CLAIMS:

1. A method for generating hydrogen in a refinery, the method comprising: introducing a fuel stream comprising a reformable fuel into an anode of a molten carbonate fuel cell, an internal reforming element associated with the anode, or a combination thereof; introducing a cathode inlet stream comprising CO_2 and O_2 into a cathode of the molten carbonate fuel cell; generating electricity within the molten carbonate fuel cell; generating an anode exhaust comprising H_2 and CO_2; performing a separation (e.g., using a membrane) on the anode exhaust to form a CO_2-rich gas stream having a CO_2 content greater than a CO_2 content of the anode exhaust, and a CO_2-depleted gas stream having a CO_2 content less than the CO_2 content of the anode exhaust, which CO_2-depleted gas stream optionally comprises an H_2-rich gas stream and a syngas stream; and delivering the CO_2-depleted gas stream to one or more second refinery processes.

2. The method of Claim 1, wherein the cathode inlet stream comprises one or more CO_2-containing streams derived directly or indirectly from one or more first refinery processes.

3. The method of Claim 1 or 2, wherein the molten carbonate fuel cell is operated at a thermal ratio from about 0.25 to about 1.5 (e.g., from about 0.25 to about 1.3, from about 0.25 to about 1.15, from about 0.25 to about 1.0, from about 0.25 to about 0.85, or from about 0.25 to about 0.75).

4. The method of any of the above claims, further comprising separating H_2O from at least one of the anode exhaust, the CO_2-depleted stream, and the CO_2-rich stream in one or more separation stages.

5. The method of any of the above claims, wherein an amount of the reformable fuel introduced into the anode, the internal reforming element associated with the anode, or the combination thereof, provides a reformable fuel surplus ratio of at least about 1.5 (e.g., at least about 2.0, at least about 2.5 or at least about 3.0).

6. The method of any of the above claims, wherein a ratio of net moles of syngas in the anode exhaust to moles of CO_2 in a cathode exhaust is at least about 2.0 (e.g., at least about 3.0, at least about 4.0, at least about 5.0, at least about 10.0, or at

least about 20.0), and optionally is about 40.0 or less (e.g., about 30.0 or less or about 20.0 or less).

7. The method of any of the above claims, wherein a fuel utilization in the anode is about 50% or less (e.g., about 45% or less, about 40% or less, about 35% or less, about 30% or less, about 25% or less, or about 20% or less) and a CO_2 utilization in the cathode is at least about 60% (e.g., at least about 65%, at least about 70%, or at least about 75%).

8. The method of any of the above claims, wherein the molten carbonate fuel cell is operated at a first operating condition to generate electrical power and at least about 50 mW/cm^2 (e.g., at least about 80 mW/cm^2 or at least 100 mW/cm^2) of waste heat, the first operating condition providing a current density of at least about 150 mA/cm^2, and wherein an effective amount of an endothermic reaction is performed to maintain a temperature differential between an anode inlet and an anode outlet of about 100°C or less (e.g., about 80°C or less or about 60°C or less).

9. The method of Claim 8, wherein performing the endothermic reaction consumes at least about 40% (e.g., at least about 50%, at least about 60%, or at least about 75%) of the waste heat.

10. The method of any of the above claims, wherein an electrical efficiency for the molten carbonate fuel cell is between about 10% and about 40% (e.g., between about 10% and about 35%, between about 10% and about 30%, between about 10% and about 25%, or between about 10% and about 20%) and a total fuel cell efficiency for the molten carbonate fuel cell is at least about 55% (e.g., at least about 60%, at least about 65%, at least about 70%, at least about 75%, or at least about 80%).

11. The method of any of the above claims, wherein one or more of the following are satisfied: at least one process in the one or more first refinery processes is a process in the one or more second refinery processes; the fuel stream is derived from one or more third refinery processes; and the anode exhaust has a molar ratio of H_2 to CO of at least about 3.0:1, and has a CO_2 content of at least about 10 vol%.

12. The method of any of the above claims, wherein at least a portion of the fuel stream passes through a pre-reforming stage prior to being introduced into the anode.

~~13. The method of any of the above claims, wherein at least a portion of the~~ fuel stream passes through a desulfurization stage prior to being introduced into the anode.

14. The method of any of the above claims, further comprising modifying an H_2 content of one or more of the anode exhaust, the CO_2-rich gas stream, and the a CO_2-depleted gas stream using a water gas shift process.

15. The method of any of the above claims, wherein the CO_2-depleted gas stream is further separated into a first H_2-rich stream having a first H_2 purity and a second H_2-rich stream having a second H_2 purity, wherein the second H_2-rich stream is ~~compressed to a pressure greater than the first H_2-rich stream.~~

CLAIMS:

1. A method for generating hydrogen in a refinery, the method comprising:

introducing a fuel stream comprising a reformable fuel into an anode of a molten carbonate fuel cell, an internal reforming element associated with the anode, or a combination thereof;

introducing a cathode inlet stream comprising CO_2 and O_2 into a cathode of the molten carbonate fuel cell;

generating electricity within the molten carbonate fuel cell;

generating an anode exhaust comprising H_2 and CO_2;

performing a separation on the anode exhaust to form a CO_2-rich gas stream having a CO_2 content greater than a CO_2 content of the anode exhaust, and a CO_2-depleted gas stream comprising hydrogen and having a CO_2 content less than the CO_2 content of the anode exhaust; and

delivering the CO_2-depleted gas stream to one or more second refinery processes,

wherein the molten carbonate fuel cell is operated (i) such that a CO_2 utilization in the cathode is at least about 60% and either (ii) so as to achieve a thermal ratio from about 0.25 to about 1.15, or (iii) such that an amount of the reformable fuel introduced into the anode, the internal reforming element associated with the anode, or the combination thereof, provides a reformable fuel surplus ratio of at least about 1.5, or (iv) both (ii) and (iii).

2. The method of claim 1, wherein the cathode inlet stream comprises one or more CO_2-containing streams derived directly or indirectly from one or more first refinery processes.

3. The method of claim 1, further comprising separating H_2O from at least one of the anode exhaust, the CO_2-depleted stream, and the CO_2-rich stream in one or more separation stages.

4. The method of claim 1, wherein a ratio of net moles of syngas in the anode exhaust to moles of CO_2 in a cathode exhaust is at least about 2.0.

5. The method of claim 1, wherein a fuel utilization in the anode is about 50% or less and/or wherein an amount of the reformable fuel introduced into the anode, the internal reforming element associated with the anode, or the combination thereof, provides a reformable fuel surplus ratio of at least about 2.0 and/or wherein the molten carbonate fuel cell is operated at a thermal ratio from about 0.25 to about 1.0.

6. The method of claim 1, wherein the molten carbonate fuel cell is operated to generate electrical power at a current density of at least about 150 mA/cm^2 and at least about 80 mW/cm^2 of waste heat, the method further comprising performing an effective amount of an endothermic reaction to maintain a temperature differential between an anode inlet and an anode outlet of about 100°C or less.

7. The method of claim 6, wherein performing the endothermic reaction consumes at least about 40% of the waste heat.

8. The method of claim 1, wherein an electrical efficiency for the molten carbonate fuel cell is between about 10% and about 40% and/or a total fuel cell efficiency for the molten carbonate fuel cell is at least about 55%.

9. The method of claim 1, wherein the CO_2-depleted gas stream comprises an H_2-rich gas stream and a syngas stream, each of which having a CO_2 content less than the CO_2 content of the anode exhaust.

10. The method of claim 2, wherein at least one process in the one or more first refinery processes is a process in the one or more second refinery processes.

11. The method of claim 2, wherein the fuel stream is derived from one or more third refinery processes.

12. The method of claim 11, wherein at least a portion of the fuel stream passes through a pre-reforming stage prior to being introduced into the anode.

13. The method of claim 11, wherein at least a portion of the fuel stream passes through a desulfurization stage prior to being introduced into the anode.

14. The method of claim 9, further comprising separating H_2O from one or more of the anode exhaust, the CO_2-rich gas stream, and the a CO_2-depleted gas stream.

15. The method of claim 2, wherein the anode exhaust has a molar ratio of H_2 to CO of at least about 3.0:1, and has a CO_2 content of at least about 10 vol %.

16. The method of claim 2, further comprising modifying an H_2 content of one or more of the anode exhaust, the CO_2-rich gas stream, and the a CO_2-depleted gas stream using a water gas shift process.

17. The method of claim 2, wherein the separating of the anode exhaust comprises using a membrane.

18. The method of claim 1, wherein the CO_2-depleted gas stream is further separated into a first H_2-rich stream having a first H_2 purity and a second H_2-rich stream having a second H_2 purity, wherein the second H_2-rich stream is compressed to a pressure greater than the first H_2-rich stream.

19. The method of claim 1, wherein at least one of the one or more second refinery processes involves using hydrogen as a reactant and/or as a combustant.

20. The method of claim 1, wherein the molten carbonate fuel cell is operated at steady state conditions with regard to the CO_2 utilization in the cathode, the thermal ratio, and/or the reformable fuel surplus ratio.