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Hydrogen catalysis power cell for energy conversion systems

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ABSTRACT

An energy conversion system is provided for generating heat based on hydrogen catalysis and for transferring the generated heat to a working fluid and utilizing the heat or converting it to mechanical or electrical energy. The energy conversion system comprises a hydrogen catalysis power cell, the power cell comprising a heat transfer assembly having at least one reaction chamber containing the means to dissociate molecular hydrogen gas to atomic hydrogen and a delivery assembly connected in fluid communication to the reaction chamber for delivering hydrogen gas and vaporous catalyst for hydrogen catalysis. The delivery assembly comprises a catalyst vessel for generating the vaporous catalyst, a source of hydrogen gas, and a semi-permeable membrane assembly connected in fluid communication with the hydrogen gas source and the heat transfer assembly. The power cell further comprises means for regulating the temperature of the catalyst vessel and means for regulating the temperature surrounding the semi-permeable membrane. An energy conversion system is also provided having a hydrogen catalysis power cell as described herein, a working fluid for receiving the heat released from hydrogen catalysis, means for converting the heat in the working fluid to mechanical or electrical energy, and preferably means to balance the heat removed by the working fluid with the energy produced by hydrogen catalysis.

CLAIMS

Claims:

1. A power cell for generating heat based on hydrogen catalysis and for transferring said generated heat to a working fluid, the power cell comprising:
(a) a heat transfer assembly comprising at least one enclosed, vacuum-tight reaction chamber containing a means for dissociating molecular hydrogen gas into atomic hydrogen;
(b) a delivery assembly connected in fluid communication with the reaction chamber for delivering hydrogen gas and vaporous catalyst for hydrogen catalysis to the heat transfer assembly, the delivery assembly comprising (1) a catalyst vessel for generating vaporous catalyst for hydrogen catalysis, (2) a source of hydrogen gas, and (3) a semi-permeable membrane assembly connected in fluid communication with the hydrogen gas source and the heat transfer assembly, which membrane assembly contains a semi-permeable membrane which permits the passage of hydrogen but substantially inhibits the passage of vaporous catalyst therethrough;

(c) means for regulating the temperature of the catalyst vessel;
and (d) means for regulating the temperature surrounding the semi-permeable membrane.

2. The power cell of claim 1, wherein the heat transfer assembly further comprises a header for distributing hydrogen gas and vaporous catalyst to said at least one reaction chamber.

3. The power cell of claim 1, wherein the heat transfer assembly further comprises a means for passage of working fluid in proximity with the reaction chamber to receive the heat generated by the hydrogen catalysis reaction in the reaction chamber.

4. The power cell of claim 3, wherein the heat transfer assembly is enclosed in an evacuated housing.

5. The power cell of claim 3, further comprising means for controlling heat transfer from the reaction chamber to said means for passage of working fluid in proximity with the reaction chamber.

6. The power cell of claim 5, wherein the means for controlling heat transfer from the reaction chamber to said means for passage of working fluid comprises a radiation shield.

7. The power cell of claim 3, wherein the means for regulating the temperature of the catalyst vessel and the means for regulating the temperature surrounding the semi-permeable membrane comprise a radiation shield for regulating heat evolved in the reaction chamber radiating to the delivery assembly.

8. The power cell of claim 7, wherein the radiation shield comprises an apertured grating slidably movable over an apertured stationary grating.
9. The power cell of claim 1, wherein the means for dissociating hydrogen gas is a catalyst for the dissociation of hydrogen gas.

10. The power cell of claim 9, wherein the catalyst is coated on a substrate surface in said at least one reaction chamber.

11. The power cell of claim 9, wherein the catalyst forms a lattice structure in the reaction chamber and the reaction chamber further comprises:

(a) an inner wall surrounding the lattice structure;

(b) an outer wall surrounding the inner wall, the outer wall having an interior surface and an exterior surface; and (c) an evacuated annular space between the inner wall and the outer wall.

12. The power cell as in claim 11, wherein the reaction chamber further comprises a surface coating lining the interior surface of the outer wall, which surface coating promotes the transfer of heat from within the reaction chamber to the working fluid.

13. The power cell of claim 1, wherein the semi-permeable membrane assembly comprises a collection housing enclosing the semi-permeable membrane, which membrane is shaped to form a closed internal space within the collection housing, said internal space being in communication with the hydrogen gas source, said collection housing having an inlet end and an outlet end, said outlet end connected in fluid communication with the heat transfer assembly, so that hydrogen gas passing through the membrane and collected in the collection housing is directed to the reaction chamber.

14. The power cell of claim 1, wherein at least one of the semi-permeable membrane assembly and the catalyst vessel are independently connected in fluid communication with said at least one reaction chamber.

15. The power cell of claim 1, wherein the semi-permeable membrane comprises palladium-coated tantalum.

16. The power cell of claim 1, further comprising a heater for supplying heat to the catalyst to generate vaporous catalyst.

17. The power cell of claim 16, wherein the heater comprises heating elements surrounding the exterior of the catalyst vessel.

18. The power cell of claim 1, wherein the semi-permeable membrane assembly is positioned within the reaction chamber.

19. The power cell of claim 1, wherein the means for regulating the temperature of the catalyst vessel comprises a conduit for carrying a heated working fluid from the heat transfer assembly to the delivery assembly.

20. The power cell of claim 19, wherein the means for regulating the temperature of the catalyst vessel further comprises a conduit for returning a working fluid from the delivery assembly to the heat transfer assembly.

21. The power cell of claim 1, wherein the means for regulating the temperature surrounding the semi-permeable membrane comprises a conduit for carrying a heated working fluid from the heat transfer assembly to the delivery assembly.

22. The power cell of claim 21, wherein the means for regulating the temperature surrounding the semi-permeable membrane further comprises a conduit for returning a working fluid from the delivery assembly to the heat transfer assembly.

23. The power cell of claim 1, wherein the power cell further comprises means for evacuating the reaction chamber.

24. The power cell of claim 1, wherein the power cell further comprises means for terminating hydrogen catalysis within the reaction chamber.

25. The power cell of claim 1, wherein the power cell further comprises means for initiating hydrogen catalysis within the reaction chamber.

26. The power cell of claim 1, wherein the working fluid is water and the power cell further comprises means to separate steam from water vapor.

27. A method for utilizing heat released from a hydrogen catalysis reaction, the method comprising:

(a) introducing hydrogen gas and vaporous catalyst into a reaction chamber of a power cell;

(b) dissociating hydrogen molecules of the gas into hydrogen atoms;

(c) reacting hydrogen atoms and catalyst in a reaction such that (i) the reaction of a hydrogen atom with a catalyst has a net enthalpy of reaction of about m.cndot. 27.21 eV, where m is an integer, which results in a hydrogen atom having a binding energy greater than about 13.6 eV and the release of energy, or (ii) the reaction of two or more hydrogen atoms having a binding energy greater than about 13.6 eV results in a net release of energy and at least one hydrogen atom having a binding energy higher than the initial binding energy of said hydrogen atom before the reaction.

(d) transferring the released heat to a working fluid.

28. The method of claim 27, wherein the catalyst is potassium iodide.

29. The method of claim 27, wherein the partial pressure of the hydrogen gas in said reaction chamber is from about 50 millitorr to about 100 torr, and the partial pressure of catalyst in said reaction chamber is from about 50 millitorr to about 100 torr.

30. The method of claim 27, wherein the power cell comprises (a) a heat transfer assembly comprising at least one enclosed, vacuum-tight reaction chamber containing a means for dissociating molecular hydrogen gas into atomic hydrogen;

(b) a delivery assembly connected in fluid communication with the reaction chamber for delivering hydrogen gas and vaporous catalyst for hydrogen catalysis to the heat transfer assembly, the delivery assembly comprising (1) a catalyst vessel for generating vaporous catalyst for hydrogen catalysis, (2) a source of hydrogen gas, and (3) a semi-permeable membrane assembly connected in fluid communication with the hydrogen gas source and the heat transfer assembly, which membrane assembly contains a semi-permeable membrane which permits the passage of hydrogen but substantially inhibits the passage of vaporous catalyst therethrough;

(c) means for regulating the temperature of the catalyst vessel;
and (d) means for regulating the temperature surrounding the semi-permeable membrane.

31. An energy conversion system for converting thermal energy released by hydrogen catalysis, the energy conversion system comprising:

(a) a hydrogen catalysis power cell as set forth in claim 1;

(b) a working fluid for receiving the heat released from hydrogen catalysis;

(c) means for converting the heat in the working fluid to mechanical or electrical energy.

32. The energy conversion system of claim 31, further comprising means for balancing the heat energy extracted by the working fluid with heat produced from hydrogen catalysis and consumed by said means for converting the heat in the working fluid to mechanical or electrical energy.

33. The energy conversion system of claim 32, wherein the means for balancing the heat energy extracted by the working fluid with heat produced from hydrogen catalysis and consumed by said means for converting the heat in the working fluid to mechanical or electrical energy comprises an automated control system.

34. The energy conversion system of claim 33, wherein the control system comprises means to control at least one of the rate of hydrogen catalysis, the temperature of the working fluid, the heat capacity of the working fluid, the amount of heat delivered to the heat transfer assembly, the amount of heat taken from the heat transfer assembly, and the power consumed by the means for converting the heat in the working fluid to mechanical or electrical energy.

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