CLAIMS

What is claimed is:

1. A sorption heat pump, comprising:

an evaporator structured to contain a working fluid, and operable to evaporate the working fluid to produce a working fluid gas in the evaporator;

a sorber structured to contain a sorption material to sorb the working fluid gas during a sorption phase;

a vapor pathway connecting the evaporator and the sorber;

a thermal control unit positioned to control the rate of vapor flow between the evaporator and the sorber through the vapor pathway, and being selectively operable to permit the flow of working fluid gas through the vapor pathway, to next stop the flow of working fluid gas through the vapor pathway, and after stopping the flow to then permit resumption of the flow of working fluid gas through the vapor pathway; and

a vacuum barrier material positioned about the sorber, evaporator, and vapor pathway to provide a reduced pressure therewithin to promote vaporation of the working fluid at a reduced temperature compared to the temperature required at ambient pressure, the vacuum barrier material being a multilayer laminate material and including first, second, and third multilayer laminate material portions, and the thermal control unit includes a vapor control valve made from the first, second, and third multilayer laminate material portions, a seal gasket, and a seal pin operable to control the rate of vapor flow between the evaporator and the sorber through the vapor pathway, the third multilayer laminate material portion having a first end portion and a second end portion, the first end portion being in sealed engagement with the first multilayer laminate material portion and the second end portion being in sealed engagement with the second multilayer laminate material portion to define an internal barrier, the third multilayer laminate material portion being positioned with the seal gasket to create a stable sealing surface, the seal pin protruding through the third multilayer laminate material portion, but not through the first multilayer laminate material portion or through the second multilayer laminate material portion, the seal pin being located proximal to the seal gasket, and the seal pin being movable toward the sealing surface by atmospheric pressure.

2. (Original Claim 19) The sorption heat pump of claim 1, further including a phase change material buffer positioned in thermal contact with the evaporator to create a heat pipe effect to distribute heat within the evaporator.

3. (Original Claim 20) The sorption heat pump of claim 1, wherein the vapor pathway has a cross sectional size between 0.01 and 10.0 square centimeters.

4. (Original Claim 21) The sorption heat pump of claim 1, wherein the vapor pathway has a cross sectional size between 0.1 and 5.0 square centimeters.

5. (Original Claim 22) The sorption heat pump of claim 1, wherein the vapor pathway has a maximum size in one dimension of between 0.01 and 2.0 centimeters.

6. (Original Claim 23) The sorption heat pump of claim 1, wherein the sorption material is zeolite, the working fluid is water, and the ratio of water to zeolite is 100-500 grams of water per kilogram of dry zeolite.

7. (Original Claim 24) The sorption heat pump of claim 1, wherein the sorption material is zeolite, the working fluid is water, and the ratio of water to zeolite is 150-350 grams of water per kilogram of dry zeolite.

8. (Original Claim 25) The sorption heat pump of claim 1, wherein the sorption material is zeolite, and the size of the zeolite granules is between 0.5 and 12.0 millimeters in diameter.

9. (Original Claim 26) The sorption heat pump of claim 1, wherein the sorption material is zeolite, and the size of the zeolite granules is between 1.5 and 8.0 millimeters in diameter.

10. (Original Claim 27) The sorption heat pump of claim 1, wherein the sorption material is zeolite, and the size of the zeolite granules is between 2.5 and 3.5 millimeters in diameter.

11. (Original Claim 28) The sorption heat pump of claim 1, further including a heater in thermal contact with the sorber to desorb the working fluid from the sorption material to produce the working fluid gas.

12. (Original Claim 29) The sorption heat pump of claim 1, wherein the sorber removably retains the sorption material therein and is structured to permit removal of sorbed sorption material and replacement with desorbed sorption material.

13. (Original Claim 30) The sorption heat pump of claim 12, wherein the sorption material is contained inside a removable cartridge and the sorber has a cartridge receiver within which the cartridge is removably positionable, the cartridge retaining the sorption material therein as the sorber sorbs the working fluid gas during the sorption phase.

14. The sorption heat pump of claim 1, further including a vacuum barrier material positioned about the sorber and the evaporator to provide a reduced pressure therewithin to promote evaporation of the working fluid at a reduced temperature compared to the temperature required at ambient pressure.

15. The sorption heat pump of claim 14, wherein the vacuum barrier material is a multilayer laminate material.

16. The sorption heat pump of claim 14, wherein the thermal control unit is positioned inward of the vacuum barrier material.

17. The sorption heat pump of claim 14, wherein the thermal control unit is positioned outward of the vacuum barrier material.

18. The sorption heat pump of claim 14, wherein the thermal control unit is positioned partially inward of vacuum barrier material and partially outward of the vacuum barrier material.

19. The sorption heat pump of claim 14, wherein the sorption material is zeolite, the working fluid is water, and the reduced pressure is equal to or less than 10 mbar absolute pressure.

20. The sorption heat pump of claim 14, wherein the vacuum barrier material is a multilayer laminate material with an aluminum layer of at least seven micrometers thickness and a sealing layer of polypropylene or polyamide with a melting temperature greater than 150 degrees Celsius.

21. (Original Claim 4) The sorption heat pump of claim 14, wherein the vacuum barrier material is also positioned about the vapor pathway.

22. (Original Claim 5) The sorption heat pump of claim 21, wherein the vacuum barrier material is a multilayer laminate material.

23. The sorption heat pump of claim 1, wherein the thermal control unit further includes an actuator positioned outward of the first and second multilayer laminate material portions and proximal to the seal pin, the actuator being operable to move the seal pin to at least one of at least partially opening the vapor control valve and at least partially closing the vapor control valve.

24. The sorption heat pump of claim 23, wherein the actuator is operable to move the seal pin by pushing on the seal pin and deforming the vacuum barrier material, and closing the vapor control valve by not pushing on the seal pin.

25. The sorption heat pump of claim 23, wherein the actuator is controlled by a controller.

26. A sorption heat pump, comprising:

an evaporator structured to contain a working fluid, and operable to evaporate the working fluid to produce a working fluid gas in the evaporator;

a sorber structured to contain a sorption material to sorb the working fluid gas during a sorption phase;

a vapor pathway connecting the evaporator and the sorber;

a thermal control unit positioned to control the rate of vapor flow between the evaporator and the sorber through the vapor pathway, and being selectively operable to permit the flow of working fluid gas through the vapor pathway, to next stop the flow of working fluid gas through the vapor pathway, and after stopping the flow to then permit resumption of the flow of working fluid gas through the vapor pathway; and

a first vacuum barrier positioned about the sorber, a second vacuum barrier positioned about the evaporator, and a third vacuum barrier positioned about the vapor pathway, to provide a reduced pressure therewithin to promote evaporation of the working fluid at a reduced temperature compared to the temperature required at ambient pressure, the first, second, and third vacuum barriers being multilayer laminate materials, and the thermal control unit includes a vapor control valve made from the first, second, and third vacuum barriers, a seal gasket, and a seal pin operable to control the rate of vapor flow between the evaporator and the sorber through the vapor pathway, the third vacuum barrier having a first end portion and a second end portion, the first end portion being in sealed engagement with the first vacuum barrier and the second end portion being in sealed engagement with the second vacuum barrier to define an internal barrier, the third vacuum barrier being positioned with the seal gasket to create a stable sealing surface, the seal pin protruding through the third vacuum barrier, but not through the first vacuum barrier or through the second vacuum barrier, the seal pin being located proximal to the seal gasket, and the seal pin being movable toward the sealing surface by atmospheric pressure.

27. The sorption heat pump of claim 26, wherein the thermal control unit further includes an actuator positioned outward of the first and second vacuum barriers and proximal to the seal pin, the actuator being operable to move the seal pin to at least one of at least partially opening the vapor control valve and at least partially closing the vapor control valve.

28. The sorption heat pump of claim 27, wherein the actuator is operable to move the seal pin by pushing on the seal pin and deforming at least one of the first, second, and third vacuum barriers, and closing the vapor control valve by not pushing on the seal pin.

29. The sorption heat pump of claim 27, wherein the actuator is controlled by a controller.

30. A sorption heat pump, comprising:

an evaporator containing a working fluid, and operable to evaporate the working fluid to produce a working fluid gas in the evaporator;

a sorber containing a sorption material to sorb the working fluid gas during a sorption phase;

a vapor pathway connecting the evaporator and the sorber;

a thermal control unit positioned to control the rate of vapor flow between the evaporator and the sorber through the vapor pathway, and being selectively operable to permit the flow of working fluid gas through the vapor pathway, to next stop the flow of working fluid gas through the vapor pathway, and after stopping the flow to then permit resumption of the flow of working fluid gas through the vapor pathway; and

a first vacuum barrier positioned about the sorber, a second vacuum barrier positioned about the evaporator, and a third vacuum barrier positioned about the vapor pathway, to provide a reduced pressure therewithin to promote evaporation of the working fluid at a reduced temperature compared to the temperature required at ambient pressure, the first, second, and third vacuum barriers being multilayer laminate materials, and the thermal control unit includes a vapor control valve made from the first, second, and third vacuum barriers, a seal gasket, and a seal pin operable to control the rate of vapor flow between the evaporator and the sorber through the vapor pathway, the third vacuum barrier having a first end portion and a second end portion, the first end portion being in sealed engagement with the first vacuum barrier and the second end portion being in sealed engagement with the second vacuum barrier to define an internal barrier, the third vacuum barrier being positioned with the seal gasket to create a stable sealing surface, the seal pin protruding through the third vacuum barrier, but not through the first vacuum barrier or through the second vacuum barrier, the seal pin being located proximal to the seal gasket, and the seal pin being movable toward the sealing surface by atmospheric pressure.