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CLAIMS

What is claimed is:

1. A system for treating a gaseous feed stream, comprising:
a selective component removal system, comprising:
 - 5 a gaseous feed stream inlet configured to pass a gaseous feed stream into a swing adsorption unit having at least one structured adsorbent bed comprising a high surface area solid, wherein:
 - the gaseous feed stream includes a volume of oil droplets and a volume of oil vapor and has a pressure of at least about 1,000 pounds per square inch;
 - 10 the at least one structured adsorbent bed is configured to remove at least a portion of the volume of oil droplets and a portion of the volume of oil vapor to provide a substantially oil-free gaseous outlet stream; and
 - the at least one structured adsorbent bed is regenerated in a kinetic swing adsorption process.
- 15 2. The system of claim 1, wherein the kinetic swing adsorption process is selected from the group consisting of a calcination process, a temperature swing process, a pressure swing process, an inert purge process, and any combination thereof.
- 20 3. The system of claim 2, wherein the system is configured to remove the volume of oil droplets and vapor in a sharp adsorption front as modeled by a Langmuir isotherm.
4. The system of claim 3, wherein the at least one structured adsorbent bed is regenerated by raising the temperature of the structured adsorbent bed to at least about 250°C.
- 25 5. The system of claim 2, wherein the structured adsorbent bed is regenerated by a thermal wave process.
6. The system of claim 2, wherein the structured adsorbent bed is regenerated by a gas or fluid flowed co-currently, counter-currently, or orthogonally (e.g. crossflow) to a flow
30 direction of the gaseous feed stream.

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7. The system of claim 1, further comprising a fluid impermeable housing substantially surrounding the swing adsorption unit.

8. The system of claim 7, wherein the fluid impermeable housing is operable at up to
5 about 10,000 pounds per square inch.

9. The system of claim 2, wherein the structured adsorbent bed is selected from the group consisting of a parallel channel contactor, a structured flow through adsorbent contactor, a flow through adsorbent, and any combination thereof.

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10. The system of claim 9, further comprising a segmented contactor configured to house at least two structured adsorbent beds, wherein each pair of structured adsorbent beds is separated by a seal.

15 11. The system of claim 1, wherein the oil is a substantially ash-free oil.

12. The system of claim 1, wherein the oil is a synthetic composed of a random copolymer of ethylene oxide and propylene oxide.

20 13. The system of claim 12, wherein the random copolymer of ethylene oxide and propylene oxide has an average molecular weight greater than about 1,200 gram/mole and less than or equal to about 2,500 gram/mole.

14. The system of claim 1, further comprising a cooling jacket operatively engaging the at
25 least one structured adsorbent bed.

15. The system of claim 2, further comprising a heater selected from the group consisting of an indirect electric adsorbent bed heater, a direct electric adsorbent bed heater, a direct gas heating fluid, and any combination thereof.

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16. The system of claim 1, further comprising a heat exchanger configured to utilize cooling fluid to cool the substantially oil-free gaseous outlet stream.

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17. The system of claim 1, further comprising an accumulator configured to hold the substantially oil-free gaseous outlet stream.

18. The system of claim 1, wherein the high surface area solid is selected from the group consisting of: alumina, mesoporous solids, and microporous solids.

19. The system of claim 18, wherein the high surface area solid is selected from the group consisting of: aluminas, carbons, activated carbon, charcoal, cationic zeolites, high silica zeolites, highly siliceous ordered mesoporous materials, sol gel materials, ALPO materials (microporous and mesoporous materials containing predominantly aluminum phosphorous and oxygen), SAPO materials (microporous and mesoporous materials containing predominantly silicon aluminum phosphorous and oxygen), MOF materials (microporous and mesoporous materials comprised of a metal organic framework) and ZIF materials (microporous and mesoporous materials comprised of zeolitic imidazolate frameworks).

20. The system of claim 18, wherein the high surface area solid has a surface area greater than about 10 square meters per gram (m^2/gm).

21. The system of claim 3, wherein greater than 99.99999 percent of the oil is removed from the gaseous feed stream.

22. The system of claim 18, wherein the high surface area solid is a 12-14 ring zeolite with a Si to Al ratio of more than about 50:1.

23. The system of claim 18, wherein the high surface area solid is an ordered mesoporous material of the M41S family.

24. The system of claim 1, further comprising a conditioning unit.

25. A method of treating a gaseous feed stream, comprising:
providing a gaseous feed stream having a volume of oil therein;
treating a portion of the gaseous feed stream using a selective component removal system having at least one swing adsorption process unit to form a utility stream for use in a

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utility component, wherein the at least one swing adsorption process unit includes a structured adsorbent bed comprising a high surface area solid and configured to remove at least a portion of the volume of oil;

regenerating the swing adsorption process unit in a calcination process;

5 feeding the utility stream into the utility component, wherein the utility stream is compatible with the utility component; and

utilizing the utility stream in the utility component.

26. The method of claim 25, wherein the gaseous feed stream contains at least one
10 hydrocarbon component.

27. The method of claim 25, wherein the gaseous feed stream is a compressor discharge stream.

15 28. The method of claim 25, wherein the gaseous feed stream is a high pressure process stream.

29. The method of any one of claims 25-28, wherein the gaseous feed stream is at a pressure above the critical point of the gaseous feed stream.

20 30. The method of claim 28, wherein the gaseous feed stream is at a pressure of from at least about 100 bar to at least about 500 bar.

31. The method of claim 28, wherein the gaseous feed stream is at a pressure of from at
25 least about 200 bar to at least about 320 bar.

32. The method of any one of claims 25-31, wherein at least one of the at least one utility component is selected from the group consisting of a compressor, a compressor string, a turbo-expander compressor, a turbo-expander generator, a pump, a fired steam boiler, a fired
30 process heater, a gas engine, a hermetically sealed direct-drive electric motor, turbomachinery equipped with magnetic bearings, and a gas turbine.

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33. The method of claim 32, wherein the first utility stream is utilized as a dry seal gas for at least one of a dry gas seal, a labyrinth seal, and a mechanical seal in the at least one utility component.

5 34. The method of claim 33, wherein the at least one swing adsorption process unit is selected from the group of units consisting of a pressure swing adsorption (PSA) unit, a thermal swing adsorption (TSA) unit, a partial pressure swing or displacement purge
10 adsorption (PPSA) unit, a rapid cycle thermal swing adsorption (RCTSA) unit, a rapid cycle pressure swing adsorption (RCPSA) unit, a rapid cycle partial pressure swing or displacement purge adsorption (RCPPSA) unit, a compact PSA, a compact TSA, a compact PPSA, and any combination thereof.

35. The method of claim 34, wherein the selective component removal system (SCRS) further comprises at least one of an absorption unit, a membrane separation unit, a molecular
15 sieve, a distillation tower, and a glycol contactor.

36. A structured adsorbent contactor, comprising:
an inlet end;
an outlet end; and
20 a plurality of open flow channels extending from the inlet end to the outlet end, wherein a portion of the plurality of open flow channels are sealed at the inlet end and the remainder of the plurality of flow channels are sealed at the outlet end, and wherein the surface of the open flow channels are comprised of a structured adsorbent material having a selectivity for a first component of a mixture over a second component of the mixture greater
25 than one.

37. The contactor of claim 36, wherein the contactor has less than about 20 volume percent of its open pore volume in pores with diameters greater than about 20 angstroms and less than about one micron.

30 38. The structured adsorbent contactor of claim 36, wherein the adsorbent material has a selectivity for oil over CH₄ greater than about 10.

39. The adsorbent contactor of claim 36 wherein the adsorbent material is comprised of a high surface area solid material selected from the group consisting of alumina, mesoporous solids, and microporous solids.

40. The adsorbent contactor of claim 39 wherein the adsorbent material is a structured microporous adsorbent selected from the group consisting of zeolites, titanosilicates, ferrosilicates, stannosilicates, aluminophosphates (ALPOs), silicaaluminophosphates (SAPOs), microporous and mesoporous activated carbons, mesoporous materials, structured mesoporous materials, and carbon molecular sieves.

41. The adsorbent contactor of claim 40 wherein the structured microporous adsorbent is a zeolite selected from the group consisting of MFI, faujasite, and Beta.

42. The adsorbent contactor of claim 40 wherein the structured microporous adsorbent is comprised of a molecular sieve selected from the group consisting of carbons, activated carbons, charcoal, cationic zeolites, high silica zeolites, highly siliceous ordered mesoporous materials, sol gel materials, aluminophosphates (ALPOs), silicaaluminophosphates (SAPOs), metal organic framework (MOF) materials, and zeolitic imidazolate framework (ZIF) materials.

43. The adsorbent contactor of claim 42, wherein the structured microporous adsorbent is an 12-14 ring zeolite with a Si to Al ratio of more than about 50:1.

CLAIMS

1. A system for treating a gaseous feed stream, comprising: a selective component removal system, comprising: a gaseous feed stream inlet configured to pass a gaseous feed stream into a swing adsorption unit having at least one
5 structured adsorbent bed comprising a high surface area solid, the high surface area solid being selected from the group consisting of aluminas, carbons, activated carbon, charcoal, cationic zeolites, high silica zeolites, highly siliceous ordered mesoporous materials, sol gel materials, ALPO materials (microporous and mesoporous materials containing predominantly aluminum phosphorous and
10 oxygen), SAPO materials (microporous and mesoporous materials containing predominantly silicon aluminum phosphorous and oxygen), MOF materials (microporous and mesoporous materials comprised of a metal organic framework) and ZIF materials (microporous and mesoporous materials comprised of zeolitic imidazolate frameworks), wherein:
- 15 the gaseous feed stream includes a volume of oil droplets and a volume of oil vapor and has a pressure of at least about 1,000 pounds per square inch;
the at least one structured adsorbent bed is configured to remove at least a portion of the volume of oil droplets and a portion of the volume of oil vapor to provide a substantially oil-free gaseous outlet stream; and
20 the at least one structured adsorbent bed is regenerated in a kinetic swing adsorption process.
2. The system of claim 1, wherein the kinetic swing adsorption process is selected from the group consisting of a calcination process, a temperature swing process, a pressure swing process, an inert purge process, and any combination
25 thereof.
3. The system of claim 1 or 2, wherein the system is configured to remove the volume of oil droplets and vapor in a sharp adsorption front as modeled by a Langmuir isotherm.

4. The system of any one of claims 1 to 3, wherein the at least one structured adsorbent bed is regenerated by raising the temperature of the structured adsorbent bed to at least about 250°C.
5. The system of any one of claims 1 to 3, wherein the structured adsorbent bed is regenerated by a thermal wave process.
6. The system of any one of claims 1 to 3, wherein the structured adsorbent bed is regenerated by a gas or fluid flowed co-currently, counter-currently, or orthogonally (e.g. crossflow) to a flow direction of the gaseous feed stream.
7. The system of any one of the preceding claims, further comprising a fluid impermeable housing substantially surrounding the swing adsorption unit.
8. The system of claim 7, wherein the fluid impermeable housing is operable at up to about 10,000 pounds per square inch.
9. The system of any one of the preceding claims, wherein the structured adsorbent bed is selected from the group consisting of a parallel channel contactor, a structured flow through adsorbent contactor, a flow through adsorbent, and any combination thereof.
10. The system of claim 9, further comprising a segmented contactor configured to house at least two structured adsorbent beds, wherein each pair of structured adsorbent beds is separated by a seal.
11. The system of any one of the preceding claims, wherein the oil is a substantially ash-free oil.
12. The system of any one of the preceding claims, wherein the oil is a synthetic composed of a random copolymer of ethylene oxide and propylene oxide.

13. The system of claim 12, wherein the random copolymer of ethylene oxide and propylene oxide has an average molecular weight greater than about 1,200 gram/mole and less than or equal to about 2,500 gram/mole.
14. The system of any one of the preceding claims, further comprising a
5 cooling jacket operatively engaging the at least one structured adsorbent bed.
15. The system of any one of claims 2 to 14, further comprising a heater selected from the group consisting of an indirect electric adsorbent bed heater, a direct electric adsorbent bed heater, a direct gas heating fluid, and any combination thereof.
- 10 16. The system of any one of the preceding claims, further comprising a heat exchanger configured to utilize cooling fluid to cool the substantially oil-free gaseous outlet stream.
17. The system of any one of the preceding claims, further comprising an accumulator configured to hold the substantially oil-free gaseous outlet stream.
- 15 18. The system of any one of the preceding claims, wherein the high surface area solid has a surface area greater than about 10 square meters per gram (m^2/gm).
19. The system of any one of claims 3 to 18, wherein greater than 99.99999 percent of the oil is removed from the gaseous feed stream.
- 20 20. The system of any one of the preceding claims, wherein the high surface area solid is a 12-14 ring zeolite with a Si to Al ratio of more than about 50:1.
21. The system of any one of the preceding claims, wherein the high surface area solid is an ordered mesoporous material of the M41S family.
22. The system of any one of the preceding claims, further comprising a
25 conditioning unit.

23. A method of treating a gaseous feed stream, comprising:
providing a gaseous feed stream having a volume of oil therein;
treating a portion of the gaseous feed stream using a selective component removal system having at least one swing adsorption process unit to form a utility stream for use in a utility component, wherein the at least one swing adsorption process unit includes a structured adsorbent bed comprising a high surface area solid, the high surface area solid being selected from the group consisting of aluminas, carbons, activated carbon, charcoal, cationic zeolites, high silica zeolites, highly siliceous ordered mesoporous materials, sol gel materials, ALPO materials (microporous and mesoporous materials containing predominantly aluminum phosphorous and oxygen), SAPO materials (microporous and mesoporous materials containing predominantly silicon aluminum phosphorous and oxygen), MOF materials (microporous and mesoporous materials comprised of a metal organic framework) and ZIF materials (microporous and mesoporous materials comprised of zeolitic imidazolate frameworks) and configured to remove at least a portion of the volume of oil;
regenerating the swing adsorption process unit in a calcination process;
feeding the utility stream into the utility component, wherein the utility stream is compatible with the utility component and wherein the utility stream is a dry seal gas; and
utilizing the utility stream in the utility component.
24. The method of claim 23, wherein the gaseous feed stream contains at least one hydrocarbon component.
25. The method of claim 23, wherein the gaseous feed stream is a compressor discharge stream.
26. The method of claim 23, wherein the gaseous feed stream is a high pressure process stream.
27. The method of any one of claims 23-26, wherein the gaseous feed stream is at a pressure above the critical point of the gaseous feed stream.

28. The method of claim 26, wherein the gaseous feed stream is at a pressure of from at least about 100 bar to at least about 500 bar.

29. The method of claim 26, wherein the gaseous feed stream is at a pressure of from at least about 200 bar to at least about 320 bar.

5 30. The method of any one of claims 23-29, wherein the utility component is selected from the group consisting of a compressor, a compressor string, a turbo-expander compressor, a turbo-expander generator, a pump, a fired steam boiler, a fired process heater, a gas engine, a hermetically sealed direct-drive electric motor, turbomachinery equipped with magnetic bearings, and a gas turbine.

10 31. The method of claim 30, wherein the utility stream is utilized as a dry seal gas for at least one of a dry gas seal, a labyrinth seal, and a mechanical seal in the at least one utility component.

32. The method of claim 31, wherein the at least one swing adsorption process unit is selected from the group of units consisting of a pressure swing adsorption (PSA) unit, a thermal swing adsorption (TSA) unit, a partial pressure swing or displacement purge adsorption (PPSA) unit, a rapid cycle thermal swing adsorption (RCTSA) unit, a rapid cycle pressure swing adsorption (RCPSA) unit, a rapid cycle partial pressure swing or displacement purge adsorption (RCPPSA) unit, a compact PSA, a compact TSA, a compact PPSA, and any combination
15 thereof.
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33. The method of claim 32, wherein the selective component removal system (SCRS) further comprises at least one of an absorption unit, a membrane separation unit, a molecular sieve, a distillation tower, and a glycol contactor.

34. The system of any one of claims 1 to 21, wherein the structured adsorbent
25 bed comprises:
an inlet end;
an outlet end; and

a plurality of open flow channels extending from the inlet end to the outlet end, wherein a portion of the plurality of open flow channels are sealed at the inlet end and the remainder of the plurality of flow channels are sealed at the outlet end, and wherein the surface of the open flow channels are comprised of a structured adsorbent material having a selectivity for a first component of a mixture over a second component of the mixture greater than one.

35. The system of claim 9 or 10, wherein the contactor has less than about 20 volume percent of its open pore volume in pores with diameters greater than about 20 angstroms and less than about one micron.

10 36. The system of claim 34 or 35, wherein the adsorbent material has a selectivity for oil over CH₄ greater than about 10.

37. The system of any one of claims 1 to 23 or 34 to 36 wherein the structured microporous adsorbent is a zeolite selected from the group consisting of MFI, faujasite, and Beta.

15 38. The system of claim 37, wherein the structured mesoporous adsorbent is selected from the M41S family.

39. The system of claim 38, wherein the structured microporous adsorbent is an 12-14 ring zeolite with a Si to Al ratio of more than about 50:1.