

CLAIMS

What is claimed is:

1. A refrigerator system, configured to cycle through a moisture collection mode, a water production mode, and a cooling mode, wherein the system comprises:
 - an atmospheric water harvesting unit, comprising:
 - a plurality of plates, wherein each plate is independently coated on one or both sides with water capture material, and wherein the water capture material adsorbs moisture from surrounding air in the moisture collection mode, and desorbs water in the form of water vapor in the water production mode; and
 - a condenser;
 - a compressor, configured to produce heated refrigerant, wherein the heated refrigerant is circulated to the condenser and heats up at least a portion of the plates, thereby causing desorption of water from at least a portion of the moisture sequestered in the water capture material in the water production mode;
 - an expansion valve, configured to receive the refrigerant from the condenser, and allow adiabatic expansion of the refrigerant to produce a cooled refrigerant, wherein the cooled refrigerant cools the interior of the system in the cooling mode;
 - a water condensing unit, configured to condense the desorbed water vapor into liquid water in the water production mode;
 - a water tank, configured to store the liquid water; and
 - a control system configured to shift the system from one mode to another.
2. A refrigerator system, configured to cycle through a moisture collection mode, a water production mode, a cooling mode, and a standby mode, wherein the system comprises:
 - an atmospheric water harvesting unit, comprising:
 - a plurality of plates, wherein each plate is independently coated on one or both sides with water capture material, wherein the plates are arranged parallel to each other and a gap exists between adjacent plates, and wherein the water capture material adsorbs moisture from surrounding air during the moisture

collection mode, and desorbs water in the form of water vapor during the water production mode;

an air inlet, configured to bring surrounding air into the atmospheric water harvesting unit;

a condenser, positioned in proximity to the plurality of plates;

a condenser fan, positioned in between the air inlet and the plurality of plates;

an exhaust valve; and

a steam valve;

a cooling unit, comprising:

an evaporator; and

an evaporator fan;

a water condensing unit;

a water tank;

a compressor;

an expansion valve, connected to the evaporator and the condenser;

a control system, comprising:

a humidity sensor, configured to detect moisture saturation of the water capture material;

a temperature sensor, configured to detect temperature of the refrigerator system interior;

a water volume sensor, configured to detect water level in the water tank;

wherein, in the moisture collection mode,

the compressor is off,

the steam valve is closed,

the exhaust valve is open, and

the condenser fan is configured to draw surrounding air into the atmospheric water harvesting unit through the air inlet and blow the surrounding air through the gap between adjacent plates, thereby causing the water capture material to adsorb moisture from the surrounding air;

wherein, in the water production mode,

the steam valve is open,

the exhaust valve is closed,

the compressor is on and configured to compress refrigerant, thereby producing a heated refrigerant,

the condenser is configured to receive the heated refrigerant from the compressor and heat up at least a portion of the plates, thereby causing desorption of at least a portion of moisture sequestered in the water capture material, and

the condenser fan is configured to push desorbed water vapor through the steam valve into the water condensing unit, wherein the water vapor condenses into liquid water that is stored in the water tank;

wherein, in the cooling mode,

the steam valve is closed,

the exhaust valve is open,

the compressor remains on,

the expansion valve is configured to receive the refrigerant from the condenser, and allow adiabatic expansion of the refrigerant, thereby producing a cooled refrigerant,

the evaporator is configured to receive the cooled refrigerant, and

the evaporator fan is configured to cool the interior of the system, and

wherein the compressor and the expansion valve are configured to

compress/expand the refrigerant in one or more continuous cycles until the refrigerator system interior exceeds a threshold temperature;

wherein, in the standby mode,

the steam valve is closed,

the exhaust valve is open,

the compressor is off, and

the condenser fan is off; and

wherein the control system is configured to shift the system to:

the moisture collection mode when the water level in the water tank drops is detected by the water volume sensor to drop below a threshold water level;

the water production mode when the moisture saturation level is detected by the humidity sensor to exceed a threshold moisture saturation level;

the cooling mode when the temperature of the refrigerator system interior is detected by the temperature sensor to exceed a threshold temperature; and

the standby mode when the temperature of the refrigerator system interior is detected by the temperature sensor to drop below a threshold temperature, and the water level in the water tank is detected by the water volume sensor to exceed a threshold water level.

3. The system of claim 1 or 2, wherein the water capture material comprises metal organic framework.
4. The system of claim 1 or 2, wherein the water capture material comprises a desiccant material.
5. The system of any one of claims 1 to 4, wherein each plate in the atmospheric water harvesting unit is a metal plate.
6. The system of claim 5, wherein the metal plate comprises aluminum.
7. The system of any one of claims 1 to 6, wherein each coating of water capture material on a cooling fin has an average thickness between 50 micrometers to 500 micrometers.
8. The system of any one of claims 1 to 7, wherein each plate has a surface textured with topographic features.
9. The system of claim 8, wherein the topographic features are holes, bumps, ridges, or grooves, or any combination thereof.
10. The system of any one of claims 2 to 9, wherein the distance of the gap between adjacent plates relative to the length of each plate achieves optimal air flow and maximizes water adsorption.

11. The system of any one of claims 1 to 10, wherein both sides of each plate is coated with the at least one water capture material.
12. The system of claim 11, wherein each layer has a thickness and each plate has a thickness, and wherein the ratio of the thickness of the first layer to the thickness of the plate to the thickness of the second layer optimizes desorption of water and energy used to heat the plurality of the plates in the chamber.
13. The system of any one of claims 2 to 12, wherein the condenser fan is configured to blow air having a laminar flow through the gap between adjacent plates.
14. The system of any one of claims 2 to 13, wherein the compressor is configured to compress and heat the refrigerant to a temperature of at least 50°C.
15. The system of claim 14, wherein the temperature is between 60°C and 70°C.
16. The system of any one of claims 1 to 15, the system is configured to (i) dispense the liquid water in the water tank as drinking water; or (ii) dispense ice cubes produced from the liquid water in the water tank, or a combination of (i) and (ii).
17. A method of operating a refrigerator system, wherein the system sources water from an atmospheric water harvesting unit by atmospheric water harvesting, wherein the system comprises:
 - an atmospheric water harvesting unit, comprising: a plurality of plates, wherein each plate is independently coated on one or both sides with water capture material; and a condenser;
 - a cooling unit;
 - a water condensing unit;
 - a water tank;
 - a compressor; and
 - an expansion valve,the method comprising:
 - a) directing surrounding air into the atmospheric water harvesting unit, wherein at least a portion of the water capture material adsorbs moisture from the surrounding air;

- b) compressing refrigerant in the compressor to produce a heated refrigerant;
- c) heating at least a portion of the plates as the condenser cools heated refrigerant received from the compressor, wherein at least a portion of moisture sequestered in the water capture material is desorbed in the form of water vapor;
- d) condensing the desorbed water vapor in the water condensing unit to produce liquid water;
- e) storing the liquid water in the water tank;
- f) adiabatically expanding the refrigerant received from the condenser in the expansion valve to produce cooled refrigerant; and
- g) cooling the refrigerator system interior as the cooling unit receives cooled refrigerant from the expansion valve,

wherein step (a) is performed when the system is in moisture collection mode;

wherein steps (b) and (d) are performed when the system is in water collection mode;

wherein steps (f) and (g) are performed when the system is in cooling mode.

18. A method of operating a refrigerator system, wherein the system sources water from an atmospheric water harvesting unit by atmospheric water harvesting, wherein the system comprises:

- an atmospheric water harvesting unit, comprising: a plurality of plates, wherein each plate is independently coated on one or both sides with water capture material; and a condenser;
- a cooling unit;
- a water condensing unit;
- a water tank;
- a compressor; and
- an expansion valve,

the method comprising:

- a) directing surrounding air into the atmospheric water harvesting unit, wherein at least a portion of the water capture material adsorbs water from the surrounding air;

- b) shifting the system from moisture collection mode to water production mode when the moisture saturation level of the water capture material in the atmospheric water harvesting unit exceeds a threshold moisture saturation level;
- c) compressing refrigerant to produce a heated refrigerant in the water production mode;
- d) cooling the heated refrigerant to room temperature in the condenser in the water production mode, thereby heating up at least a portion of the plates and causing desorption of at least a portion of water sequestered in the water capture material;
- e) transferring the desorbed water vapor into the water condensing unit in the water production mode;
- f) condensing the desorbed water vapor into liquid water in the water production mode;
- g) storing the liquid water in the water tank;
- h) shifting the system from water production mode to cooling mode when the temperature of the refrigerator system interior exceeds a threshold temperature;
- i) adiabatically expanding the refrigerant received from the condenser using an expansion valve in the cooling mode, thereby producing a cooled refrigerant;
- j) circulating the cooled refrigerant to an evaporator in the cooling mode;
- k) cooling the refrigerator system interior using an evaporator fan positioned near the evaporator in the cooling mode; and
- l) compressing and expanding the refrigerant through one or more continuous cycles in the cooling mode.

19. The method of claim 18, further comprising: shifting the system to standby mode when the temperature of the refrigerator system interior drops below a threshold temperature, and the water level in the water tank exceeds a threshold water level.

20. The method of any one of claims 17 to 19, further comprising: (i) dispensing the liquid water in the water tank as drinking water; or (ii) dispensing ice cubes produced from the liquid water in the water tank, or a combination of (i) and (ii).

21. The method of any one of claims 17 to 20, wherein the atmospheric water harvesting unit further comprises a steam valve and an exhaust valve, the method further comprising:
closing the steam valve and opening the exhaust valve in the moisture collection mode;

opening the steam valve and closing the exhaust valve in the water production mode; and
closing the steam valve and opening the exhaust valve in the cooling mode.

22. The method of any one of claims 17 to 21, wherein the system further comprises a control system, wherein the control system comprises: a humidity sensor, a temperature sensor, and a water volume sensor,

the method further comprising:

detecting the moisture saturation level of the water capture material in the atmospheric water harvesting unit using the humidity sensor;

detecting the temperature of the refrigerator system interior using the temperature sensor;
and

detecting the water level in the water tank using the water volume sensor.

23. The method of any one of claims 17 to 22, wherein the water capture material comprises metal organic framework.

24. The method of any one of claims 17 to 22, wherein the water capture material comprises a desiccant material.

25. The method of any one of claims 17 to 24, wherein each plate in the atmospheric water harvesting unit is a metal plate.

26. The method of claim 25, wherein the metal plate comprises aluminum.

27. The method of any one of claims 17 to 26, wherein both sides of each plate is coated with the at least one water capture material.