

CLAIMS

1. A method comprising:
 - a. treating a syngas stream from a gasification process or an industrial waste gas by adsorbing on an adsorbent a component comprising at least one of a hydrocarbon, an oxygenate, a sulfur compound, a nitrogen compound, or any combination thereof and generating a treated stream;
 - b. fermenting at least a portion of the treated stream in a bioreactor using a microorganism to generate an effluent comprising at least one product and a tail gas stream comprising at least carbon dioxide;
 - c. regenerating the adsorbent by at least partially desorbing the component using at least a portion of the tail gas stream to provide an enriched tail gas stream comprising the carbon dioxide and the desorbed component; and
 - d. utilizing the enriched tail gas stream in at least one of:
 - i. combusting in a steam boiler to produce steam;
 - ii. generating power;
 - iii. recycling to a gasification process; or
 - iv. passing to a product recovery zone.
2. The method of claim 1 wherein the tail gas further comprises methane, carbon monoxide, and hydrogen.
3. The method of claim 1 wherein the microorganism is one or more C1-fixing microorganisms.
4. The method of claim 3 wherein C1-fixing microorganism is selected from *Moorella*, *Clostridium*, *Ruminococcus*, *Acetobacterium*, *Eubacterium*, *Butyribacterium*, *Oxobacter*, *Methanosarcina*, and *Desulfotomaculum*.
5. The method of claim 1 wherein the steam is high pressure steam.
6. The method of claim 1 further comprising employing the steam for distillation of fermentation products, operation of an adsorption chiller, steam driven compression, evaporation of waste water, drying of biomass, steam in place operations, clean in place operations, drying of feedstock, steam driven feedstock conveyors, heating of buildings, generation of power, and generating power to power a compressor of the fermentation process.
7. The method of claim 1 wherein the industrial waste gas is from processes selected from ferrous metal products manufacturing, non-ferrous products manufacturing, petroleum

- refining, electric power production, carbon black production, paper and pulp manufacturing, ammonia production, methanol production, coke manufacturing, and any combination thereof, and or the syngas stream is from the gasification of coal, gasification of refinery residues, gasification of biomass, gasification of lignocellulosic material, black liquor gasification, gasification of municipal solid waste, gasification of industrial solid waste, gasification of sewerage, gasification of sludge from wastewater treatment, reforming of natural gas, reforming of biogas, reforming of landfill gas or any combination thereof.
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8. The process of claim 1 wherein the generating power is cogeneration or direct generation.
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9. The process of claim 1 wherein the tail gas stream, as compared to the syngas stream from a gasification process or the industrial waste gas, is
- a. enriched in N₂;
- b. enriched in CO₂;
- 15 c. depleted in impurities; or
- d. any combination of (a) (b) or (c).
10. The process of claim 9 wherein the desorbing the component using at least a portion of the tail gas stream is improved as compared to desorbing the component using a syngas stream.
- 20
11. A method comprising:
- a. gasifying a gasification feedstock to produce syngas comprising at least carbon monoxide, hydrogen, water, and tars;
- b. cooling the syngas to separate water and at least one tar by condensation and provide a remainder of the syngas depleted in water and at least one tar;
- 25 c. disposing of the at least one tar by:
- i. combusting the at least one tar using a flame produced by the combustion of fuel gas, natural gas, syngas, tail gas from a gas fermentation process, or any combination thereof; or
- ii. passing the at least one tar to a wastewater treatment process; and
- 30 d. fermenting at least a portion of the remainder of the syngas in a bioreactor using a microorganism to generate an effluent comprising at least one product.
12. The method of claim 11 further comprising removing at least a second tar from the syngas by adsorption using an adsorbent.

13. The method of claim 12 wherein the fermenting further generates the tail gas.
14. The method of claim 13 further comprising regenerating the adsorbent using the tail gas.
15. The method of claim 14 further comprising utilizing the tail gas after regenerating the adsorbent to generate steam.
16. The method of claim 15 further comprising using the steam to generate electricity.
17. The method of claim 16 further comprising using the electricity to power a compressor of the fermenting step.
18. An apparatus comprising:
- a. an adsorption unit housing an adsorbent;
 - b. a bioreactor in fluid communication with the adsorption unit;
 - c. a tail gas conduit in fluid communication with the bioreactor and the adsorption unit;
 - d. an enriched tail gas utilization unit comprising at least one of
 - i. a gasifier in fluid communication with the adsorption unit;
 - ii. a steam generation unit;
 - iii. a power production unit; or
 - iv. a product recovery unit in fluid communication with the bioreactor; and
 - e. an enriched tail gas conduit in fluid communication with the adsorption unit and the enriched tail gas utilization unit.
19. The apparatus of claim 18 further comprising a steam conduit in fluid communication with the steam generation unit and a power generation system.
20. The apparatus of claim 19 further comprising a compressor in electrical communication with the power generation system and in fluid communication with the bioreactor.
21. The apparatus of claim 18 wherein the power production unit is a cogeneration power production unit or a direct power production unit.
22. The apparatus of claim 18 further comprising a feedstock conduit in fluid communication with the adsorption unit.