What is claimed is:

1. A humidity management system for an HVAC system comprising:

a regenerable nanostructured desiccant porous material configured to adsorb water from an inlet stream at a first air pressure and to release water when subjected to a second air pressure wherein said second air pressure is lower than the first air pressure, the regenerable nanostructured desiccant porous material being in fluid communication with a fluid source through a fluid path through which the inlet stream passes;

a vacuum source that is in communication with the regenerable nanostructured desiccant porous material; and

at least one heat transfer pipe thermally coupled to the regenerable nanostructured desiccant porous material and configured to alternately remove heat from and provide heat to the regenerable nanostructured desiccant porous material.

2. The humidity management system of claim 1, wherein the regenerable nanostructured desiccant porous material comprises one or more material selected from metal organic framework material, zeolite, mesoporous silica, covalent organic framework material; Porous organic polymer; or porous carbon.

3. The humidity management system of claim 1 wherein the regenerable nanostructured desiccant porous material comprises a metal organic framework material.

4. The humidity management systems of claim 3 wherein the metal organic framework material is selected from MOF 303, MOF 801, or MOF 841.

5. The humidity management system of claim 1 wherein the regenerable nanostructured desiccant porous material comprises MOF 303 or 801.

6. The humidity management system of claim 1 wherein at least a portion of the regenerable nanostructured desiccant porous material is formed on an outer surface of at least a portion of the at least one heat transfer pipe.

7. The humidity management system of any of claims 1-6, wherein the regenerable nanostructured desiccant porous material has a three dimensional shape.

8. A method for removing water from a fluid stream, the method comprising:

passing a fluid stream comprising water over a regenerable nanostructured porous material configured to adsorb water from an inlet stream at a first air pressure and to release water when subjected to a second air pressure, wherein the second air pressure is lower than the first air pressure;

placing the regenerable nanostructured porous material under the first pressure;

transferring heat from the regenerable nanostructured porous material while the regenerable nanostructured porous material is under the first pressure;

placing the regenerable nanostructured porous material under the second pressure; and

transferring heat to the regenerable nanostructured porous material while the regenerable nanostructured porous material is under the second pressure.

9. The humidity management system of claim 1, wherein regenerable nanostructured desiccant porous material is disposed within a conduit, at least a first seal is configured to seal a first end of the conduit and at least a second seal is configured to seal a second end of the conduit, wherein the regenerable nanostructured desiccant porous material is disposed between the at least a first seal and the at least a second seal.

10. The humidity management system of claim 1, wherein the regenerable nanostructured desiccant porous material is coated on a plurality of thermally conductive fins.

11. The method of claim 8, wherein the transferring the heat comprises transferring heat through a heat pipe.

12. The method of claim 8, wherein the regenerable nanostructured desiccant porous material comprises one or more material selected from metal organic framework material, zeolite, mesoporous silica, covalent organic framework material; porous organic polymer; or porous carbon.

13. The humidity management system of claim 1, wherein the first fluid source comprises air.

14. The method of claim 8, wherein the fluid stream comprises air.

15. The humidity management system of claim 1, further comprising a condenser positioned downstream of and in communication with the regenerable nanostructured desiccant porous material, and wherein the condenser is in communication with the vacuum source.

16. The humidity management system of claim 15, further comprising a water pump in communication with the condenser.

17. The method of claim 8, wherein placing the regenerable nanostructured porous material under the second pressure produces a water vapor-containing stream, and the method further comprises sufficiently increasing the vapor pressure of the water vapor-containing stream resulting in condensing the water vapor into liquid water condensate.

18. The method of claim 17, further comprising increasing the pressure of the liquid water condensate to atmospheric pressure.

19. A humidity management system comprising:

an air stream inlet;

a first regenerable nanostructured desiccant porous material configured to adsorb water from an air stream at a first pressure and to release water when subjected to a second pressure, wherein the second pressure is lower than the first pressure, wherein the first regenerable nanostructured desiccant porous material is positioned in a first conduit;

a second regenerable nanostructured desiccant porous material configured to adsorb water from an air stream at a first pressure and to release water when subjected to a second pressure, wherein the second pressure is lower than the first pressure, wherein the second regenerable nanostructured desiccant porous material is positioned in a second conduit;

wherein the first conduit and the second conduit are arranged separate from each other;

a vacuum source that alternately communicates with the first regenerable nanostructured desiccant porous material or the second regenerable nanostructured desiccant porous material; and

at least one heat transfer pipe thermally coupled to the first regenerable nanostructured desiccant porous material and the second regenerable nanostructured desiccant porous material.

20. The humidity management system of claim 19, further comprising an air flow diverter positioned upstream of the first regenerable nanostructured desiccant porous material and the second regenerable nanostructured desiccant porous material.

21. The humidity management system of claim 19, further comprising a condenser positioned downstream of and in communication with the first regenerable nanostructured desiccant porous material and the second regenerable nanostructured desiccant porous material, and wherein the condenser is in communication with the vacuum source.

22. The humidity management system of claim 21, further comprising a water pump in communication with the condenser.

23. The humidity management system of claim 19, wherein the first regenerable nanostructured desiccant porous material and the second regenerable nanostructured desiccant porous material each comprise a metal organic framework material.

24. The humidity management system of claim 19, wherein the first conduit and the second conduit are arranged parallel to each other.

25. A method comprising:

operating the system of claim 19 in (A) adsorption mode to remove water from an air stream (B) regeneration mode to release adsorbed water,

wherein the adsorption mode comprises contacting the air stream with the first regenerable nanostructured desiccant porous material at a first pressure to adsorb water from the air stream and transferring heat from the first regenerable nanostructured porous material to the second regenerable nanostructured porous material while the first regenerable nanostructured porous material is under the first pressure; and

the regeneration mode comprises releasing water adsorbed by the first regenerable nanostructured desiccant porous material at a second pressure, wherein the second pressure is lower than the first pressure, and transferring heat to the first regenerable nanostructured porous material from the second regenerable nanostructured porous material while first regenerable nanostructured porous material is under the second pressure.

26. The method of claim 25, comprising operating the apparatus such that the first regenerable nanostructured desiccant porous material operates in adsorption mode when the second regenerable nanostructured porous material operates in regeneration mode, and the second regenerable nanostructured porous material operates in adsorption mode when the first regenerable nanostructured porous material operates in regeneration mode.