## Claims

1. A system for removing acid gases from a sour gas stream, comprising:

an acid gas removal system for receiving the sour gas stream, the sour gas stream comprising less than about 10% sulfurous components, wherein the acid gas removal system utilizes a cryogenic distillation tower that freezes carbon dioxide and that separates the sour gas stream into an overhead gas stream comprised primarily of methane, and a liquefied bottom acid gas stream comprised primarily of carbon dioxide and sulfurous components; and

a sulfurous components removal system downstream of the acid gas removal system, wherein the sulfurous components removal system receives the bottom acid gas stream and generally separates the bottom acid gas stream into a carbon dioxide fluid stream and a hydrogen sulfide stream, and

wherein the sulfurous components removal system comprises at least one of a solid adsorbent bed and an extractive distillation system.

2. The system of claim 1, wherein the sour gas stream contains between about 4 ppm and 100 ppm sulfurous components.

3. The system of claim 1 or 2, wherein the cryogenic acid gas removal system further comprises a heat exchanger for chilling the sour gas stream before entry into the cryogenic distillation tower.

4. The system of any one of claims 1 to 3, wherein:

the cryogenic distillation tower comprises a lower distillation zone and an intermediate controlled freezing zone that receives a cold liquid spray comprised primarily of methane, the tower receiving and then separating the sour gas stream into an overhead methane stream and the bottom acid gas stream; and

refrigeration equipment downstream of the cryogenic distillation tower for cooling the overhead methane stream and returning a portion of the overhead methane stream to the cryogenic distillation tower as the cold spray.

5. The system of any one of claims 1 to 4, wherein the acid gas removal system is a bulk fractionation system.

6. The system of any one of claims 1 to 5, wherein:

the sulfurous components removal system comprises at least one solid adsorbent bed for substantially adsorbing sulfurous components, the sulfurous components being released as the hydrogen sulfide stream when the at least one solid adsorbent bed is regenerated; and

the at least one solid adsorbent bed substantially passes methane and $CO_2$ as the sour gas stream.

7. The system of claim 6, wherein the solid adsorbent bed (i) is fabricated from a zeolite material, or (ii) comprises at least one molecular sieve.

8. The system of claim 7, wherein the sulfurous components removal system further comprises a separator for separating carbon dioxide from sulfurous components in the hydrogen sulfide stream.

9. The system of any one of claims 6 to 8, wherein the regeneration is part of a pressure-swing adsorption process.

10. The system of claim 9, wherein the at least one solid adsorbent bed comprises at least three adsorbent beds, with: a first of the at least three adsorbent beds being in service for adsorbing hydrogen sulfide;

a second of the at least three adsorbent beds undergoes regeneration; and

a third of the at least three adsorbent beds is held in reserve to replace the first of the at least three adsorbent beds.

11. The system of claim 10, wherein the sulfurous components removal system further comprises a vacuum for applying negative relative pressure to the first of the at least three adsorbent beds to aid in desorbing hydrogen sulfide from the first of the at least three adsorbent beds before the hydrogen sulfide stream enters the separator.

12. The system of any one of claims 6 to 8, wherein the regeneration is part of a thermal-swing adsorption process.

13. The system of claim 12, wherein the at least one solid adsorbent bed comprises at least three adsorbent beds, with:

a first of the at least three adsorbent beds being in service for adsorbing hydrogen sulfide;

a second of the at least three adsorbent beds undergoes regeneration; and

a third of the at least three adsorbent beds is held in reserve to replace the first of the at least three adsorbent beds.

14. The system of claim 13, wherein:

the sulfurous components removal system further comprises a regeneration gas heater for (i) receiving a regenerating gas, (ii) heating the regenerated gas, and (iii) desorbing hydrogen sulfide from the second adsorbent bed by applying heat from the heated regenerated gas to the second adsorbent bed;

the regeneration gas heater releases a gas stream to the first solid adsorbent bed for separation of the gas stream into the hydrogen sulfide stream and the sour gas stream; and

the sulfurous components removal system further comprises a separator for separating out any methane from the hydrogen sulfide stream.

15. The system of claim 14, wherein the sulfurous components removal system further comprises a cooler for receiving the hydrogen sulfide stream and chilling the hydrogen sulfide fluid stream before it enters the separator.

16. The system of any one of claims 1 to 5, wherein:

the sulfurous components removal system comprises at least one solid adsorbent bed for substantially adsorbing hydrogen sulfide, the hydrogen sulfide being released as the hydrogen sulfide stream when the at least one solid adsorbent bed is regenerated; and

the at least one solid adsorbent bed substantially passes methane and carbon dioxide as the sour gas stream.

17. The system of claim 16, wherein the at least one solid adsorbent bed is an adsorptive kinetic separations bed.

18. The system of any one of the preceding claims, wherein the overhead gas stream comprises not only methane, but also helium, nitrogen, or combinations thereof.

19. The system of any one of the preceding claims, wherein the acid gas removal system

further comprises a heat exchanger for chilling the sour gas stream before entry into the distillation tower.

20. The system of claim 19, wherein the cryogenic distillation tower comprises:

a lower distillation zone and an intermediate controlled freezing zone that receives a cold liquid spray comprised primarily of methane, the tower receiving and then separating the sour gas stream into an overhead methane stream and a bottom liquefied acid gas stream; and

refrigeration equipment downstream of the cryogenic distillation tower for cooling the overhead methane stream and returning a portion of the overhead methane stream to the cryogenic distillation tower as liquid reflux.

21. The system of any one of claims 1 to 5, wherein the sulfurous components removal system comprises:

at least one solid adsorbent bed for substantially adsorbing hydrogen sulfide from the bottom acid gas stream, the hydrogen sulfide being released as the hydrogen sulfide stream when the at least one solid adsorbent bed is regenerated; and

the at least one solid adsorbent bed substantially passes acid gases comprising carbon dioxide as the carbon dioxide fluid stream.

22. The system of claim 21, wherein the at least one solid adsorbent bed comprises at least one adsorptive kinetic separations bed.

23. The system of any one of the preceding claims, wherein the sulfurous components removal system comprises an extractive distillation system having at least two extractive distillation columns.

24. The system of claim 23, wherein the extractive distillation system comprises:

a first extractive distillation column that serves as a propane recovery column, the propane recovery column mixing a solvent with the acid gas stream to absorb acid gases, causing the solvent to leave the column as a solvent bottoms stream while separately releasing the carbon dioxide stream;

a second extractive distillation column that serves as a $CO_2$ removal column, the $CO_2$ removal column causing solvent and heavy hydrocarbons to leave the acid gas removal column as a second solvent bottoms stream while separately releasing the $CO_2$; and

a third extractive distillation column that serves as an additive recovery column, the additive recovery column using distillative principles to separate heavy hydrocarbon components, known as "natural gas liquids," from solvent such that a bottom solvent stream is released as a regenerated additive, while natural gas liquids separately exit the column overhead.

25. The system of any one of the preceding claims, wherein the sour gas stream comprises less than about 1% sulfurous components.