SYSTEMS AND METHODS FOR MANAGING A FUEL CELL

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of US Provisional Application number 61/569,133 filed 09-DEC-2011, which is incorporated in its entirety by this reference.

TECHNICAL FIELD

[0002] This invention relates generally to the fuel cell field, and more specifically to a new and useful system and method of managing a fuel cell system in the fuel cell field.

BACKGROUND

[0003] In many applications, fuel cell systems provide a compelling solution as a portable power source, due to their portability and low carbon footprint.

[0004] However, the fuel cell systems often require long startup times to bring the fuel cells and fuel cartridges up to operational temperatures. These long startup times can be prohibitive to wide consumer adoption of fuel cell systems as power sources, especially with the ubiquity of preexisting power sources, such as wall outlets connected to an electrical grid. However, since preexisting power sources tend to be immobile and not easily portable, it can be desirable for users to utilize preexisting power sources in certain settings and the fuel cell system in others.

[0005] Thus, there is a need in the fuel cell system field to create an improved system and method of allowing and leveraging multiple power source usage.

SUMMARY OF DISCLOSURE

[0005a] In accordance with a first aspect of the embodiment, a method of operating a power adapter for a load is disclosed. The power adapter includes a fuel cell system including a fuel supply and a fuel cell stack. The power adapter also includes an energy storage device electrically connected to the fuel cell system. The fuel supply includes a fuel generator including a fuel storage composition storing fuel in a chemically bound form that thermolyses at a decomposition temperature to generate fuel. The method includes

determining a connectivity state of an auxiliary power source with the energy storage device;

determining a connectivity state of a load with the fuel cell system;

selecting a power adapter operation mode based on the connection states of the auxiliary power source and the load, the operation modes comprising:

an auxiliary mode when the auxiliary power source is connected to the energy storage device and the load is connected to the fuel cell system, comprising: providing power from the auxiliary power source to the load, and providing power to the fuel cell system, preheating the fuel storage composition to a temperature lower than the decomposition temperature with power from the auxiliary power source, measuring a parameter of the fuel cell system indicative of power generation from the fuel cell system, and ceasing power generation when the measured parameter indicates power generation by cooling the fuel supply below the decomposition temperature;

a fuel cell mode when the auxiliary power source is disconnected from the energy storage device and the load is connected to the fuel cell system, comprising: providing fuel to the fuel cell stack from the fuel source, generating power from the fuel by the fuel cell stack, and providing the generated power to the load; and

wherein the measured parameter is indicative of energy generation when the fuel supply temperature exceeds a decomposition temperature of a fuel storage composition of the fuel supply.

[0005b] In accordance with a second aspect of the embodiment, a power adapter for a load is disclosed. The power adapter includes a fuel cell system including

a fuel cell system comprising:

a fuel generator that generates fuel from a fuel storage composition, the fuel storage composition storing fuel in chemically bound form that thermolyses at a decomposition temperature to generate fuel;

a fuel cell stack, fluidly coupled to the fuel generator, that converts fuel from the fuel generator into electrical power;

a rechargeable battery electrically connected to the fuel cell system that receives power from an auxiliary power source;

a control circuit, electrically connected to the battery and the fuel cell system, that controls power provision from the battery to the fuel cell system, the control circuit operable between:

a connected mode when the power conditioning unit is electrically connected to the auxiliary power source; and

a disconnected mode when the power conditioning unit is electrically disconnected from the auxiliary power source and the load is electrically connected to the fuel cell system, wherein the control circuit powers the fuel cell system with power from the battery;

an energy generation control system connected to the fuel cell system that ceases energy generation by the fuel cell system upon satisfaction of a cessation condition, wherein the energy generation control system comprises one or more of a cooling system that cools the fuel supply below the decomposition temperature when the cessation condition is satisfied and a valve that seals a fuel flow path from the fuel supply to the fuel cell system when the cessation condition is satisfied; and,

wherein the fuel generator comprises a heating element thermally connected to the fuel storage composition.

BRIEF DESCRIPTION OF THE FIGURES

[0006] FIGURE 1 is a schematic representation of a power adapter for a load.

[0007] FIGURE 2 is a schematic representation of a fuel generator.

[0008] FIGURES 3-11 are schematic representations of a first, second, third, fourth, fifth, sixth, seventh, and eighth variation of a power adapter.

[0009] FIGURE 12 is a schematic representation of a method of power adapter operation.

[0010] FIGURE 13 is a schematic representation of the power adapter operating in a variation of the auxiliary mode. [0011] FIGURE 14 is a schematic representation of the power adapter operating in a second variation of the auxiliary mode.

Claims

We claim:

1. A method of operating a power adapter for a load, the power adapter including a fuel cell system including a fuel supply and a fuel cell stack, the power adapter also including an energy storage device electrically connected to the fuel cell system, wherein the fuel supply comprises a fuel generator comprising a fuel storage composition storing fuel in a chemically bound form that thermolyses at a decomposition temperature to generate fuel, the method comprising:

determining a connectivity state of an auxiliary power source with the energy storage device;

determining a connectivity state of a load with the fuel cell system;

selecting a power adapter operation mode based on the connection states of the auxiliary power source and the load, the operation modes comprising:

an auxiliary mode when the auxiliary power source is connected to the energy storage device and the load is connected to the fuel cell system, comprising: providing power from the auxiliary power source to the load, and providing power to the fuel cell system, preheating the fuel storage composition to a temperature lower than the decomposition temperature with power from the auxiliary power source, measuring a parameter of the fuel cell system indicative of power generation from the fuel cell system, and ceasing power generation when the measured parameter indicates power generation by cooling the fuel supply below the decomposition temperature;

a fuel cell mode when the auxiliary power source is disconnected from the energy storage device and the load is connected to the fuel cell system, comprising: providing fuel to the fuel cell stack from the fuel source, generating power from the fuel by the fuel cell stack, and providing the generated power to the load; and

wherein the measured parameter is indicative of energy generation when the fuel supply temperature exceeds a decomposition temperature of a fuel storage composition of the fuel supply.

~~2. The method of claim 1, wherein the auxiliary mode further comprises pre-heating the fuel cell system.~~

~~3~~2. The method of claim ~~2~~1, wherein pre-heating the fuel cell system comprises heating the fuel cell stack to a fuel cell stack operational temperature.

~~4~~3. The method of claim ~~3~~2, wherein heating the fuel cell stack to a fuel cell stack operational temperature comprises heating the fuel cell stack to the operational temperature with power from the auxiliary power source.

~~5~~4. The method of claim 1, wherein the fuel source comprises a fuel generator, wherein providing fuel to the fuel cell stack comprises providing power to the fuel generator to initiate fuel generation.

~~6~~5. The method of claim ~~5~~4, ~~wherein the fuel generator thermolyses a fuel storage composition at a decomposition temperature to generate fuel,~~ wherein providing power to the fuel generator to initiate fuel generation comprises ~~providing heating~~ powering one or more heaters in the fuel generator to thermolyse the fuel storage composition ~~to the degradation~~at the decomposition temperature.

~~7~~6. The method of claim ~~6~~5, wherein heating the fuel storage composition to the decomposition ~~degradation~~ temperature comprises heating the fuel generator with power from the energy storage device.

~~8. The method of claim 6, wherein the auxiliary mode further comprises pre-heating the fuel storage composition to a temperature lower than the decomposition temperature.~~

~~9. The method of claim 8, wherein pre-heating the fuel storage composition comprises pre-heating the fuel generator with power from the auxiliary power source.~~

~~10~~7. The method of claim 1, further comprising selecting a pre-heating mode when the auxiliary power source is connected to the energy storage device, comprising pre-heating the fuel cell system.

~~11~~8. The method of claim 1, wherein providing the generated power to the load further comprises supplementing the generated power with power from the energy storage device to meet a power demand from the load.

~~12. The method of claim 1, wherein the auxiliary mode further comprises:~~

~~measuring a parameter of the fuel cell system indicative of power generation from the fuel cell system; and~~

~~ceasing energy production when the measured parameter indicates power generation.~~

~~13~~9. The method of claim ~~12~~1, wherein measuring a parameter of the fuel cell system comprises measuring the temperature of the fuel supply~~, wherein the measured parameter is indicative of energy generation when the fuel supply temperature exceeds a degradation temperature of a fuel storage composition of the fuel supply, and wherein ceasing energy production comprises cooling the fuel supply below the degradation temperature~~.

~~14~~10. The method of claim 1, wherein providing power from the auxiliary power source to the load comprises conditioning the auxiliary power into power suitable for the load and providing the conditioned power to the load.

~~15~~11. The method of claim ~~14~~10, wherein providing power from the auxiliary power source to the load comprises routing auxiliary power to the energy storage device, converting the auxiliary power into power suitable for the load at the energy storage device, and routing the power from the energy storage device to the load.

~~16~~12. A power adapter for a load, the power adapter comprising:

a fuel cell system comprising:

a fuel generator that generates fuel from a fuel storage composition, the fuel storage composition storing fuel in chemically bound form that thermolyses at a decomposition temperature to generate fuel;

a fuel cell stack, fluidly coupled to the fuel generator, that converts fuel from the fuel generator into electrical power;

a rechargeable battery electrically connected to the fuel cell system that receives power from an auxiliary power source;

a control circuit, electrically connected to the battery and the fuel cell system, that controls power provision from the battery to the fuel cell system, the control circuit operable between:

a connected mode when the power conditioning unit is electrically connected to the auxiliary power source; and

a disconnected mode when the power conditioning unit is electrically disconnected from the auxiliary power source and the load is electrically connected to the fuel cell system, wherein the control circuit powers the fuel cell system with power from the battery;

an energy generation control system connected to the fuel cell system that ceases energy generation by the fuel cell system upon satisfaction of a cessation condition, wherein the energy generation control system comprises one or more of a cooling system that cools the fuel supply below the decomposition temperature when the cessation condition is satisfied and a valve that seals a fuel flow path from the fuel supply to the fuel cell system when the cessation condition is satisfied; and,

wherein the fuel generator comprises a heating element thermally connected to the fuel storage composition.

~~17. The power adapter of claim 16, wherein the fuel storage composition comprises a thermolytic composition that thermolyses at a degradation temperature to generate fuel, wherein the fuel generator comprises a heating element thermally connected to the fuel storage composition.~~

~~18~~13. The power adapter of claim ~~16~~12, wherein the battery has a maximum energy capacity large enough to simultaneously power the fuel cell system and the load for a predetermined period of time.

~~19~~14. The power adapter of claim ~~16~~12, further comprising a charging circuit, wherein the charging circuit regulates an amount of power supplied from the auxiliary power supply to the battery based on a state of charge of the battery and a rate of power consumption from the energy storage device.

~~20~~15. The power adapter of claim ~~19~~14, wherein the control circuit, when in connected mode, powers the load and the fuel cell system with power from the auxiliary power source.

~~21~~16. The power adapter of claim ~~16~~12, further comprising a power converter electrically connected to a battery inlet that converts power from the auxiliary power source into power suitable for the battery.

~~22~~17. The power adapter of claim ~~21~~16, wherein the power converter is located within an auxiliary power connector that removably connects to the battery and the auxiliary power source.

~~23~~18. The power adapter of claim ~~16~~12, further comprising a power converter electrically connected between the battery and the fuel cell system that converts power from the battery into power suitable for the fuel cell system.

~~24. The power adapter of claim 16, further comprising an energy generation control system connected to the fuel cell system that ceases energy generation by the fuel cell system upon satisfaction of a cessation condition.~~

~~25~~19. The power adapter of claim ~~24~~12, wherein the cessation condition is satisfied when the auxiliary power supply is connected to the energy storage device and a fuel flow rate from the fuel supply to the fuel cell stack is greater than a predetermined flow rate.

~~26. The power adapter of claim 25, wherein the energy generation control system comprises a cooling system that cools the fuel supply when the cessation condition is satisfied.~~

~~27~~20. The power adapter of claim ~~26~~12, wherein the energy generation control system comprises a cooling system ~~comprises~~ comprising one or more of a fan, a cold plate, and a piezo-electric heat pump~~a fan~~.

~~28. The power adapter of claim 25, wherein the energy generation control system comprises a valve that seals a fuel flow path from the fuel supply to the fuel cell system when the cessation condition is satisfied.~~