniform thin film of the heat exchange fluid can be provided on to the inner surface of the inner member.
19. A reactor as set forth in claim 1, further including an energy source provided about the outer vessel to act as a source for heating or cooling the fluid being processed along the inner surface of the outer vessel.

20. A reactor as set forth in claim 1, further including a bed of packing material within the annular space to increase surface area over which a volume of the fluid being processed can come into contact to enhance its transport rates.
21. A reactor as set forth in claim 20, wherein the bed of packing material can provide a substantially uniform temperature distribution across the annular space.
22. A reactor as set forth in claim 1, further including a third vessel situated within the inner vessel, and another annular space between the third vessel and the inner vessel to permit the fluid being processed multiple passes through the reactor to enhance transport rates.
23. A system for processing fluid wherein a plurality of the reactors of claim 1 are connected in series to permit the fluid being processed with multiple passes through the reactors to enhance transport rates.
24. A system as set forth in claim 23, wherein each reactor is designed to process the fluid being processed differently.
25. A method for processing a fluid, the method comprising:
introducing into an outer vessel and against its inner surface a fluid being processed;
providing, within the outer vessel, an inner vessel with a heat exchange surface at a temperature different than that of the fluid being processed;
imparting a substantially uniform thin film flow of a heat exchange fluid against an inner surface of the inner vessel; and
maintaining a temperature differential across a pathway between the outer vessel and the inner vessel to impart to the fluid being processed therein relatively high transport rates.

26. A method as set forth in claim 25, wherein the step of introducing includes generating a substantially uniform thin film flow of the fluid being processed against the inner surface of the outer vessel.
27. A method as set forth in claim 26, wherein, in the step of generating, the substantially uniform thin film flow enhances ability of the fluid to be treated, processed, and/or separated.
28. A method as set forth in claim 26, wherein the step of generating includes permitting the fluid being processed to have a relatively high rate of thermal transfer, mass transfer, mixing, or a combination thereof.
29. A method as set forth in claim 26, wherein the step of generating includes rotationally dispensing within the outer vessel substantially fine droplets or fiber-like elements of the fluid being processed.
30. A method as set forth in claim 25, wherein the step of introducing includes imparting the inner surface of the outer vessel with a profiled pattern to create additional surface area over which the fluid being processed can flow to facilitate one of treatment, processing, separation, increase in residence time of the fluid being treated within the pathway, or a combination thereof.
31. A method as set forth in claim 25, wherein the step of introducing includes coating the inner surface of the outer vessel to facilitate treatment, processing, and/or separation of the fluid being treated.
32. A method as set forth in claim 25, wherein the step of providing includes distributing against an inner surface of the inner vessel a heat exchange fluid at a temperature different than that of the fluid being processed.

33. A method as set forth in claim 32, wherein the step of distributing includes creating a temperature differential between the outer surface of the inner vessel and the inner surface of the outer vessel.
34. A method as set forth in claim 29, wherein the step of distributing includes rotationally dispensing within the inner vessel substantially fine droplets or fiber-like elements of the heat exchange fluid.
35. A method as set forth in claim 25, wherein the step of providing includes providing the inner surface of the inner vessel with a profiled pattern to increase surface tension, so as to impart and maintain a substantially thin and uniform film of the heat exchange fluid.
36. A method as set forth in claim 25, further including directing a second fluid into the pathway between the outer vessel and the inner vessel to permit interaction with the fluid being processed.
37. A method as set forth in claim 36, wherein the step of directing includes increasing points of contact at an interface between the second fluid and the fluid being processed over a relatively large surface area within the pathway to impart the fluid being processed with relatively high transport rates.
38. A method as set forth in claim 36, wherein the step of directing includes allowing the second fluid to move within the pathway in a counter-current manner relative to the fluid being processed.
39. A method as set forth in claim 25, wherein the step of maintaining includes providing the pathway with a relatively short distance between the outer surface of the inner vessel and the inner surface of the outer vessel in order to impart the fluid being processed with relatively high transport rates.

40. A method as set forth in claim 25, further including heating or cooling the fluid being processed along the inner surface of the outer vessel.
41. A method as set forth in claim 25, further placing a bed of a packing material within the pathway between the outer vessel and the inner vessel to increase surface area over which the fluid being processed can come into contact to enhance its transport rates.
42. A method as set forth in claim 41, wherein, in the step of placing, a volume of the fluid being processed is introduced into the outer vessel.
43. A method as set forth in claim 41, wherein the step of placing includes utilizing the bed of packing material to provide a substantially uniform temperature distribution across the pathway between the outer vessel and the inner vessel.
44. A method as set forth in claim 25, wherein the fluid being processed is utilized in fluid-fluid reactions in connection with organic systems.
45. A method as set forth in claim 25, wherein the fluid being processed is utilized in a distillation or an evaporation process.
46. A method as set forth in claim 25, wherein the fluid being processed is superheated steam being deheated or cooled.
47. A method as set forth in claim 25, wherein the fluid being processed is utilized in ultraviolet and/or microwave initiated reactions.
48. A method as set forth in claim 25, wherein the fluid being processed is utilized in a desalination process.
49. A method as set forth in claim 25, wherein the fluid being processed is saturated with carbon dioxide and is being utilized in a carbon dioxide removal process.