CLAIMS

1. A system for forming microspheres, the system comprising:

a dispersed phase needle having a proximal first end and a distal second end, the dispersed phase needle including:

a dispersed phase input fitting at the proximal first end,

a dispersed phase output fitting situated between the dispersed phase input fitting and the distal second end, and

a needle tube extending from the dispersed phase output fitting to the distal second end,

wherein the dispersed phase needle comprises a hollow bore throughout its length;

a tee or a wye including:

a plurality of tubes,

a tee input fitting or a wye input fitting,

a continuous phase input fitting, and

a continuous phase output fitting situated between the dispersed phase output fitting and the dispersed phase needle's distal second end,

wherein the tubes each comprise a hollow bore throughout their respective lengths; and

a chamber, the chamber including:

an input tube having an input fitting situated adjacent to the dispersed phase needle's distal second end and comprising a hollow bore throughout its length,

a housing,

an output tube having an output fitting and comprising a hollow bore throughout its length,

a hollow interior, and

an impeller is oriented within the hollow interior,

wherein the impeller includes a plurality of impeller blades and a base, wherein the base includes a magnet to magnetically engage a rotating magnetic field outside of the chamber, and wherein the impeller rotates and creates a direction of natural flow of a fluid through the chamber in a direction from the output tube toward the input tube.

2. The system of claim 1, wherein the dispersed phase needle output fitting engages the tee input fitting to create a seal.

3. The system of claim 1, wherein the continuous phase output fitting engages the chamber input fitting to create a seal.

4. The system of claim 1, wherein a dispersed phase liquid is pumped through the hollow bore of the dispersed phase needle and into the hollow interior of the chamber in a direction opposite the direction of natural flow, and wherein a continuous phase liquid is pumped through the tee or the wye and into the hollow interior of the chamber in a direction opposite the direction of natural flow, and wherein the dispersed phase liquid and the continuous phase liquid are homogenized in a high shear environment created by rotation of the impeller within the hollow interior of the chamber.

5. The system of claim 1, wherein the dispersed phase needle is oriented through the tee or the wye.

6. The system of claim 1, wherein the tee or the wye is formed from three tubes, wherein two of the three tubes are coaxial in arrangement.

7. The system of claim 1, wherein each of the tubes' hollow bore is in fluid communication with each of the other tubes' hollow bore, the dispersed phase needle's hollow bore, the chamber's input tube's hollow bore, and the chamber's output tube's hollow bore.

8. The system of claim 1, further comprising a pump in fluid communication with the dispersed phase needle's input fitting, the pump configured to exert a pressure that is greater than the pressure of the natural flow.

9. The system of claim 1, further comprising a pump in fluid communication with the tee or the wye's continuous phase input fitting, the pump configured to generate a pressure that is greater than the pressure of the natural flow.

10. The system of claim 1, wherein the hollow interior is free of a rotor, a stator, a bushing, and a gasket.

11. The system of claim 1, wherein the needle tube terminates within the input tube.

12. A system for forming microspheres, the system comprising:

a tee or a wye including:

a plurality of tubes,

a tee input fitting or a wye input fitting,

a continuous phase input fitting, and

a continuous phase output fitting,

wherein the tubes each include a hollow bore; and

a chamber including:

an input tube having an input fitting and a hollow bore,

a housing,

an output tube having an output fitting and a hollow bore,

a hollow interior, and

an impeller oriented within the hollow interior,

wherein the impeller includes a plurality of impeller blades and a base,

wherein the base includes a magnet to magnetically engage a rotating magnetic field outside of the chamber, and

wherein the impeller rotates and creates a direction of natural flow of a fluid through the chamber in a direction from the output tube toward the input tube; and

wherein a dispersed phase liquid is pumped through at least one of the plurality of tubes of the tee or the wye and into the hollow interior of the chamber in a direction opposite the direction of natural flow,

wherein a continuous phase liquid is pumped through the tee or the wye and into the hollow interior of the chamber in a direction opposite the direction of natural flow, and

wherein the dispersed phase liquid and the continuous phase liquid are homogenized in a high shear environment created by rotation of the impeller within the hollow interior of the chamber.

13. The system of claim 12, further comprising a dispersed phase needle including:

a dispersed phase input fitting at a first end,

a needle tube at a second end, and

a dispersed phase output fitting oriented between the dispersed phase input fitting and the needle tube,

wherein the dispersed phase needle has a hollow bore.

14. The system of claim 13, wherein the dispersed phase liquid is pumped through the dispersed phase needle, wherein the dispersed phase needle is oriented through the tee or the wye.

15. The system of claim 14, wherein the dispersed phase liquid is pumped through the dispersed phase needle into the hollow interior of the chamber in a direction opposite the direction of natural flow.

16. The system of claim 13, wherein the dispersed phase needle output fitting engages the tee input fitting or the wye input fitting to create a seal, and wherein the continuous phase output fitting engages the chamber input fitting to create a seal.

17. The system of claim 13, wherein the continuous phase output fitting engages the chamber input fitting to create a seal.

18. A method for making microspheres, the method comprising:

providing a dispersed phase;

providing a continuous phase;

providing a chamber, the chamber including:

a housing,

a hollow interior, and

an impeller oriented within the hollow interior,

wherein the impeller includes a plurality of impeller blades and a base,

wherein the base includes a magnet to magnetically engage a rotating magnetic field outside of the chamber, and

wherein the impeller rotates creates a direction of natural flow;

pumping the dispersed phase under positive pressure into the chamber in a direction opposite the direction of natural flow;

pumping the continuous phase under positive pressure into the chamber in a direction opposite the direction of natural flow; and

homogenizing the dispersed phase and the continuous phase within the chamber.

19. The method of claim 18, wherein the dispersed phase is pumped through a dispersed phase needle and into the chamber.

20. The method of claim 18, wherein the pumped dispersed phase and the pumped continuous phase contact the rotating impeller, thereby creating a high shear environment within the hollow interior.

21. The method of claim 18, wherein the dispersed phase and the continuous phase are passed through a tee or a wye that is operably connected to the chamber and contact each other in the tee or wye prior to entering the chamber.

22. A method for making a polymer microsphere that encapsulates an active pharmaceutical ingredient ("API"), the method comprising:

providing a dispersed phase, the dispersed phase comprising a biodegradable polymer, the API, and a solvent;

providing a continuous phase, the continuous phase comprising water and, optionally, a surfactant;

providing a tee or a wye, wherein the tee or wye comprises a plurality of tubes including a dispersed phase input tube, a continuous phase input tube, and an output tube;

pumping the dispersed phase into the tee or wye via the dispersed phased input tube and pumping the continuous phase into the tee or wye via the continuous phase input tube, thereby combining the dispersed phase and the continuous phase in the tee or wye to form a mixture;

providing a chamber, the chamber including:

a hollow interior,

an impeller including a plurality of impeller blades, and

wherein the impeller is oriented within the hollow interior and wherein the rotation of the impeller creates a direction of natural flow; and

pumping the mixture under a positive pressure into the chamber in a direction opposite the direction of natural flow.

23. The method of claim 22, wherein the mixture returned to the emulsion vessel is pumped a second time into the chamber via the levitating magnetic impeller intended output in a direction opposite the direction of natural flow.

24. The method of claim 22, wherein the pump used to pump the mixture from the emulsion vessel to the chamber is a peristaltic pump.

25. A method for producing microspheres, microparticles, or emulsions using a levitating magnetic impeller, comprising:

wherein the levitating magnetic impeller includes a chamber having a hollow interior and a rotating impeller oriented within the hollow interior;

wherein a dispersed phase liquid or dispersed phase suspension is pumped into the hollow interior;

wherein a continuous phase liquid is pumped into the hollow interior; and

wherein the dispersed phase liquid and the continuous phase liquid are homogenized in a high shear environment created by the pumped dispersed phase and the pumped continuous phase contacting the rotating impeller within the hollow interior of the chamber, to form microspheres, microparticles, or emulsions.