

WHAT IS CLAIMED IS:

1. A primary enclosure wall assembly (8045) for balancing temperature within a solid oxide fuel cell (SOFC) stack, the primary enclosure wall assembly comprising:

a combustion region wall defining a combustion region around an outlet end of the SOFC stack for collecting spent fuel flow and spent cathode air flow exiting the SOFC stack, wherein the spent fuel and the spent cathode air mix, combust and generate heat in the combustion region wherein the heat is transferred from the combusted mixture to the combustion region wall by convection; and a first sidewall depending from the combustion region wall along the SOFC stack gas flow axis (x), wherein: the sidewall has a distal end adjacent an inlet end of the SOFC stack; the heat absorbed by the combustion region wall is thermally conducted to the distal end of the first sidewall; and

the heat conducted to the distal end of the first sidewall radiates from surfaces of the first side wall that extend from combustion region wall to inlet end of the SOFC stack to outside surfaces of a cell, and is transferred to a cathode air flow by convection, to reduce a temperature of the combustion region wall and increase a temperature of surfaces of the first side wall that extend from combustion region wall to the inlet end of the SOFC stack.

2. The primary enclosure wall assembly (8045) of Claim 1 further comprising: a second sidewall depending from the combustion region wall opposing the sidewall; wherein the first side wall and the second sidewall face opposing side of the SOFC stack; first and second hot zone enclosure end walls (8080, 8085) coupled to each of the first sidewall, and the second sidewall enclose the SOFC stack inside of a cathode chamber (8055).

3. The primary enclosure wall assembly (8045) of Claim 1 further comprising a fuel input manifold (8015) or a hot zone enclosure base wall or an intermediate chamber enclosure base wall (9010) disposed to provide a bottom boundary of the cathode chamber.

4. The hot zone enclosure assembly (8042) of Claim 1, wherein the combustion region wall and the first sidewall comprises a thermally conductive core having a coefficient of thermal conductivity that is greater than 100 W/m²K at temperatures above 350° c.

5. The hot zone enclosure assembly (8042) of Claim 2, wherein the combustion region wall, the first sidewall and the second side wall comprises a thermally conductive core having a coefficient of thermal conductivity that is greater than 100 W /m²K at temperatures above 3 50°.

6. The hot zone enclosure assembly (8042) of Claim 5, wherein the thermally conductive core is fabricated from material selected from the group consisting of: copper and copper alloys; molybdenum; aluminum copper alloys; copper nickel alloys; and combinations thereof.

7. The hot zone enclosure assembly (8042) of Claim 6 wherein the fuel cell stack shape is selected from the group consisting of: oval shaped, square shaped, rectangular, and triangular.

8. The hot zone enclosure assembly of Claim 1, wherein the SOFC stack includes one or more rows of SOFC cells separated by the sidewall.

9. The hot zone enclosure assembly of Claim 8, further comprising: a first outer sidewall depending from the combustion region wall and enclosing a first of the at least two rows with the sidewall; and a second outer sidewall depending from the combustion region wall and enclosing a second of the at least two rows with the sidewall, wherein the first and second outer sidewalls receive heat from the combustion region wall by thermal conduction and radiate heat to the inlet end of the SOFC stack.

10. A method of manufacturing an enclosure wall assembly, the method comprising:

a) forming a thermally conductive core;

b) shaping the thermally conductive core, such that an exterior surface of the thermally conductive core is positioned to face an SOFC stack along a longitudinal axis (x) thereof and to extend between a fuel output end (8025) and a fuel input end (8020) of individual fuel cells of the SOFC stack; and

c) shielding the thermally conductive core from oxidation with a protective layer such that contact between the thermally conductive core is protected by the protective layer from exposure to oxygen rich cathode air flow.

11. The method of manufacturing an enclosure wall assembly in Claim 10, further comprising forming a plurality of thermally conductive cores.

12. The method of manufacturing an enclosure wall assembly in Claim 10, wherein shaping the thermally conductive core comprises shaping the thermally conductive core into a U-shaped structure.

13. The method of manufacturing an enclosure wall assembly in Claim 10 further comprising forming input ports that pass through the protective layer.

14. A Solid Oxide Fuel Cell (SOFC) system comprising:
a primary wall assembly (8045) configured to enclose a cathode chamber (8055) therein and formed to provide one or more thermally conductive pathways extending between different regions of the primary wall assembly; and
an SOFC stack (8005) enclosed by the primary wall assembly, wherein a first portion of the primary wall assembly receives heat from a combustion region enclosed by the primary wall assembly conducts the heat to a second portion of the primary wall assembly, and the second portion radiates heat to a first portion of the solid oxide fuel cell and transfers heat to a cathode air flow passing by surfaces of the primary wall assembly by heat exchange.
15. A method of forming a hot zone enclosure comprising the steps of:
providing a sheet of a thermally conductive material that forms from a thermally conductive pathway;
protecting the sheet from oxidation by applying outer layers to exposed surfaces thereof;
and
mounting the flat sheet adjacent an SOFC stack so that the sheet extends from a hot portion to a cold portion of the SOFC stack for conducting heat from the hot portion and radiating heat to the cold portion.
16. A method as recited in Claim 15, wherein the thermally conductive core (8200) has a thickness in the range of 0.127 to 6.0 mm, (0.005 to 0.24 inches).
17. A method as recited in Claim 15, further comprising the step of bending the thermally conductive core to form a U-shaped element.
18. A method as recited in Claim 15, wherein protective layer includes nickel plating applied by an electro-plating or electroless plating process to a thickness of at least 0.0005 inches to prevent oxygen diffusion there through at operating temperatures of 350 to 1200° C.
19. A method as recited in Claim 15, wherein protective layer is formed via anodizing, thermal spraying, plasma spraying, chemical deposition.
20. A method wherein the protective layer is formed via a cladding process including thermal bonding, hot pressing, cold pressing, impact pressing, co-rolling or co-extrusion.
21. A method as recited in Claim 15, wherein at least one of the outer layers forms an oxide layer during operation of the SOFC stack.

22. A hot zone enclosure assembly (8042) for balancing temperature in a solid oxide fuel cell (SOFC) stack, the hot zone enclosure assembly comprising:

a combustion region wall defining a combustion region around an outlet end of the SOFC stack for collecting anode fuel and cathode air exiting the SOFC stack, wherein the anode fuel and the cathode air, burn and generate heat in the combustion region so that the heat is absorbed by the combustion region wall; and

a sidewall depending from the combustion region wall along the SOFC stack, wherein: the sidewall has a distal end adjacent an inlet end of the SOFC stack; the absorbed heat passes by conduction to the distal end of the sidewall; and the absorbed heat radiates from the distal end to the inlet end of the SOFC stack to balance temperature along the SOFC stack.

23. The hot zone enclosure assembly (8042) of Claim 22 further comprising:

a second sidewall depending from the combustion region wall opposing the sidewall;

a hot zone enclosure base wall (8075) coupled to the sidewall (8070) and the second sidewall; and

first and second hot zone enclosure end walls (8080, 8085) coupled to the combustion region wall, the sidewall, and the second sidewall to enclose the SOFC stack.

24. The hot zone enclosure assembly (8042) of Claim 22, wherein the combustion region wall comprises a thermally conductive core.

25. The hot zone enclosure assembly (8042) of Claim 24, wherein the thermally conductive core has a coefficient of thermal conductivity that is greater than $1.00 \text{ W/m}^\circ\text{K}$ at temperatures above 350°C .

26. The hot zone enclosure assembly (8042) of Claim 24, wherein the thermally conductive core is fabricated from material selected from the group consisting of: copper; molybdenum; aluminum copper; copper nickel alloys; and combinations thereof.

27. The hot zone enclosure assembly (8042) of Claim 22 further comprising a fuel input manifold (8015) adjacent to an inlet end of the SOFC stack.

28. The hot zone enclosure assembly (8042) of Claim 22 wherein the SOFC stack is configured to receive a cathode gas from an external air flow source, the cathode gas reacting with a cathode layer surface of a fuel cell within the SOFC stack.

29. The hot zone enclosure assembly (8042) of Claim 28 wherein the fuel cell stack shape is selected from the group consisting of: oval shaped, square shaped, rectangular, and triangular.

30. The hot zone enclosure assembly of Claim 22, wherein the SOFC stack is at least two rows of SOFC cells separated by the sidewall.

31. The hot zone enclosure assembly of Claim 30, further comprising: a first outer sidewall depending from the combustion region wall and enclosing a first of the at least two rows with the sidewall; and a second outer sidewall depending from the combustion region wall and enclosing a second of the at least two rows with the sidewall, wherein the first and second outer sidewalls receive heat from the combustion region wall by thermal conduction and radiate heat to the inlet end of the SOFC stack.

32. A method of manufacturing an enclosure wall assembly, the method comprising:
a) forming a thermally conductive core;
b) shaping the thermally conductive core, such that an exterior surface of the thermally conductive core is positioned to face an SOFC stack; and
c) shielding the thermally conductive core from oxidation with a protective layer such that contact between the thermally conductive core is protected by the protective layer from exposure to oxygen rich cathode air flow.

33. The method of manufacturing an enclosure wall assembly in Claim 32, further comprising forming a plurality of thermally conductive cores.

34. The method of manufacturing an enclosure wall assembly in Claim 32, wherein shaping the thermally conductive core comprises shaping the thermally conductive core into a T-shaped structure.

35. The method of manufacturing an enclosure wall assembly in Claim 32 further comprising forming input ports that pass through the protective layer.

36. A Solid Oxide Fuel Cell (SOFC) system comprising:
an elongated SOFC stack disposed inside a hot zone cavity along an axis, wherein the elongated SOFC stack has a top end and a bottom end; and
a thermal mass receiving heat from the hot zone cavity, conducting heat from the top end to the bottom end along the axis, and radiating heat to the bottom end radially with respect to the axis.