Claims

1. A method for processing an acid gas, comprising:

using a first processor for receiving and processing the acid gas to obtain a gas phase stream 1 and a liquid phase stream 2, wherein the stream 2 is partially or completely recycled to the first processor,

using a second processor for processing the stream 1 from the first processor to obtain a gas phase stream 3 and a liquid phase stream 4, which is divided into three sub-streams including a stream 41, a stream 42, and a stream 43, wherein the stream 41 is returned to the first processor as a processing solution used for processing the acid gas, and the stream 42 is recycled to the second processor,

using a third processor for processing the stream 3 from the second processor to obtain a gas phase stream 5 and a liquid phase stream 6, which is divided into two sub-streams including a stream 61 and a stream 62, wherein the stream 61 is returned to the second processor as a processing solution used for processing the stream 1, and the stream 62 is recycled to the third processor, and

using a fourth processor for receiving the stream 43 from the second processor and using the stream 43 as a processing solution for processing the stream 5 from the third processor to obtain a gas phase stream 7 and a liquid phase stream 8, which can be divided into two sub-streams including a stream 81 and a stream 82, wherein the stream 81 is returned to the third processor as a processing solution, and the stream 82 is recycled to the fourth processor.

2. The method of claim 1, wherein the acid gas comprises hydrogen sulfide and carbon dioxide.

3. The method of claim 1 or 2, wherein the stream 61 obtained in the third processor is mixed with a treatment agent and then fed into the second processor to be used as a processing solution.

4. The method of any one of claims 1 to 3, wherein the stream 81 obtained in the fourth processor is mixed with a treatment agent, and then fed into the third processor to be used as a processing solution.

5. The method of any one of claims 1 to 4, wherein the third processor can comprise one or more reactors.

6. The method of any one of claims 3 to 5, wherein the treatment agent is a solution comprising an alkali, preferably at least one selected from a group consisting of a sodium hydroxide solution, a potassium hydroxide solution, and an aqueous ammonia solution, and more preferably a sodium hydroxide solution.

7. The method of any one of claims 3 to 6, wherein the volume flow ratio of the treatment agent added in the second processor to the treatment agent added in the third processor is in the range from 1:1 to 3:1, preferably 3:2 to 5:2.

8. The method of any one of claims 1 to 7, wherein the first processor, the second processor, the third processor, and the fourth processor are each independently selected from a group consisting of a bubble column reactor, a packed column reactor, an impinging stream reactor, a rotating bed reactor, and a Venturi reactor.

9. The method of any one of claims 1 to 8, wherein the first processor and the second processor are respectively Venturi reactors, and the third processor and the fourth processor are respectively rotating bed reactors.

10. The method of claim 9, wherein the rotating speed of the rotating bed reactor is controlled within the range from 50 rpm to 5,000 rpm, preferably 150 rpm to 2,000 rpm.

11. The method of any one of claims 1 to 10, wherein the treatment temperature in the first processor and the second processor is in the range from 70 ºC to 100 ºC, preferably 80 ºC to 95 ºC.

12. The method of any one of claims 1 to 11, wherein the treatment temperature in the third processor and the fourth processor is in the range from 60 ºC to 90 ºC, preferably 65 ºC to 80 ºC.

13. The method of any one of claims 8 to 12, wherein the first processor and the

second processor are respectively Venturi reactors each comprising:

an upper liquid storage tank for receiving and storing liquid streams,

a middle straight reaction tube, a feed section of which has an upper portion extending into the liquid storage tank to form a sleeve structure, and

a lower gas-liquid separation tube which is connected to the straight reaction tube via a lower portion of a discharge section of the straight reaction tube,

wherein the liquid storage tank is provided with a gas phase inlet for receiving a gas to be treated, the gas phase inlet being located above an upper inlet of the feed section of the straight reaction tube, and is provided with a circulating fluid inlet on a sidewall thereof for receiving recycled liquid, so that a liquid stream entering the circulating fluid inlet is first stored in the liquid storage tank at a space below the upper inlet of the feed section of the straight reaction tube, and will overflow when the liquid is level with the upper end of the feed section, thus forming a liquid film on an inner wall of the straight reaction tube, so as to prevent formation of crystals of a material on the inner wall thereof, which would otherwise cause blockage.

14. The method of claim 13, wherein the straight reaction tube of the Venturi reactor is provided with a liquid stream inlet on a tube wall thereof for receiving a liquid stream as a processing solution, wherein the liquid stream inlet is located at a position adjacent to a connecting portion of the liquid storage tank and the straight reaction tube, and the gas-liquid separation tube is provided with a gas phase outlet and a liquid phase outlet.

15. The method of claim 13 or 14, wherein the feed section of the Venturi reactor has a tooth-shaped upper end, which is one selected from a group consisting of sector tooth-shaped, square tooth-shaped, and triangular tooth-shaped upper ends, preferably a triangular tooth-shaped upper end.

16. The method of claim 14, wherein the liquid stream inlet of the Venturi reactor is connected to a liquid phase distributor, which is provided at the center line of the straight reaction tube and can inject an absorption liquid downwardly, wherein 1 to 10, preferably 4 to 6 liquid phase distributors can be arranged.

17. The method of claim 14, wherein the Venturi reactor is used as the first

processor, and the stream 2 that is recycled to the first processor completely or partially enters the first processor via the circulating fluid inlet and an absorption fluid inlet thereof, respectively, wherein the volume flow ratio of the stream that enters the first processor via the circulating fluid inlet to the stream that enters the first processor via the absorption fluid inlet is in the range from 1:6 to 1:2, preferably 1:4 to 1:3.

18. The method of claim 17, wherein the Venturi reactor is used as the second processor and the stream 42 that is recycled to the second processor enters the second processor via the circulating fluid inlet and the absorption fluid inlet thereof, respectively, wherein the volume flow ratio of the stream that enters the second processor via the circulating fluid inlet to the stream that enters the second processor via the absorption fluid inlet is in the range from 1:6 to 1:2, preferably 1:4 to 1:3.

19. An apparatus for processing an acid gas, comprising:

a first processor comprising a first gas inlet and a final liquid outlet;

a second processor comprising a first liquid inlet;

a third processor comprising a second liquid inlet;

a fourth processor comprising a final gas outlet;

a gas stream that enters the apparatus through the first gas inlet in the first processor, passing through all of the four processors, and exits the apparatus through the final gas outlet in the fourth processor;

an alkaline solution that enters the apparatus through the first liquid inlet in the second processor and the second liquid inlet in the third processor simultaneously, passing through all of the four processors, and exits the apparatus through the final liquid outlet in the first processor, and

wherein the gas stream entering the apparatus comprises H_2S and CO_2, and the alkaline solution exiting the apparatus comprises Na_2S and NaHS,

wherein at least one of the first processor, the second process, the third processor, and the fourth processor is a Venturi reactor comprising:

an upper liquid storage tank that stores a first liquid, comprising a gas inlet and a liquid inlet;

a Venturi tube comprising a straight reaction tube, a throat pipe section, a discharge section, a contraction section disposed between the straight reaction tube and the throat pipe section, and an expansion section disposed between the throat pipe section and the discharge section; and

a lower gas-liquid separation tube comprising a second gas outlet and a second liquid outlet,

wherein the straight reaction tube comprises a third liquid inlet upstream from the contraction section and a feed section extending into the upper liquid storage tank so that the upper liquid storage tank discharges the first liquid into the straight reaction tube by causing the aqueous solution to overflow the feed section, and

wherein the discharge section extends into the lower gas-liquid separation tube.

20. The apparatus of claim 19, wherein the first processor, the second processor, the third processor, and the fourth processor are each independently selected from a group consisting of a bubble column reactor, a packed column reactor, an impinging stream reactor, a rotating bed reactor, and the Venturi reactor.

21. The apparatus of claim 20, wherein the first processor and the second processor are respectively Venturi reactors, and the third processor and the fourth processor are respectively rotating bed reactors.

22. The apparatus of claim 19, wherein the liquid stream inlet is located at a position adjacent to a connecting portion of the liquid storage tank and the straight reaction tube.

23. The apparatus of claim 19 or 22, wherein the feed section of the Venturi reactor has a tooth-shaped upper end, which is one selected from a group consisting of sector tooth-shaped, square tooth-shaped, and triangular tooth-shaped upper ends, preferably a triangular tooth-shaped upper end.

24. The apparatus of claim 19 or 22, wherein the liquid stream inlet of the Venturi reactor is connected to a liquid distributor, which is provided at the center line of the

straight reaction tube and can inject absorbed liquid downwardly.