Claims

1. A membrane emulsification apparatus for dispersing a first phase in a second phase, comprising:

a membrane defining a plurality of apertures connecting a first volume on a first side of the membrane to a second volume on a second, different, side of the membrane, the apparatus being arranged to receive a first phase containing a liquid in the first volume and to receive a second phase in the second volume the apparatus being adapted to generate an emulsion through egression of the first phase into the second phase via the plurality of apertures;

the apparatus also comprising a refiner arranged to receive the emulsion from the membrane; and wherein said refiner comprises an inlet and an outlet wherein an opening adapted to converge flow of the emulsion and to break up droplets of the emulsion into a refined emulsion is located between the inlet and the outlet;

wherein the opening is adjustable and the opening comprises adjustment means, such that the refiner is tunable by adjustment of the opening.

2. Membrane emulsification apparatus according to claim 1 wherein the adjustment means in the refiner that is tunable comprises a differential screw.

3. Membrane emulsification apparatus according to claim 2 wherein the differential screw comprises a spindle with two external screw threads of differing thread pitch.

4. Membrane emulsification apparatus according to claim 2 wherein the differential screw comprises a spindle with two external screw threads are generally congruous.

5. Membrane emulsification apparatus according to claim 2 wherein the differential screw comprises a spindle with two external screw threads of differing handedness.

6. Membrane emulsification apparatus according to claim 2 wherein nuts are located around two external screw threads of the differential screw.

7. Membrane emulsification apparatus according to claim 3 wherein the first end of the spindle, adjacent the refiner opening, is smaller than the second end of the spindle, which is distal to the refiner opening.

8. Membrane emulsification apparatus according to claim 7 wherein the distal end of the spindle is provided with a first external thread, the diameter of which is wider than that of the end of the spindle adjacent the opening, which is provided with a second external thread.

9. Membrane emulsification apparatus according to any one of the preceding claims wherein the refiner is integral to the membrane.

10. Membrane emulsification apparatus according to claim 1 wherein the opening that is adjustable comprises a refiner plug adjacent the opening, such that movement of an insert rod closer to the opening reduces the size of the opening.

11. Membrane emulsification apparatus according to claim 10 wherein the end of the insert rod adjacent to the opening comprises a frusto conical member with a terminal protrusion.

12. Membrane emulsification apparatus according to claim 11 wherein the terminal protrusion comprises a flat end surface.

13. Membrane emulsification apparatus according to claim 10 wherein the insert rod is adapted to simulate multiple passes of the emulsion through the opening.

14. Membrane emulsification apparatus according to any one of claims 1 to 13 wherein the apparatus is used in a continuous mode.

15. Membrane emulsification apparatus according to claim 14 wherein the refiner comprises multiples inlets and/ or multiple outlets.

16. A method of preparing a refined emulsion, said method comprising using a membrane emulsification apparatus according to any one of the preceding claims.

17. A method of preparing a refined emulsion according to claim 16 wherein the method comprises providing a first phase to the first volume of the apparatus;

providing a second phase to the second volume of the apparatus;

causing the egression of the first phase into the second phase via a plurality of apertures in a membrane to preparing an emulsion;

passing the emulsion through an inlet of a refiner and converging the flow of the emulsion through an adjustable opening to break up droplets of the emulsion into a refined emulsion;

wherein the opening is adjustable and the opening comprises adjustment means, such that the refiner is tunable by adjustment of the opening.

18. A method of preparing a refined emulsion according to claim 16 wherein the membrane emulsification apparatus for dispersing a first phase in a second phase, comprises:

a membrane defining a plurality of apertures connecting a first volume on a first side of the membrane to a second volume on a second, different, side of the membrane, the apparatus being arranged to receive a first phase containing a liquid in the first volume and to receive a second phase in the second volume the apparatus being adapted to generate an emulsion through egression of the first phase into the second phase via the plurality of apertures;

the apparatus also comprising a tunable refiner arranged to receive the emulsion from the membrane; and wherein said refiner comprises an inlet and an outlet wherein an adjustable opening adapted to converge flow of the emulsion and to break up droplets of the emulsion into a refined emulsion is located between the inlet and the outlet;

wherein the opening is adjustable and the opening comprises adjustment means, such that the refiner is tunable by adjustment of the opening.

19. A method of preparing a refined emulsion according to any one of claims 16 to 18 wherein the apparatus is arranged to receive a first phase containing a liquid in the first volume and to receive a second phase in the second volume; the apparatus being adapted to generate an emulsion through egression of the first phase into the second phase via the plurality of apertures.

20. A method of preparing a refined emulsion according to any one of claims 16 to 19 wherein the apparatus is arranged so that flow of the second phase in the second volume creates a shear field at the area of egression of the first phase, the shear field being in a direction substantially perpendicular to the direction of egression of the first phase.

21. A method of preparing a refined emulsion according to any one of claims 16 to 20 wherein the membrane is tubular in shape and comprises a first end and a second end; wherein the first end is for receiving the second phase; and the refiner is coupled to the second end.

22. A method of preparing a refined emulsion according to any one of claims 16 to 21 wherein the apparatus is used in a continuous mode.

23. A method of preparing a refined emulsion according to claim 22 wherein the refiner comprises multiples inlets and/ or multiple outlets.

24. A method of preparing a refined emulsion, said method comprising using a membrane emulsification apparatus for dispersing a first phase in a second phase, wherein the membrane emulsification apparatus comprises a cross-flow apparatus for producing an emulsion or dispersion by dispersing a first phase in a second phase; said cross-flow apparatus comprising:

an outer tubular sleeve provided with a first inlet at a first end; an emulsion outlet; and a second inlet, distal from and inclined relative to the first inlet;

a tubular membrane provided with a plurality of pores and adapted to be positioned inside the tubular sleeve; and

optionally an insert adapted to be located inside the tubular membrane, said insert comprising an inlet end and an outlet end, each of the inlet end and an outlet end being provided with chamfered region; the chamfered region is provided with a plurality of orifices and a furcation plate;

the apparatus also comprising a refiner arranged to receive the emulsion from the membrane and wherein said refiner comprises an inlet and an outlet wherein an opening adapted to converge flow of the emulsion and to break up droplets of the emulsion into a refined emulsion is located between the inlet and the outlet;

wherein the opening is adjustable and the opening comprises adjustment means, such that the refiner is tunable by adjustment of the opening.

25. A membrane emulsification refiner apparatus for dispersing a first phase in a second phase, comprising:

a membrane emulsification apparatus defining a plurality of apertures connecting a first volume on a first side of the membrane to a second volume on a second, different, side of the membrane, the apparatus being arranged to receive a first phase containing a liquid in the first volume and to receive a second phase in the second volume the apparatus being adapted to generate an emulsion through egression of the first phase into the second phase via the plurality of apertures;

the apparatus also comprising a refiner arranged to receive the emulsion from the membrane; and wherein said refiner comprises an inlet and an outlet wherein an adjustable opening adapted to converge flow of the emulsion and to break up droplets of the emulsion into a refined emulsion is located between the inlet and the outlet;

wherein the adjustable opening is adjustable and the opening comprises adjustment means, such that the refiner is tunable by adjustment of the opening; and

wherein the refiner comprises multiple stages.

26. Membrane emulsification refiner apparatus according to claim 17 wherein the refiner comprises multiple inlets and/ or multiple outlets.