

CLAIMS:

1. A process for removing a first gas component selected from the group consisting of CO₂, N₂, and H₂S from a gas mixture containing said first gas component and a second gas component, which process comprises:

a) conducting said gas mixture to a swing adsorption gas separation unit wherein the gas separation unit contains at least one adsorbent contactor comprised of:

i) a gas inlet end; and

ii) a gas outlet end;

wherein the gas inlet end and the gas outlet end are in fluid connection by a plurality of open flow channels wherein the surface of the open flow channels are comprised of an adsorbent material that has a selectivity for said first gas component over said second gas component of a gas mixture greater than 5, wherein the contactor has less than about 20% of its open pore volume in pores with diameters greater than about 20 angstroms and less than about 1 micron, and wherein at least a fraction of said first gas component is adsorbed into said adsorbent material, thereby resulting in a product stream depleted of said first gas component;

b) collecting said the product stream;

c) desorbing the adsorbed gas from said adsorbent material, thereby resulting in a waste gas stream rich in said first gas component; and

d) collecting said waste gas stream.

2. The process of claim 1 wherein the second gas component is CH₄ and the gas mixture is comprised of natural gas.

3. The process of claim 2 wherein greater than about 90% of the CH_4 in the gas mixture is recovered in the product stream.
4. The process of any preceding claim wherein the adsorbent material is comprised of an 8-ring zeolite that has a Si to Al ratio of about 1:1 to about 1000:1.
5. The process of claim 4 wherein the 8-ring zeolite is DDR.
6. The process of claim 4 wherein the 8-ring zeolite is selected from Sigma-1 and ZSM-58.
7. The process of any of claims 4-6 wherein the 8-ring zeolites are in the form of zeolite crystals which are substantially uniform in size.
8. The process of any preceding claim wherein the first gas is H_2S and the adsorbent material is comprised of a stannosilicate.
9. The process of any preceding claim wherein the adsorbent contactor is comprised of a first adsorption zone comprising a first adsorbent material which is in fluid contact with a second adsorption zone comprising a second adsorbent material, wherein the composition of the first adsorbent material is different from the composition of a second adsorbent material.
10. The process of claim 9 wherein the first adsorbent material has a selectivity for the first gas component of a gas mixture over a second gas component of the gas mixture greater than 5; the second adsorbent material has a selectivity for a third gas component over the second gas component of the gas mixture greater than 5; and the second adsorbent material has a greater adsorption uptake for the third gas component than the first adsorbent material.
11. The process of any of claims 9-10 wherein the first gas component is CO_2 , the second gas component is CH_4 and the third gas component is H_2S .

12. The process of any of claims 9-10 wherein the first gas component is N_2 , the second gas component is CH_4 and the third gas component is H_2S .

13. The process of any preceding claim wherein the adsorbent contactor has less than about 15% of its open pore volume in pores with diameters greater than about 20 angstroms and less than about 1 micron.

14. The process of any preceding claim wherein adsorbent contactor contains an effective amount of a thermal mass material having a higher capacity or adsorbing heat than the adsorbent material.

15. The process of any preceding claim wherein the adsorbent contactor contains both mesopores and macropores and wherein at least some of the mesopores and macropores are occupied with a blocking agent of an effective size so that it is small enough to fit into a mesopore but too large to fit into a micropore.

16. The process of claim 15 wherein the blocking agent is selected from the group consisting of polymers, microporous materials, solid hydrocarbons, and liquids.

17. The process of any preceding claim wherein the adsorbent contactor is in the form selected from: a) monolith comprised of a microporous adsorbent; b) a monolith formed from a non-adsorbent material but whose channels are lined with a microporous adsorbent; c) an array of hollow fibers comprised of a microporous adsorbent; and d) laminated sheets having an upper and lower face both of which are comprised of a microporous adsorbent.

18. The process of claim 17 wherein the channel gap of the open flow channels is from about 5 to about 1000 microns.

19. The process of any of claims 17-18 wherein the ratio of adsorbent volume to open flow channel volume is from about 0.5:1 to about 100:1.

CLAIMS

1. A process for removing a first gas component selected from the group consisting of CO₂, N₂, and H₂S from a gas mixture containing said first gas component and a second gas component, which process comprises:

a) conducting said gas mixture to a swing adsorption gas separation unit wherein the gas separation unit contains at least one adsorbent contactor comprised of:

i) a gas inlet end; and

ii) a gas outlet end;

wherein the gas inlet end and the gas outlet end are in fluid connection by a plurality of open flow channels wherein the surface of the open flow channels are comprised of an adsorbent material that has a selectivity for said first gas component over said second gas component of a gas mixture greater than 5, wherein the contactor has less than about 20% of its open pore volume in pores with diameters greater than about 20 angstroms and less than about 1 micron, and wherein at least a fraction of said first gas component is adsorbed into said adsorbent material, thereby resulting in a product stream depleted of said first gas component;

b) collecting said the product stream;

c) desorbing the adsorbed gas from said adsorbent material, thereby resulting in a waste gas stream rich in said first gas component; and

d) collecting said waste gas stream.

2. The process of claim 1 wherein the second gas component is CH₄ and the gas mixture is comprised of natural gas.

3. The process of claim 2 wherein greater than about 90% of the CH₄ in the gas mixture is recovered in the product stream.

4. The process of claim 1 wherein the adsorbent material is comprised of an 8-ring zeolite that has a Si to Al ratio of about 1:1 to about 1000:1.

5. The process of claim 4 wherein the 8-ring zeolite is DDR.

6. The process of claim 4 wherein the 8-ring zeolite is selected from Sigma-1 and ZSM-58.
7. The process of claim 5 wherein the 8-ring zeolites are in the form of zeolite crystals which are substantially uniform in size.
8. The process of claim 1 wherein the first gas is H_2S and the adsorbent material is comprised of a stannosilicate.
9. The process of claim 1 wherein the adsorbent contactor is comprised of a first adsorption zone comprising a first adsorbent material which is in fluid contact with a second adsorption zone comprising a second adsorbent material, wherein the composition of the first adsorbent material is different from the composition of a second adsorbent material.
10. The process of claim 9 wherein the first adsorbent material has a selectivity for the first gas component of a gas mixture over a second gas component of the gas mixture greater than 5; the second adsorbent material has a selectivity for a third gas component over the second gas component of the gas mixture greater than 5; and the second adsorbent material has a greater adsorption uptake for the third gas component than the first adsorbent material.
11. The process of claim 10 wherein the first gas component is CO_2 , the second gas component is CH_4 and the third gas component is H_2S .
12. The process of claim 10 wherein the first gas component is N_2 , the second gas component is CH_4 and the third gas component is H_2S .
13. The process of claim 10 wherein the first adsorbent material is comprised of an 8-ring zeolite that has a Si to Al ratio of about 1:1 to about 1000:1 and the second adsorbent material is comprised of a stannosilicate.
14. The process of claim 13 wherein the 8-ring zeolite is DDR.
15. The process of claim 13 wherein the 8-ring zeolite is selected from Sigma-1 and ZSM-58.

16. The process of claim 13 wherein the 8-ring zeolites are in the form of zeolite crystals which are substantially uniform in size.

17. The process of claim 1 wherein the adsorbent contactor has less than about 15% of its open pore volume in pores with diameters greater than about 20 angstroms and less than about 1 micron.

18. The process of claim 1 wherein adsorbent contactor contains an effective amount of a thermal mass material having a higher capacity for adsorbing heat than the adsorbent material.

19. The process of claim 1 wherein the adsorbent contactor contains both mesopores and macropores and wherein at least some of the mesopores and macropores are occupied with a blocking agent of an effective size so that it is small enough to fit into a mesopore but too large to fit into a micropore.

20. The process of claim 19 wherein the blocking agent is selected from the group consisting of polymers, microporous materials, solid hydrocarbons, and liquids.

21. The process of claim 1 wherein the adsorbent contactor is a parallel channel contactor.

22. The process of claim 21 wherein the gas mixture is comprised of natural gas containing CH_4 and greater than about 95% of the CH_4 in the gas mixture is recovered in the product stream.

23. The process of claim 21 wherein the adsorbent material is comprised of an 8-ring zeolite selected from DDR, Sigma-1, and ZSM-58 having a Si to Al ratio of about 1:1 to about 1000:1.

24. The process of claim 23 wherein the 8-ring zeolites are in the form of zeolite crystals which are substantially uniform in size.

25. The process of claim 21 wherein the adsorbent contactor is comprised of a first adsorption zone comprising a first adsorbent material which is in fluid contact with a second

adsorption zone comprising a second adsorbent material, wherein the composition of the first adsorbent material is different from the composition of a second adsorbent material.

26. The process of claim 25 wherein the first adsorbent material has a selectivity for the first gas component of said natural gas stream over a second gas component of the gas mixture greater than 5; the second adsorbent material has a selectivity for a third gas component over the second gas component of said natural gas stream greater than 5; and the second adsorbent material has a greater adsorption uptake for the third gas component than the first adsorbent material.

27. The process of claim 26 wherein the first gas component is CO_2 , the second gas component is CH_4 and the third gas component is H_2S .

28. The process of claim 26 wherein the first gas component is N_2 , the second gas component is CH_4 and the third gas component is H_2S .

29. The process of claim 26 wherein the third gas component is H_2S and the second adsorbent material is comprised of a stannosilicate.

30. The process of claim 26 wherein the first adsorbent material is comprised of an 8-ring zeolite selected from DDR, Sigma-1, and ZSM-58 having a Si to Al ratio of about 1:1 to about 1000:1.

31. The process of claim 29 wherein the first adsorbent material is comprised of an 8-ring zeolite selected from DDR, Sigma-1, and ZSM-58 having a Si to Al ratio of about 1:1 to about 1000:1.

32. The process of claim 26 wherein the parallel channel contactor has less than about 15% of its open pore volume in pores with diameters greater than about 20 angstroms and less than about 1 micron.

33. The process of claim 32 wherein the parallel channel contactor is in the form selected from: a) monolith comprised of a microporous adsorbent; b) a monolith formed from a non-adsorbent material but whose channels are lined with a microporous adsorbent; c) an array of hollow fibers comprised of a microporous adsorbent; and d) laminated sheets having an upper and lower face both of which are comprised of a microporous adsorbent.

34. The process of claim 33 wherein the channel gap of the open flow channels is from about 5 to about 1000 microns.

35. The process of claim 33 wherein the ratio of adsorbent volume to open flow channel volume is from about 0.5:1 to about 100:1.