Claims

1. A system for generating liquid water from air, the system comprising:

a housing defining an adsorption zone and a desorption zone;

a desiccant selectively movable between:

an adsorption zone in which the desiccant is in fluid communication with a process airflow path such that the desiccant can capture water from air in the process airflow path; and

a desorption zone in which the desiccant is in fluid communication with a regeneration fluid path such that the desiccant can release water to regeneration fluid in the regeneration fluid path;

an actuator configured to move the desiccant between the adsorption zone and the desorption zone;

a first blower configured to adjust a flow rate of air through the process airflow path;

a circulator configured to adjust a flow rate of regeneration fluid through the regeneration fluid path;

a thermal unit comprising a casing in fluid communication with the regeneration fluid path and configured to provide thermal energy to regeneration fluid in the regeneration fluid path;

a condenser configured to receive regeneration fluid from the desorption zone via the regeneration fluid path and to produce liquid water from the received regeneration fluid; and

a controller configured to optimize liquid water production based, at least in part, on measurements of one or more of: an ambient air temperature, ambient air relative humidity, and a level of solar insolation.

2. The system of claim 1, where the controller is configured to optimize liquid water production at least by controlling a blower speed of the first blower and a speed of the circulator.

3. A system for generating liquid water from air, the system comprising:

a housing defining an adsorption zone and a desorption zone;

a desiccant continuously and selectively movable between:

an adsorption zone in which the desiccant is in fluid communication with a process airflow path such that the desiccant can capture water from air in the process airflow path; and

a desorption zone in which the desiccant is in fluid communication with a regeneration fluid path such that the desiccant can release water to regeneration fluid in the regeneration fluid path;

an actuator configured to move the desiccant between the adsorption zone and the desorption zone;

a thermal unit comprising a casing in fluid communication with the regeneration fluid path and configured to provide thermal energy to regeneration fluid in the regeneration fluid path;

a condenser configured to receive regeneration fluid from the desorption zone via the regeneration fluid path and to produce liquid water from the received regeneration fluid; and

a controller configured to optimize liquid water production based, at least in part, on measurements of one or more of: an ambient air temperature, ambient air relative humidity, and a level of solar insolation.

4. The system of any of claims 1-3, where the controller is configured to optimize liquid water production at least by controlling movement of the desiccant between the adsorption zone and the desorption zone.

5. A system for generating liquid water from air, the system comprising:

a housing defining an adsorption zone and a desorption zone;

a desiccant selectively movable between:

an adsorption zone in which the desiccant is in fluid communication with a process airflow path such that the desiccant can capture water from air in the process airflow path; and

a desorption zone in which the desiccant is in fluid communication with a regeneration fluid path such that the desiccant can release water to regeneration fluid in the regeneration fluid path;

an actuator configured to move the desiccant between the adsorption zone and the desorption zone;

a thermal unit comprising a casing in fluid communication with the regeneration fluid path and configured to provide thermal energy to regeneration fluid in the regeneration fluid path;

a condenser configured to receive regeneration fluid from the desorption zone via the regeneration fluid path and to produce liquid water from the received regeneration fluid; and

a controller configured to optimize liquid water production at least by controlling a rate of desiccant movement between the adsorption zone and the desorption zone based, at least in part, on an optimal rate of desiccant movement, contained in a look-up table, that corresponds to measurements of two or more of: an ambient air temperature, ambient air relative humidity, and a level of solar insolation.

6. The system of any of claims 3-5, comprising:

a first blower configured to adjust a flow rate of air through the process airflow path; and

a circulator configured to adjust a flow rate of regeneration fluid through the regeneration fluid path.

7. The system of claim 6, where the controller is configured to optimize liquid water production at least by controlling a blower speed of the first blower and a speed of the circulator.

8. The system of any of claims 1-7, where the controller is configured to optimize liquid water production over a diurnal cycle based, at least in part, on diurnal variations in measurements of one or more of: an ambient air temperature, ambient air relative humidity, and a level of solar insolation.

9. The system of claims 1-8, where the housing is configured such that dimensions of the adsorption zone and the desorption zone are adjustable.

10. The system of any of claims 1-9, comprising a temperature sensor configured to capture data indicative of an ambient air temperature.

11. The system of any of claims 1-10, comprising a humidity sensor configured to capture data indicative of an ambient air relative humidity.

12. The system of any of claims 1-11, comprising a solar insolation sensor configured to capture data indicative of a level of solar insolation.

13. The system of claim 12, where the solar insolation sensor comprises a temperature sensor configured to capture data indicative of a temperature of regeneration fluid in the regeneration fluid path downstream of the thermal unit.

14. The system of any of claims 1-13, comprising:

a temperature sensor configured to capture data indicative of a temperature of air in the process airflow path;

where the controller is configured to optimize liquid water production based, at least in part, on the data captured by the temperature sensor.

15. The system of claims 1-14, comprising:

a humidity sensor configured to capture data indicative of a relative humidity of air in the process airflow path;

where the controller is configured to optimize liquid water production based, at least in part, on the data captured by the humidity sensor.

16. The system of claims 1-15, comprising:

a humidity sensor configured to capture data indicative of a relative humidity of regeneration fluid in the regeneration fluid path;

where the controller is configured to optimize liquid water production based, at least in part, on the data captured by the humidity sensor.

17. The system of any of claims 1-16, comprising:

a flow sensor configured to capture data indicative of a flow rate of air through the process airflow path;

where the controller is configured to optimize liquid water production based, at least in part, on the data captured by the flow sensor.

18. The system of any of claims 1-17, comprising:

a flow sensor configured to capture data indicative of a flow rate of regeneration fluid through the regeneration fluid path;

where the controller is configured to optimize liquid water production based, at least in part, on the data captured by the flow sensor.

19. The system of any of claims 1-18, where the thermal unit is configured to absorb sunlight to provide at least a portion of the thermal energy to regeneration fluid in the regeneration fluid path.

20. The system of claim 19, where the thermal unit comprises:

a transparent layer configured to allow sunlight to enter the casing of the thermal unit;

an absorber configured to absorb thermal energy from the sunlight and provide at least a portion of the absorbed thermal energy to regeneration fluid in the regeneration fluid path; and

an insulator configured to insulate at least a portion of the casing.

21. The system of any of claims 1-20, where the condenser is configured to transfer thermal energy from regeneration fluid in the regeneration fluid path downstream of the desiccant to air in the process airflow path upstream of the desiccant.

22. The system of any of claims 1-21, comprising a water collection unit configured to receive the produced liquid water from the condenser.

23. The system of claim 22, where the water collection unit comprises a filter.

24. The system of claim 22 or 23, where the water collection unit comprises an ultraviolet (UV) light source.

25. The system of any of claims 22-24, where the water collection unit comprises a receptacle configured to receive one or more additives for introduction to the produced liquid water.

26. The system of any of claims 22-25, where the water collection unit has a footprint with a maximum transverse dimension less than or equal to 2.44m (8 feet (ft)).

27. The system of claim 26, where an area of the footprint is less than or equal to 5.95m^2 (64 square feet (ft^2)).

28. The system of claim 26 or 27, where the water collection unit can be contained within a cubic volume less than or equal to 14.50m^3 (512 cubic feet (ft^3)).

29. The system of any of claims 1-28, comprising a solar power unit configured to provide electrical power to the system.

30. The system of claim 29, where the solar power unit comprises a solar panel.

31. The system of claim 29 or 30, where the system is configured to operate without an external source of electrical power.

32. The system of any of claims 1-31, comprising a purge airflow path configured to transfer thermal energy from a portion of the adsorption zone to a portion of the desorption zone.

33. The system of claim 32, where the controller is configured to optimize liquid water production based, at least in part, on a temperature of air in the purge airflow path.

34. The system of any of claims 1-33, comprising a recovery heat exchanger configured to transfer thermal energy from regeneration fluid in the regeneration fluid path downstream of the desiccant to regeneration fluid in the regeneration fluid path upstream of the desiccant.

35. The system of any of claims 1-34, comprising a second desiccant configured to transfer water from regeneration fluid in the regeneration fluid path downstream of the condenser to regeneration fluid in the regeneration fluid path upstream the condenser, and/or to transfer heat from one path of the regeneration fluid to another.

36. The system of any of claims 1-35, where the first desiccant is disposed on a disk, the desiccant configured to move between the adsorption zone and the desorption zone as the disk is rotated.

37. The system of any of claims 1-36, where the system is configured such that a first portion of the first desiccant can be disposed within the adsorption zone with a second portion of the first desiccant simultaneously disposed within the desorption zone.

38. The system of any of claims 1-37, where each of the housing, the thermal unit, and the condenser have a footprint with a maximum transverse dimension less than or equal to 2.44m (8 feet (ft)).

39. The system of any of claims 1-38, comprising a transceiver configured to receive and transmit information associated with operation of the system.

40. The system of any of claims 1-39, where the regeneration fluid path comprises a closed-loop.

41. A method for generating liquid water from air, the method comprising:

moving a desiccant into fluid communication with a process airflow path such that the desiccant captures water from air in the process airflow path;

communicating regeneration fluid in a regeneration fluid path through a housing of a thermal unit to heat regeneration fluid in the regeneration fluid path;

moving the desiccant into fluid communication with the regeneration fluid path such that the desiccant releases water to regeneration fluid in the regeneration fluid path;

receiving, in a condenser, regeneration fluid from the desiccant via the regeneration fluid path to produce liquid water from the received regeneration fluid; and

controlling, with a controller, at least a rate of the movement of the desiccant to optimize liquid water production based on one or more of: an ambient air temperature, ambient air relative humidity, and a level of solar insolation.

42. The method of claim 41, where the controlling is performed, at least in part, by the controller referencing an optimal rate of desiccant movement, contained in a look-up table, that corresponds to at least one of: an ambient air temperature, an ambient air relative humidity, and a level of solar insolation.

43. The method of claim 41, where the controlling is performed, at least in part, by the controller determining an optimal rate of desiccant movement as indicated by a parametric function based on at least one of: an ambient air temperature, an ambient air relative humidity, and a level of solar insolation.

44. The method of claim 42, comprising generating the look-up table by:

performing a simulation of a system of any of claims 1-40 at each of a plurality of operational parameter sets, each operational parameter set including at least: an ambient air temperature, ambient air relative humidity, and a level of solar insolation;

determining, for each of the plurality of operational parameter sets, at least an optimal rate of desiccant movement that optimizes liquid water production by the system; and

storing each optimal rate of desiccant movement in the look-up table.

45. The method of any of claims 41-44, where the controlling comprises optimizing liquid water production based, at least in part, on a temperature of regeneration fluid in the regeneration fluid path downstream of the thermal unit.

46. The method of any of claims 41-45, where the controlling comprises optimizing liquid water production based, at least in part, on a temperature of air in the process airflow path.

47. The method of any of claims 41-46, where the controlling comprises optimizing liquid water production based, at least in part, on a relative humidity of air in the process airflow path.

48. The method of any of claims 41-47, where the controlling comprises optimizing liquid water production based, at least in part, on a relative humidity of regeneration fluid in the regeneration fluid path.

49. The method of any of claims 41-48, where the controlling comprises controlling at least a speed of a blower to adjust a flow rate of air through the process airflow path to optimize liquid water production.

50. The method of any of claims 41-49, where the controlling comprises controlling at least a speed of a circulator to adjust a flow rate of regeneration fluid through the regeneration fluid path to optimize liquid water production.

51. The method of any of claims 41-50, comprising absorbing sunlight with the thermal unit to heat regeneration fluid in the regeneration fluid path.

52. The method of any of claims 41-51, comprising communicating air in the process airflow path through the condenser to transfer thermal energy from regeneration fluid in the regeneration fluid path to air in the process airflow path.

53. The method of any of claims 41-52, comprising collecting liquid water produced by the condenser.

54. The method of any of claims 41-53, comprising filtering liquid water produced by the condenser.

55. The method of any of claims 41-54, comprising dissolving additives into liquid water produced by the condenser.

56. The method of any of claims 41-55, comprising transferring, with a second desiccant, water from regeneration fluid in the regeneration fluid path downstream of the condenser to regeneration fluid in the regeneration fluid path upstream of the condenser, and/or to transfer heat from one path of the regeneration fluid to another.

57. The method of any of claims 41-56, where a flow rate of air in the process airflow path is at least 5 times a flow rate of regeneration fluid in the regeneration fluid path.