Claims

1. A solid precipitation apparatus, comprises a housing, an inlet for a stream comprising a solvent and a solute, a discharging outlet (namely a stream outlet), and a support disposed in an inner chamber of said housing, wherein said support is solid particle, said apparatus also comprising an inner member disposed in the inner chamber of said housing, wherein said inner member comprises a hollow tube substantially coaxial with the central axis of said housing, the upper and lower ends of said hollow tube are open, said inner member also comprises a baffle located above said hollow tube, said hollow tube comprises an upper straight tube section and a lower conical diffusion section, there exists a gap (referred to as the first gap) between the internal wall of said housing and the external wall of said hollow tube, there exists a gap (referred to as the second gap) between said baffle and the upper edge of said hollow tube, and there exists a gap (referred to as the sixth gap) between said baffle and the internal wall of said housing.

2. The solid precipitation apparatus of claim 1, said solid precipitation apparatus is a desalination apparatus, and/or the housing is vertical cylindrical housing, and/or said stream is salt-containing wastewater or high-salinity wastewater.

3. The solid precipitation apparatus of claim 1, which is operated under a supercritical condition.

4. The solid precipitation apparatus of claim 1, which is operated

under a supercritical condition of said solvent.

5. The solid precipitation apparatus of claim 1, wherein said support is selected from at least one of crystal seeds, inorganic particles, silica sphere, sand, quartz sand, refractory material particles, and solid waste.

6. The solid precipitation apparatus of claim 1, wherein the used amount (by volume) of said solid particle comprises 1/4-3/4 of the total volume of the inner chamber of said housing, and/or, the equivalent diameter of said solid particle is 0.1-1.0 mm, and/or, the specific surface area of the said solid particle is 100-300 m^2/g, and/or, the bulk density of said solid particle is 0.6-0.7 g/cm^3.

7. The solid precipitation apparatus of claim 6, wherein the used amount (by volume) of said solid particle comprises 1/4-1/2 of the total volume of the inner chamber of said housing, and/or, the equivalent diameter of said solid particle is 0.2-0.7 mm.

8. The solid precipitation apparatus of claim 1, wherein the inner member is disposed in the upper part of the inner chamber of said housing, and/or the first gap is an annular gap, and/or said baffle is an umbrella cap, and/or said baffle is substantially coaxial with the central axis of said housing, and/or the second gap is an annular gap, and/or the sixth gap is an annular gap.

9. The solid precipitation apparatus of claim 8, wherein said umbrella cap is coaxial with said hollow tube, and has a cone angle of 30-150°, and/or, the outer diameter of said straight tube section of said

hollow tube is 60-80% of the inner diameter of said housing, and/or, the height of the straight tube section of said hollow tube is 10-30% of the height of the inner chamber of said housing, and/or, the maximum outer diameter of said conical diffusion section of said hollow tube is 75-90% of the inner diameter of said housing, and/or, the height of said conical diffusion section of said hollow tube is 3-10% of the height of the inner chamber of said housing, and/or, the height of said baffle is 5-20% of the height of the inner chamber of said housing.

10. The solid precipitation apparatus of claim 9, wherein said umbrella cap has a cone angle of 60-120°, and/or, the outer diameter of said straight tube section of said hollow tube is 67-73% of the inner diameter of said housing.

11. The solid precipitation apparatus of claim 1, which also comprises a guide structure disposed around the internal wall of said housing, said guide structure surrounds the inner chamber of said housing to form a channel that is open at the top and bottom (referred to as guide opening), said guide structure is disposed below said hollow tube and above said stream inlet, there exists a gap (referred to as the third gap) between said guide structure and the lower edge of said hollow tube, and/or, said guide opening is substantially coaxial with the central axis of said housing, and/or, said guide structure is disposed in the upper part of the inner chamber of said housing.

12. The solid precipitation apparatus of claim 11, wherein the longitudinal section of said guide structure along the central axis of the said housing is a trapezoid, and/or the coverage angle Alpha and the

friction angle Beta of said trapezoid are 5-70°, and/or said guide opening is a cylindrical channel, and/or said third gap is an annular gap.

13. The solid precipitation apparatus of claim 11, wherein said stream inlet is located at the bottom or the lower part of said housing, the structure of said stream inlet is suitable for spraying said stream into the inner chamber of said housing, and/or, said discharging outlet is located at the top or the upper part of said housing, and/or, the ratio of the height of the inner chamber of said housing (the unit is m) to the inner diameter (the unit is m) is 7-17 , and/or, the inner diameter of said guide opening is 60-80% of the inner diameter of said housing, and/or, the height of said guide opening is 5-15% of the height of the inner chamber of said housing.

14. The solid precipitation apparatus of claim 13, wherein the structure of said stream inlet is a nozzle or a liquid distributor, and/or, said discharging outlet is located above the said baffle, and/or, the ratio of the height of the inner chamber of said housing (the unit is m) to the inner diameter (the unit is m) is 10-14.

15. The solid precipitation apparatus of claim 11, which also comprises a support charge inlet and a support discharging outlet, and/or, said support charge inlet is located at the top or the upper part of said housing, and/or, said support discharging outlet is located at the bottom of said housing.

16. The solid precipitation apparatus of claim 15, wherein said support charge inlet is located above said guide structure or located

above the said baffle, and/or, said support discharging outlet is located below said stream inlet.

17. The solid precipitation apparatus of claim 11, which also comprises a hot-agent inlet, said hot-agent inlet is located at the bottom or the lower part of said housing, the structure of said hot-agent inlet is fit for the hot-agent to spray into the inner chamber of said housing, and/or, said hot-agent inlet is located above or below said stream inlet.

18. The solid precipitation apparatus of claim 17, wherein the hot-agent is selected from at least one of air, oxygen gas or a heating gas, and/or the structure of said hot-agent inlet is a nozzle or a gas distributor, and/or, said hot-agent inlet is located below said stream inlet.

19. The solid precipitation apparatus of claim 17, which also comprises an inner tube, said hot-agent inlet is located at the bottom of said housing, there exists a gap between the internal wall of said housing and the external wall of said inner tube (referred to as the fourth gap), there exists a gap between the lower edge or the internal wall of said inner tube and said hot-agent inlet (referred to as the fifth gap), said fifth gap is communicated with said fourth gap and the inner space of said inner tube, said inner tube has such a configuration that said hot-agent imported from said hot-agent inlet substantially wholly enters the inner space of said inner tube, said stream inlet is disposed in said fourth gap and below the upper edge of said inner tube, and/or, the space of the inner chamber of said housing located below the upper edge of said inner tube is referred to as the buffer zone, then said buffer zone comprises 25-40% or 20-60% of the total volume of the inner chamber

of said housing, and/or, the structure of said hot-agent inlet is a gas distributor, and said inner tube is located above said gas distributor or contains said gas distributor, both are partitioned by said fifth gap, and/or, said inner tube is located below said guide structure, and/or, said stream inlet is 100-500mm lower than the upper edge of said inner tube in the vertical direction, and/or, the outer diameter of said inner tube is 60-80% of the inner diameter of said housing, and/or, the height of said inner tube is 20-60% of the height of the inner chamber of said housing, and/or, said inner tube is disposed in the lower part of the inner chamber of said housing.

20. The solid precipitation apparatus of claim 19, wherein said inner tube is straight tube-shaped or horn tube-shaped, and/or said inner tube is substantially coaxial with the central axis of said housing, and/or the fourth gap is an annular gap, and/or the fifth gap is an annular gap, and/or, said gas distributor is substantially coaxial with the central axis of said housing, and/or, the outer diameter of said inner tube is 67-73% of the inner diameter of said housing, and/or, the height of said inner tube is 30-50% of the height of the inner chamber of said housing.

21. A solid precipitation process, which comprises passing a stream containing a solute and a solvent into the solid precipitation apparatus of claim 1 to cause at least a part of the solute to be deposited and loaded on said support disposed in the inner chamber of said housing.

22. The solid precipitation process of claim 21, wherein said process is a desalination process, and/or said solute is an inorganic salt and said solvent is water, and/or at least a part of the solute is precipitated due

to a precipitation reaction or due to supersaturation.

23. The solid precipitation process of claim 21, wherein said stream, before entering said solid precipitation apparatus, is kept at a subcritical state, and/or, the temperature of said support is higher than the supercritical temperature of said solvent, and/or, a support is added to the inner chamber of said housing, and the temperature of said support is higher than the supercritical temperature of said solvent, and/or, said support and said stream are in such a proportion that after mixing them, the temperature of said stream reaches or exceeds the supercritical temperature of said solvent.

24. The solid precipitation process of claim 23, wherein said stream, before entering said solid precipitation apparatus, is kept at a subcritical state wherein the temperature is lower than the supercritical temperature of said solvent which is from room temperature to a temperature of 1-15°C, 4-10°C or 6-8°C lower than the supercritical temperature of said solvent, or wherein the pressure is at or higher than the supercritical pressure of said solvent but the temperature is lower than the supercritical temperature of said solvent which is from room temperature to a temperature of 1-15°C, 4-10°C or 6-8°C lower than the supercritical temperature of said solvent, and/or, the temperature of said support is 1-15°C, 4-10°C or 6-8°C higher than said supercritical temperature, and/or, the support added to the inner chamber of said housing is at a temperature of 1-15°C, 4-10°C or 6-8°C higher than said supercritical temperature.

25. The solid precipitation process of claim 21, wherein the operation

conditions for the inner chamber of said housing include: the operation pressure is 23-35 MPaG, the operation temperature is 350-650°C, the stream residence time is 10-1800 seconds, and the space velocity is 1.5-270 h^{-1}.

26. The solid precipitation process of claim 25, wherein the operation pressure is 25-30 MPaG, and/or said operation temperature is 450-550°C, the stream residence time is 60-600 seconds.

27. The solid precipitation process of claim 21, wherein a hot-agent is added to the inner chamber of said housing, and said hot-agent is used in such an amount that said stream, after entering the inner chamber of said housing, forms the supercritical state, and/or, said stream is a salt-containing wastewater or a high salinity wastewater, said hot-agent is an oxidizing gas, and/or, said hot-agent and said stream are in such a proportion that after mixing them, the temperature of said stream reaches or exceeds the supercritical temperature of said solvent, and/or, the used amount of said hot-agent is 100-500% of the theoretical oxygen demand for the oxidation of said stream.

28. The solid precipitation process of claim 27, wherein said stream after entering the inner chamber of said housing, reaches or exceeds the supercritical temperature of said solvent, and/or, said stream is a high salinity organic wastewater, and/or, said hot-agent is an oxygen gas or air, and/or, the used amount of said hot-agent is 150-350% of the theoretical oxygen demand for the oxidation of said stream.

29. The solid precipitation process of claim 21, wherein a pH regulating

agent is added to said stream and/or to the inner chamber of said housing, and said pH regulating agent is used in such an amount that the pH value of the content in the inner chamber of said housing is maintained at 9-13.

30. The solid precipitation process of claim 21, wherein said stream is a high salinity wastewater, said high salinity wastewater has a TDS of not higher than 20wt%, and a COD of greater than 20000 mg/L.

31. The solid precipitation process of claim 30, wherein said stream is a high salinity organic wastewater, and/or said high salinity wastewater has a TDS of 5-20wt%, and a COD of 20000-40000 mg/L.