

Claims

1. A fiber-based adsorption contactor, the contactor comprising:
a chamber comprising:
 - a feed stream inlet;
 - a feed stream outlet;
 - a heat transfer fluid inlet;
 - a heat transfer fluid outlet;
 - a plurality of substantially aligned hollow fibers, wherein each of the hollow fibers comprises:
 - a plurality of tortuous pathways, wherein the tortuous pathways are in fluid communication with the feed stream inlet and the feed stream outlet;
 - a sorbent material;
 - a lumen disposed within the hollow fiber, wherein the lumen is in fluid communication with the heat transfer fluid inlet and the heat transfer fluid outlet; and
 - a barrier layer lining the lumen to prevent fluid communication between the lumen and the plurality of tortuous pathways.
2. The fiber-based adsorption contactor of Claim 1, wherein the sorbent material is in fluid communication with at least a portion of the plurality of tortuous pathways.
3. The fiber-based adsorption contactor of Claim 1, wherein the barrier layer lining the lumen is present in at least a substantial majority of the hollow fibers.
4. The fiber-based adsorption contactor of Claim 1, wherein at least one of the plurality of hollow fibers further comprises an end cap disposed at a longitudinal end of the fiber, and the end cap does not inhibit fluid flow of a heat transfer fluid either into or out of the lumen.

5. The fiber-based adsorption contactor of Claim 4, wherein the end cap prevents fluid communication between the plurality of tortuous pathways and the heat transfer fluid in at least a substantial majority of the hollow fibers.
6. The fiber-based adsorption contactor of Claim 4, further comprising a binder material effective to interconnect adjacent fibers, which in conjunction with the end caps, prevents fluid communication between the heat transfer medium and the plurality of tortuous pathways of adjacent fibers.
7. The fiber-based adsorption contactor of Claim 1, wherein a feed stream passing from the feed stream inlet to the feed stream outlet is a flue gas, natural gas, fuel gas, bio gas, town gas, waste gas, water, coal gas, air, or a carbon dioxide-containing medium.
8. The fiber-based adsorption contactor of Claim 1, wherein the contactor is used in a temperature swing adsorption process.
9. The fiber-based adsorption contactor of Claim 4, wherein the heat transfer fluid is water, water vapor, steam, gas, or combinations thereof.
10. The fiber-based adsorption contactor of claim 1, wherein the sorbent material has a selectivity for adsorbing CO₂ over nitrogen of greater than 5.
11. The fiber-based adsorption contactor of Claim 1, wherein the sorbent material has a selectivity for carbon dioxide over nitrogen of about 10 to about 60 and a heat of sorption of about -25 kiloJoules per mole of carbon dioxide to about -90 kiloJoules per mole of carbon dioxide.
12. A method of adsorbing a component of a medium, the method comprising:
contacting a medium with a hollow fiber comprising a plurality of tortuous pathways, a sorbent material in fluid communication with the plurality of tortuous pathways, a lumen disposed within the hollow fiber, and a barrier layer lining the

lumen to prevent fluid communication between the lumen and the plurality of tortuous pathways; and

selectively adsorbing a component of the medium with the sorbent material.

13. The method of adsorbing a component of a medium of Claim 12, further comprising desorbing the component of the medium.

14. The method of adsorbing a component of a medium of Claim 12, wherein the medium comprises flue gas, natural gas, fuel gas, bio gas, town gas, waste gas, water, coal gas, air, or a carbon dioxide containing medium.

15. The method of adsorbing a component of a medium of Claim 12, further comprising preventing fluid communication between the medium and a heat exchange fluid.

16. The method of adsorbing a component of a medium of Claim 13, further comprising repeating the contacting and adsorbing.

17. The method of adsorbing a component of a medium of Claim 16, wherein a cycle time between successive adsorptions is less than about 2 minutes.

18. The method of adsorbing a component of a medium of Claim 12, wherein the component is selected from CO₂, SO_x, NO_x, and water.

19. The method of adsorbing a component of a medium of Claim 12, wherein the component is CO₂.

20. The method of adsorbing a component of a medium of Claim 19, wherein the medium is comprised of CO₂ and nitrogen, and the sorbent material has a selectivity for adsorbing CO₂ over nitrogen of greater than 5.

21. The method of adsorbing a component of a medium of Claim 19, wherein the medium is comprised of CO₂ and nitrogen, and the sorbent material has a selectivity for carbon dioxide over nitrogen of about 10 to about 60 and a heat of sorption of

about -25 kiloJoules per mole of carbon dioxide to about -90 kiloJoules per mole of carbon dioxide.

22. The method of adsorbing a component of a medium of Claim 20, wherein the medium comprises at least one of a flue gas, natural gas, fuel gas, bio gas, town gas, waste gas, water, coal gas, air, or other carbon dioxide-containing medium.

23. The method of claim 20, wherein the medium is comprised of a flue gas stream.

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 - a heat transfer fluid inlet;
 - a heat transfer fluid outlet;
 - a plurality of substantially aligned hollow fibers, wherein each of the hollow fibers comprises:
 - a plurality of tortuous pathways, wherein the tortuous pathways are in fluid communication with the feed stream inlet and the feed stream outlet;
 - a sorbent material;
 - a lumen disposed within the hollow fiber, wherein the lumen is in fluid communication with the heat transfer fluid inlet and the heat transfer fluid outlet; and
 - a barrier layer lining the lumen to prevent fluid communication between the lumen and the plurality of tortuous pathways.
2. The fiber-based adsorption contactor of claim 1, wherein the sorbent material is in fluid communication with at least a portion of the plurality of tortuous pathways.
3. The fiber-based adsorption contactor of claim 1, wherein the barrier layer lining the lumen is present in at least a substantial majority of the hollow fibers.
4. The fiber-based adsorption contactor of claim 1, wherein at least one of the plurality of hollow fibers further comprises an end cap disposed at a longitudinal end of the fiber, and the end cap does not inhibit fluid flow of a heat transfer fluid either into or out of the lumen.

5. The fiber-based adsorption contactor of claim 4, wherein the end cap prevents fluid communication between the plurality of tortuous pathways and the heat transfer fluid in at least a substantial majority of the hollow fibers.
6. The fiber-based adsorption contactor of claim 4, further comprising a binder material effective to interconnect adjacent fibers, which in conjunction with the end caps, prevents fluid communication between the heat transfer medium and the plurality of tortuous pathways of adjacent fibers.
7. The fiber-based adsorption contactor of claim 4, wherein the heat transfer fluid is water, water vapor, steam, gas, or combinations thereof.
8. The fiber-based adsorption contactor of claim 1, wherein a feed stream passing from the feed stream inlet to the feed stream outlet is a flue gas, natural gas, fuel gas, bio gas, town gas, waste gas, water, coal gas, air, or a carbon dioxide-containing medium.
9. The fiber-based adsorption contactor of claim 1, wherein the contractor is used in a temperature swing absorption process.
10. The fiber-based adsorption contactor of claim 1, wherein the sorbent material has a selectivity for adsorbing CO₂ over nitrogen of greater than 5.
11. The fiber-based adsorption contactor of claim 1, wherein the sorbent material has a selectivity for carbon dioxide over nitrogen of about 10 to about 60 and a heat of sorption of about -25 kiloJoules per mole of carbon dioxide to about -90 kiloJoules per mole of carbon dioxide.