

CLAIMS

1. A method for removing a trace amount of mercury in a natural gas feed, comprising:

5 providing a gas feed containing a first concentration of volatile mercury and acid gases;

contacting the gas feed in an absorber with an absorption solution comprising lean amine and a first complexing agent comprising volatile cations selected from ammonium polysulfide, amine polysulfides, and sulfanes, wherein the absorption solution concurrently
10 removes mercury and non-volatile mercury and acid gases from the gas feed;

generating a rich amine solution containing acid gases and at least 50% of the volatile mercury in the gas feed as non-volatile mercury and a treated gas stream with a second concentration of acid gases and mercury.

15 2. The method of claim 1, further comprising:

contacting the treated gas stream with a glycol solution in a dehydrator, wherein the glycol solution contains a second complexing agent for the glycol solution to concurrently remove mercury and water vapor from the treated gas stream,

generating a rich glycol containing non-volatile mercury and a dehydrated gas stream
20 with a reduced concentration of water and a third concentration of mercury, wherein the third concentration of mercury is less than 50% of the second concentration of mercury.

3. The method of claim 2, further comprising:

removing the non-volatile mercury from the rich glycol by at least one of filtration,
25 centrifugation, precipitation, stripping, distillation, adsorption, ion exchange, electrodialysis, a hydrocarbon steam and separation step, and combinations thereof,

generating a recycled glycol stream having a reduced concentration of mercury of less than 50% of the non-volatile mercury in the rich glycol.

30 4. The method of claim 1, wherein the lean amine in the absorption solution is selected from monoethanolamine (MEA), diethanolamine (DEA), methyldiethanolamine (MDEA), aminoethoxyethanol(diglycoamine) (DGA), triethanolamine (TEA), diisopropylamine (DIPA) and mixtures thereof.

5. The method of claim 1, wherein the absorption solution comprising lean amine has a concentration of amine ranging from 15 to 65 wt. %.

6. The method of claim 1, wherein the volatile cation is ammonium polysulfide.

7. The method of claim 1, wherein at least 90% of volatile mercury is removed from the gas feed in the absorption solution.

8. The method of claim 7, wherein at least 95% of volatile mercury is removed from the gas feed in the absorption solution.

9. The method of claim 1, wherein the treated gas stream contains less than 100 $\mu\text{g}/\text{Nm}^3$ mercury.

10. The method of claim 9, wherein the treated gas stream contains less than 10 $\mu\text{g}/\text{Nm}^3$ mercury.

11. The method of claim 10, wherein the treated gas stream contains less than 1 $\mu\text{g}/\text{Nm}^3$ mercury.

12. The method of claim 11, wherein the treated gas stream contains less than 0.1 $\mu\text{g}/\text{Nm}^3$ mercury.

13. The method of claim 1, wherein the complexing agent is added in an amount of less than 5 vol. % of the absorption solution to the absorber.

14. The method of claim 13, wherein the complexing agent is added in an amount of less than 1 vol. % of the absorption solution to the absorber

15. The method of claim 14, wherein the complexing agent is added in an amount of less than 0.5 vol. % of the absorption solution to the absorber.

16. The method of claim 1, further comprising:
heating the rich amine solution containing acid gases and non-volatile mercury in a solvent regeneration process employing at least a stripper and a reboiler, and

generating a lean amine containing non-volatile mercury for recycle in an absorber to remove acid gases.

17. The method of claim 16, further comprising:

5 treating the lean amine to remove the non-volatile mercury by processes selected from the group consisting of filtration, centrifugation, precipitation, reduction to elemental mercury followed stripping, distillation, adsorption, ion exchange, electrodialysis, or transfer to a hydrocarbon steam and separation, and combinations thereof.

10 18. The method of claim 1, wherein the glycol solution further comprises at least one of an anti-foam, a demulsifier, a compatible oxygen scavenger, and mixtures thereof.

19. The method of claim 18, wherein the demulsifier is selected from polyamines, polyamidoamines, polyimines, condensates of o-toluidine and formaldehyde, quaternary
15 ammonium compounds, ionic surfactants, polyoxyethylene alkyl phenols, aromatic sulfonic acid additive, and mixtures thereof.

20. The method of claim 18, wherein the oxygen scavenger is selected from the group of hydrazine salts, guanidine salts, N,N-Diethylhydroxylamine, oximes, dithionites,
20 ascorbic acid, and isoascorbic acid , and mixtures thereof.

21. The method of claim 18, wherein the anti-foam agent is a silicone material.

22. A method for removing a trace amount of mercury in a natural gas feed, comprising:
25 providing a gas feed containing a first concentration of volatile mercury and acid gases; and

contacting the gas feed in an absorber with an absorption solution comprising lean amine and a complexing agent, generating a treated gas stream with a reduced concentration of acid gases and mercury, wherein the absorption solution concurrently removes mercury
30 and acid gases from the gas feed for a rich amine solution containing mercury and acid gases, wherein the complexing agent is selected from ammonium polysulfide, amine polysulfides, calcium polysulfide, sulfanes, and mixtures thereof;

heating the rich amine solution containing acid gases and mercury in a solvent regeneration process employing at least a stripper and a reboiler, wherein at least a portion of the mercury is removed from the rich amine with acid gases as an overhead stream; and

5 treating the overhead stream containing mercury by adsorption in a mercury removal adsorbent bed.