temperature relative to temperature changes in its environment. The lag in temperature changes relative to the section that is exposed and thermally coupled to the environment creates the required temperature differential needed for the thermoelectric converter to operate. However, the need to include a heat capacity material and thermal insulation limits the practicality of such converters. Further, conversion effectiveness decreases as parasitic heat conduction through the device's structure becomes more and more overwhelming as the size of the device is reduced.

[0004] The present inventor disclosed ambient energy converters containing a mass of hygroscopic material within a housing that is in fluid communication with ion conductive membrane electrode assembly coupled to the housing to allow the passage of ionized water or water vapor through the ion conductive membrane electrode and into contact with the hygroscopic solution. The previously disclosed converters generate power driven by changes in temperature and humidity whereby moisture from ambient air transitions into and out of the hygroscopic liquid through the membrane electrode assembly to generate power as the hygroscopic material maintains thermodynamic equilibrium with ambient vapor pressure and temperature. The prior converter is limited to operating in environments where there are changes in humidity and/or temperature.

[0005] Thus, the need remains for an ambient energy converter that can generate electricity by extracting heat from the environment without the need for transients in temperature or humidity. It is towards this need that the present invention is directed.

BRIEF SUMMARY OF THE INVENTION

[0006] In accordance with a first aspect of the invention, there is provided a heat to electric energy converter for operation with a working fluid being in gas and liquid phases, the electric energy converter comprises a first electrode, the first electrode being

hygroscopic at a first working fluid absorption potential, a second electrode, the second electrode being hygroscopic at a working fluid absorption potential that is different from the absorption potential of the first electrode whereby a voltage potential exist between the two electrodes, an electrochemical barrier, the barrier being coupled between the first electrode and second electrode and conducting at least one ion species of the working fluid between the first electrode and the second electrode, and the first and second electrode being exposed to and coupled to each other by a gas, the gas comprising at least one constituent of the working fluid.

[0006a] In accordance with a second aspect of the invention, there is provided a heat to electric energy converter operational with a working fluid comprises a membrane electrode assembly, the membrane electrode assembly comprising a condensing electrode, an evaporating electrode, and an electrochemical barrier sandwiched between the first electrode and the second electrode, the barrier being coupled between the first electrode and second electrode and conducting a single ions species of the working fluid between the first electrode and the second electrode, the first and second electrode being exposed to and coupled to each other by a gas, the gas comprising at least one constituent of the working fluid, the electrodes maintaining working fluid gas phase absorption equilibrium relative to each other, the converter producing DC electrical current with connection of a load circuit between the two electrodes through pseudo flow of working fluid via oxidation reduction reactions from the condensing electrode to the evaporating electrode as working fluid ions are conducted through the electrochemical barrier as working fluid gas passes from the evaporating electrode to the condensing electrode.

[0006b] In accordance with a third aspect of the invention, there is provided a heat to electric energy converter operational with a working fluid being in gas and liquid phases, the electric energy converter comprises a housing; a first electrode, the first electrode being hygroscopic at a first working fluid absorption potential; a second electrode, the second electrode being hygroscopic at a working fluid absorption potential that is different from the absorption potential of the first electrode whereby a voltage potential exist between the two electrodes, and an electrochemical barrier, the barrier being coupled between the first electrode and second electrode and conducting at least one ion species of the working fluid between the first electrode and the second electrode, the housing containing the first electrode, second electrode and electrochemical barrier so that the working fluid in gas and vaporized form may freely flow between the first electrode and the second electrode, the first electrode and the second electrode being coupled to each other through the electrochemical barrier for passage of a gas constituent of the working fluid from the first electrode to the second electrode.

BRIEF DESCRIPTION OF DRAWINGS

[0007] Figure 1 is a chart showing the water vapor pressure versus temperature for water, several proton conductive membrane formulations and 60% lithium bromide solution.

[0008] Figure 2 is a functional diagram of an ambient heat to electric converter representative of the invention.

[0009] Figure 3 a graph showing the hydrogen permeability of several selected metals.

[0010] Figure 4 is a functional diagram showing a heat to electric converter using a solid metal hydrogen permeable hygroscopic solution barrier.

[0011] Figure 5 shows a stack of cells electrically and electrochemically coupled in series within a casing.

[0012] Figure 6 is a schematic, cross-sectional view of an ambient energy converter in a preferred form of the invention having a thin film, metal hydrogen permeable water barrier.