CLAIMS

We claim:

1. A continuous extraction unit, comprising:

a plurality of extraction chambers, wherein each of the extraction chambers comprises one or more valves or other means to direct a fluid flow, and wherein the extraction chamber contains extractable material for extraction of a solute by a solvent when under fluid flow;

at least one expansion chamber comprising a solution inlet, that allows a pressure drop across the solution inlet that promotes formation of a vaporized solvent from the solution and areolation, coalesce, and consolidation of the solute as a liquid or concentrated solution extract;

at least one condenser, wherein the vaporized solvent is condensed to a liquid;

at least one compressor, liquid pump or other means of the fluid flow positioned downstream of the condenser and upstream of the extraction chambers, and expansion chambers; and

at least one pump, valve or other means for continuously or periodically removing the extract without disruption of the fluid flow, wherein one of said plurality of extraction chambers is removed when the extractable material has been freed of all solute and replacing the removed extraction chamber with an equivalent extraction chamber with fresh extractable material without disruption of fluid flow through at least one of the extraction chambers, and wherein the solvent is retained within the unit.

2. The continuous extraction unit of claim 1, wherein the solution inlet, the expansion chamber and at least one of the condensers comprise a heat exchanger, wherein the solution inlet consists of at least one thermal expansion valve, and wherein the at least one of the condenser contacts the expansion chamber, whereby heat from the condenser is absorbed by the expansion chamber.

3. The continuous extraction unit of claim 1, further comprising a vacuum pump, wherein the pressure drop across the solution inlet that promotes formation of a vaporized solvent is promoted by the vacuum pump.

4. The continuous extraction unit of claim 3, wherein at least one condenser is contacted by an externally provided coolant.

5. The continuous extraction unit of claim 4, wherein the coolant is contacted by a chiller.

6. The continuous extraction unit of claim 1, further comprising check valves and/or heaters and/or chillers and/or heat exchanges, wherein the heat exchangers include exchange fluids that are heated or chilled externally to the continuous extraction unit.

7. The continuous extraction unit of claim 1, further comprising an information processor interfaced with at least one actuator and/or at least one sensor.

8. The continuous extraction unit of claim 7, wherein: the information processor comprises a programmed computer; the sensors comprise, independently or in combination, one or more flow meters, fluid density sensors, refractive index detectors, infra-red, visible or ultraviolet light detectors, and/or conductivity detectors; and the actuators comprise, independently or in combination, valves, pumps, and/or alarms.

9. A method of extracting at least one soluble component from extractable material, comprising:

providing a continuous extraction unit according to claim 1 having a plurality of extraction chambers containing an extractable material comprising an extractable solute;

flowing a liquid fluid comprising a solvent by the compressor, pump, or other means of flowing through a first conduit into a plurality of extraction chambers, wherein a solution comprising the extractable solute is formed;

directing flow of the solution comprising the extractable solute from the extraction chambers into a second conduit, wherein the solution comprising the extractable solute directed from extraction chambers is combined into a combined solution comprising the extractable solute;

flowing the combined solution comprising the extractable solute from the second conduit into the at least one solution inlet into at least one expansion chamber, wherein the expansion chamber is maintained at a lower pressure than the pressure in the second conduit, wherein the combined solution comprising the extractable solute is partitioned into a solvent vapor and an extract comprising the extractable solute;

removing the extract from the continuous extraction unit by at least one pump, valve, or other means for removing the extract continuously or periodically without disruption the fluid flow within the continuous extraction unit;

condensing the solvent vapor to the liquid solvent;

directing the flow of the liquid fluid comprising a solvent to the first conduit;

preventing flow of the liquid fluid comprising a solvent from the first conduit into any one of the extraction chambers when its extractable material is free of extractable solute;

forcing flow of the liquid fluid comprising a solvent in the extraction chamber containing extractable material free of extractable solute to the second conduit, the first conduit, and/or other portion of the continuous extraction unit until none of the solvent is retained in the extraction chamber containing extractable material free of extractable solute;

isolating and removing the extraction chamber containing extractable material free of the extractable material from the continuous extraction unit;

connecting an equivalent extraction chamber containing extractable material comprising a solute by connection to the first conduit and the second conduit;

restoring the flowing of the liquid fluid comprising a solvent through the first conduit into the equivalent extraction chamber containing extractable material comprising a solute, wherein the solution comprising the extractable solute is formed; and

redirecting flow of the solution comprising the extractable solute from the equivalent extraction chambers into the second conduit.

CLAIMS

1. A continuous extraction unit, comprising:

a plurality of extraction chambers, wherein each of the extraction chambers comprises one or more first valves to direct a fluid flow and wherein the extraction chamber contains extractable material for extraction of a solute by a solvent to form a solution when under fluid flow;

at least one compressor;

at least one heat exchanger comprising at least one expansion chamber directly contacting at least one condenser, wherein the expansion chamber comprises at least one solution inlet comprising at least one expansion valve that allows a pressure drop that promotes vaporization of the solvent from the solution and aerosolization, coalescence, and consolidation of the solute as an extract in the form of a neat solute or a concentrated solution,

wherein the solvent in a vaporized solvent is condensed to a liquid in the condenser, wherein heat from the condenser is absorbed by the expansion chamber; and

wherein the compressor is positioned upstream with respect to the fluid flow through the condenser and the extraction chambers and the compressor is positioned downstream with respect to the fluid flow through the expansion chamber; and

at least one pump or at least one second valve continuously or periodically removing the extract without disruption of the fluid flow, wherein the first valves to direct the fluid flow permit removing one of said plurality of extraction chambers when extractable material has been depleted of the extract and replacing the extraction chamber that is removed with an equivalent of the extraction chamber containing fresh extractable material without disruption of fluid flow through at least one of the extraction chambers, and wherein the solvent is retained within the continuous extraction unit.

2. The continuous extraction unit of claim 1, further comprising an information processor interfaced with at least one actuator and/or at least one sensor.

3. The continuous extraction unit of claim 2, wherein: the information processor comprises a programmed computer; the sensor comprise, independently or in combination, one or more flow meters, fluid density sensors, refractive index detectors, infra-red, visible or ultraviolet light detectors, and/or conductivity detectors; and the actuators comprise, independently or in combination, one or more valves, pumps, and/or alarms.

4. A method of extracting at least one soluble component from extractable material, comprising:

providing a continuous extraction unit according to claim 1 having a plurality of extraction chambers containing an extractable material comprising an extractable solute;

flowing a liquid fluid comprising a solvent by through a first conduit into a plurality of extraction chambers, wherein a solution comprising the extractable solute is formed;

directing flow of the solution comprising the extractable solute from the extraction chambers into a second conduit, wherein the solution comprising the extractable solute directed from extraction chambers is combined into a combined solution comprising the extractable solute;

flowing the combined solution comprising the extractable solute from the second conduit into the at least one solution inlet into at least one expansion chamber, wherein the expansion chamber is maintained at a lower pressure than the pressure in the second conduit, wherein the combined solution comprising the extractable solute is partitioned into a low pressure solvent vapor and an extract comprising the extractable solute, and wherein the low pressure solvent vapor is drawn into an intake of a compressor;

removing the extract from the continuous extraction unit by at least one pump or valve, continuously or periodically without disruption of the fluid flow within the continuous extraction unit;

compressing the low pressure solvent vapor to a hot high pressure vapor at the output of the compressor;

condensing the hot high pressure vapor to the liquid comprising a solvent in the condenser, wherein heat from the hot high pressure vapor and heat formed upon condensing is transferred directly to the expansion chamber;

directing the flow of the liquid fluid comprising a solvent to the first conduit;

preventing flow of the liquid fluid comprising a solvent from the first conduit into any one of the extraction chambers rendered depleted of extract;

removing the solvent in the extraction chamber rendered free of extractable solute to the second conduit, the first conduit, and/or portion of the continuous extraction;

isolating and removing the extraction chamber rendered depleted of the extract from the continuous extraction unit;

connecting an equivalent extraction chamber containing extractable material comprising a solute by connection to the first conduit and the second conduit;

restoring the flowing of the liquid fluid comprising a solvent through the first conduit into the equivalent extraction chamber containing extractable material comprising a solute, wherein the solution comprising the extractable solute is formed; and

redirecting flow of the solution comprising the extractable solute from the equivalent extraction chambers into the second conduit.