A system is provided including a vapor compression cycle. The vapor compression cycle includes an operably coupled compressor, condenser, first expansion device, and evaporator through which a refrigerant circulates. A thermal energy storage unit includes a heat exchanger arranged within a phase change material. The heat exchanger is fluidly coupled to the vapor compression cycle with a plurality of conduits and valves such that refrigerant flows through the heat exchanger in a heat transfer relationship with the phase change material. When the system is in a first mode, the heat exchanger is configured to function similar to the evaporator and the phase change material is configured to store thermal energy. When the system is in a second mode, the heat exchanger is configured to function similar to the condenser and the phase change material is configured to release thermal energy.
VAPO' R COMPRESSION SYSTEM WITH THERMAL ENERGY STORAGE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. provisional patent application Ser. No. 61/823,143 filed May 14, 2013, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] Exemplary embodiments of the invention relate generally to a vapor compression system, and more particularly to thermal energy storage system integrated into a vapor compression system.

[0003] Two main forms of thermal energy storage system (TES) have been implemented: sensible heat storage and latent heat storage. In heating, ventilation, air conditioning and refrigeration (HVAC&R) applications, the latent heat generated by a phase change, such as between a solid and a liquid for example, is usually much higher than the sensible heat generated from an application having a fixed temperature range. Therefore, using the latent capacity of a phase change material may significantly increase the storage capacity of a TES system.

[0004] Conventional TES systems commonly include an insulated storage tank which contains a heat exchanger arranged within an ice/water storage medium such that heat may transfer between a fluid flowing through the heat exchanger and the storage medium. Although the latent heat of an ice/water phase change is high, the drawbacks of the system limit its application. Implementation of an ice/water TES system is generally complex, and therefore, too cost prohibitive for cost sensitive markets, such as residential and light commercial HVAC markets. The volume expansion that occurs during a phase change between water and ice presents a challenge to the design of insulated tank configured to store the ice/water, as well as the heat exchanger positioned within the tank, for systems of a limited size. In addition, the evaporation temperature of a prime mover of a vapor compression cycle must be below the ice point, thereby lowering the coefficient of performance of the prime mover, even when the system is charged during off-peak time such as in early morning when the vapor compression equipment runs with high efficiency.

BRIEF DESCRIPTION OF THE DRAWING

[0005] According to another aspect of the invention, a system is provided including a vapor compression cycle. The vapor compression cycle includes an operably coupled compressor, condenser, first expansion device, and evaporator through which a refrigerant circulates. A thermal energy storage unit includes a heat exchanger arranged within a phase change material. The heat exchanger is fluidly coupled to the vapor compression cycle with a plurality of conduits and valves such that refrigerant flows through the heat exchanger in a heat transfer relationship with the phase change material. When the system is in a first mode, the heat exchanger is configured to function similar to the evaporator and the phase change material is configured to store thermal energy. When the system is in a second mode, the heat exchanger is configured to function similar to the condenser and the phase change material is configured to release thermal energy.

[0006] According to yet another embodiment of the invention, a system is provided including a water source and a water demand. A thermal energy storage unit includes a first heat exchanger arranged within a phase change material. The first heat exchanger is fluidly coupled to the water source and the water demand. The water flows through the first heat exchanger in a heat transfer relationship with the phase change material.

[0007] These and other advantages and features will become more apparent from the following description taken in conjunction with the drawings.

DETAILED DESCRIPTION OF THE INVENTION

[0008] The subject matter, which is regarded as the invention, is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

[0009] FIG. 1 is an exemplary vapor-compression cycle;

[0010] FIG. 2 is a schematic diagram of a heating, ventilation, air conditioning, and refrigeration (HVAC&R) system including a thermal energy storage device according to an embodiment of the invention;

[0011] FIG. 3 is a schematic diagram of a heating, ventilation, air conditioning, and refrigeration (HVAC&R) system including a thermal energy storage device according to another embodiment of the invention;

[0012] FIG. 4 is a schematic diagram of a heating, ventilation, air conditioning, and refrigeration (HVAC&R) system including a thermal energy storage device according to another embodiment of the invention;

[0013] FIG. 5 is a schematic diagram of a heating, ventilation, air conditioning, and refrigeration (HVAC&R) system including a thermal energy storage device according to another embodiment of the invention;

[0014] FIGS. 6 and 6a are schematic diagrams of a thermal energy storage device according to another embodiment of the invention; and

[0015] FIG. 7 is a schematic diagram of a heating, ventilation, air conditioning, and refrigeration (HVAC&R) system including a thermal energy storage device according to another embodiment of the invention.

[0016] Referring now to FIG. 1, a schematic diagram of an exemplary heating, ventilation, air conditioning, and refrigeration (HVAC&R) system including a vapor compression cycle 10 is illustrated. Refrigerant R enters an inlet 14 of the compressor 12 as a slightly superheated vapor. The compressor 12 compresses the vaporized refrigerant R such that the refrigerant R provided at an outlet 16 of the compressor 12 has an increased pressure, and therefore an increased temperature. The superheated refrigerant vapor flows through a conduit 18 to an inlet 22 of a condenser 20. The condenser 20 is a heat exchanger which allows heat energy to migrate from the refrigerant R to a first heat exchange medium, such as air A1 blown by an adjacent fan or blower 21 for example, causing the refrigerant vapor to condense to a liquid or a vapor-liquid mixture. From the condenser outlet 24, the saturated liquid refrigerant R flows through another conduit 26 to a expansion device, or thermal expansion valve 28. The pressure drop of the refrigerant R in the thermal expansion valve
28 causes a portion of the refrigerant R to vaporize such that a mixture of refrigerant liquid and vapor is provided from the expansion device 28 to an inlet 34 of an evaporator 32 through conduit 30. The evaporator 32 is also a heat exchanger which allows heat energy to migrate from a heat exchange medium, such as warm air A2 blown by an adjacent fan/blower 33 for example, to the refrigerant mixture. The warm heat exchange medium A2 causes the liquid part of the refrigerant mixture to evaporate. The vaporized refrigerant R is provided from the outlet 36 of the evaporator 32 back to the inlet 14 of the compressor 12 through yet another conduit 38 such that the refrigerant R is at both a temperature and a pressure at which the refrigeration cycle began.

[0017] The HVAC&R system 10 illustrated in FIGS. 2 and 3 has been adapted to include a thermal energy storage (TES) unit 40 having an insulated storage tank 42, which contains an amount of a suitable phase change material 44, such as coconut nut for example. In one embodiment, the phase change material 44 can have melting temperatures (freeze temperatures) ranging from about 45 degrees Fahrenheit to about 85 degrees Fahrenheit such that the material 44 undergoes a solid to liquid phase change when heated and a liquid to solid phase change when cooled. A heat exchanger 46 is immersed within the phase change material 44 and is fluidly connected to the HVAC&R system 10 such that refrigerant R is configured to flow through inlet 48. Depending on the mode of the HVAC&R system, the heat exchanger 46 may be configured to operate as either the evaporator or the condenser of the system 10. In one embodiment, the heat exchanger 46 has a tube-fin configuration such that the plurality of fins (not shown) improves the heat transfer between the refrigerant R in the heat exchanger 46 and the phase change material 44. However, heat exchangers 46 having other suitable configurations known to a person having ordinary skill in the art, such as a slab coil heat exchanger for example, are also within the scope of the invention. The inlet 48 of the heat exchanger 46 may be fluidly coupled to the conduit 26 extending between the outlet 24 of the condenser 20 and the expansion device 28, substantially upstream from a first valve 52 arranged therein. In one embodiment, a first TES inlet conduit 54 and a second TES inlet conduit 56, arranged generally in parallel, connect the heat exchanger 46 to the conduit 26. In the configuration illustrated in FIG. 4, the first TES inlet conduit 54 may include a valve 58, and the second TES inlet conduit 56 may include a expansion device 62.

[0018] The outlet 50 of the heat exchanger 46 may similarly include a first TES outlet conduit 62 and a second TES outlet conduit 64 arranged substantially in parallel. In one embodiment, the first TES outlet conduit 62 is coupled to the expansion device 28 to complete the vapor compression cycle and the second TES outlet conduit is connected to conduit 38 such that refrigerant R flowing there through is provided to the inlet 14 of the compressor 12, thereby bypassing the expansion device 28 and evaporator 32. In one embodiment, the second TES outlet conduit 64 includes another valve 66, and the first TES outlet conduit 62 includes a fourth valve 68 (see FIG. 3).

[0019] The HVAC&R system may be configured to operate in a “charge” mode, such as during off-peak periods of electrical demand for example, wherein heat from the refrigerant R is used to convert the phase change material 44 generally from a liquid to a solid. In a “charge” mode, valves 52 and 58 are generally closed such that liquid refrigerant R passes from the outlet 24 of the condenser 20 to the inlet 48 of the heat exchanger 46, through the second TES inlet conduit 56. The heat exchanger 46 operates in a manner similar to an evaporator such that the cool, reduced pressure liquid and vapor refrigerant mixture from the expansion device 60 absorbs heat from the phase change material 44 in the tank 42. In one embodiment, the refrigerant R within the heat exchanger 46 during the charge mode generally has a temperature in the range of about 55 degrees Fahrenheit to about 75 degrees Fahrenheit. Because the refrigerant R vaporizes within the heat exchanger 46, valve 66 of conduit 64 is opened, so that the refrigerant R is configured to bypass the evaporator 32. In embodiments where the first TES outlet conduit includes a valve 68, valve 68 is generally closed during the “charge” mode.

[0020] In one embodiment, the HVAC&R system 10 is also configured to operate in a “discharge” mode, wherein the phase change material 44 is generally converted from a solid to a liquid. In the discharge mode, valves 52 and 66 are closed and valve 58 is open. In addition, the blower 21 (see FIG. 1) positioned adjacent the condenser 20 is off, such that the superheated vaporized refrigerant R passes through the condenser 20 generally without experiencing a change in temperature and/or pressure. In the discharge mode, all of the superheated vapor refrigerant passes from the conduit 26 through the first TES inlet conduit 54. The heat exchanger 46 operates in a manner similar to a condenser such that heat from the refrigerant R transfers to the phase change material 44 in the storage tank 42. In one embodiment, the refrigerant R provided to the heat exchanger 46 generally has a temperature above the melting temperature of the phase change material 44. Cooled liquid refrigerant R from the outlet 50 of the heat exchanger 46 passes through the first TES outlet conduit 62 to the evaporator 32 to complete the vapor compression cycle within the HVAC&R system. In embodiments where the first TES outlet conduit includes a valve 68, valve 68 is generally open during the “discharge” mode.

[0021] The system 10 illustrated in FIG. 3 may additionally include a “charge and cool” mode, where valves 52 and 66 are open and valves 58 and 68 are closed. A first portion of the cool liquid refrigerant R is configured to flow through the valve 58 in the conduit 26 to the expansion device 28. A second portion of the cool liquid refrigerant R is configured to flow through the expansion device 60 of the second TES inlet conduit 56 to the inlet 48 of the heat exchanger 46. The refrigerant R is configured to absorb heat from the phase change material 44 as it passes through the heat exchanger 46 such that the phase change material 44 transforms from a generally liquid state to a substantially solid state. The vaporized refrigerant R is provided to conduit 38, by way of the first TES outlet conduit 64, to be recirculated through the compressor 12.

[0022] An HVAC&R system 10 configuration according to another embodiment of the invention is illustrated in FIG. 4. The conduit 18 extending between the compressor 12 and the condenser 20 includes a valve 70. A first TES inlet conduit 54 including a valve 58 extends from conduit 18 to an interface 48a of the heat exchanger 46 in the TES unit 40. A second TES inlet conduit 56 including an expansion valve 60 extends from conduit 26, upstream of valve 52, to another interface 48b of the heat exchanger 46. Another conduit 72, including a valve 74, extends from the conduit 26 to the interface 48b of the heat exchanger 46, the conduit 72 being generally parallel to conduit 56. In one embodiment, refrigerant is configured to flow from the interface 48b to the conduit 26 through conduit
72. Similar to the configurations of FIGS. 2 and 3, a first TES outlet conduit 62 and a second TES outlet conduit 64 may extend from a junction 50 of the heat exchanger 46, arranged substantially in parallel. In one embodiment, the first TES outlet conduit 62, including valve 68, is connected to the expansion device 28 to complete the vapor compression cycle of the HVAC system 10 and the second TES outlet conduit 64, including valve 66, is fluidly coupled to conduit 38 such that refrigerant R flowing there through bypasses the expansion device 28 and the evaporator 32.

[0023] During a normal vapor compression cycle of the HVAC&R system 10, valves 70 and 52 are open and valves 58, 66, 68, and 74 are generally closed so that the refrigerant does not flow through the TES unit 40. To “charge” the TES unit 40, valves 70 and 66 are open, and valves 52, 58, 68, and 74 are closed. Vaporized refrigerant R flows from the compressor 12 through conduit 18 to the condenser 20. The cool liquid refrigerant travels from conduit 26 through the second TES inlet conduit 56 to interface 48b of the heat exchanger 48. As a result of the pressure drop in the expansion valve 60 arranged within the second TES inlet conduit 56, the refrigerant R provided to the heat exchanger 46 is a mixture of liquid and vapor. Because the refrigerant R absorbs heat from the phase change material 44, the liquid portion of the refrigerant R vaporizes. The refrigerant is then configured to flow through valve 66 of the second TES outlet conduit 64 and back to the compressor 12 to repeat the cycle.

[0024] To release the thermal energy stored within the phase change material 44 of the TES unit 40, valves 52 and 58 are generally closed. As one embodiment, illustrated in FIG. 5, the TES unit 40 includes a first storage tank 42a and a second storage tank 42b arranged generally adjacent one another. Both tanks 42a, 42b are filled with a phase change material 44. A heat exchanger 46a, 46b is positioned within the phase change material 44 of each storage tank 42a, 42b, respectively. In one embodiment, the second heat exchanger 46b is configured to receive a refrigerant flow during a “discharge” mode of the HVAC&R system 10 and the first heat exchanger 46a is configured to receive the refrigerant R during a “charge” mode of the system 10. Similar to the configuration illustrated in FIG. 4, the HVAC&R system 10 includes a conduit 18, including a valve 70 arranged therein, extending from the compressor 12 to the condenser 20. A first TES inlet conduit 54 including a valve 58 extends from conduit 18 to an inlet 48a of the second heat exchanger 46b. A second TES inlet conduit 56 including a expansion device 60 and a valve 76, extends from conduit 26 connecting the condenser 20 to an inlet 48a of the first heat exchanger 46a. The second TES inlet conduit connects to conduit 26 generally upstream from a valve 52 arranged therein. A first TES outlet conduit 62 fluidly couples the outlet 50b of the second heat exchanger 46b to conduit 26. A second TES outlet conduit 64 connects the outlet 50a to conduit 38 extending between the evaporator 32 and the compressor 12.

[0027] To circulate the refrigerant through the HVAC&R system 10 but not the TES unit 40, valves 52 and 70 are open, and valves 58 and 76 are closed. In the “charge” mode, valves 70 and 76 are open, and valves 52 and 58 are closed. Refrigerant flows from the compressor 12 through conduit 18 to the condenser 20. After being cooled to a liquid, the refrigerant R flows from conduit 26 to the first heat exchanger inlet 48a through the second TES inlet conduit 56. The refrigerant R absorbs heat from the phase change material 44 such that the phase change material in the first storage tank 42a changes from a liquid to a generally solid state. From the outlet 50a of the heat exchanger 46a, the vaporized refrigerant R is provided to the compressor 12 via second TES outlet conduit 64 to repeat the vapor compression cycle. In a “discharge” mode, valves 52 and 58 are open, and valves 70 and 76 are closed. The refrigerant R from the compressor 12 flows to the first TES inlet conduit 54, thereby bypassing the condenser 20. Within the second heat exchanger 46b, the superheated, vaporized refrigerant R transfers heat to the phase change material 44 such that the phase change material 44 generally transforms from a solid to a liquid. The cool, liquid refrigerant R travels from the outlet 50b of the second heat exchanger 46b to the expansion device 28 via the first TES outlet conduit 62.

[0028] Referring now to FIGS. 6-7, a TES unit 40 according to another embodiment is illustrated. An inlet 48 of the heat exchanger 46 may be fluidly connected to a water supply 80, such as a water tower or a city water supply for example. After flowing through the heat exchanger 46, water is provided from the outlet 50 to a domestic demand 82, such as a house or apartment or the return to a water tower for example. The water from water supply 80 is generally cooler than the pre-selected designed solidification temperature of the phase change material 44. As a result, the cool water may “charge” the TES unit 40 as it flows there through by absorbing heat from the phase change material 44 such that the phase change material 44 generally transforms from a liquid to a solid. In one non-limiting embodiment, illustrated in FIG. 6a, a pump 84 may be used to circulate water from the water supply 80 through the heat exchanger 46 of the TES unit 40 to the domestic demand 82.
In the embodiment illustrated in FIG. 7, the TES unit 40 includes multiple heat exchangers 46 arranged within the insulated storage tank 42, such as a first heat exchanger 46a fluidly coupled to a water supply 80 and a second heat exchanger 46b fluidly coupled to an HVAC&R system in a manner similar to the system 10 of FIG. 2. In the illustrated non-limiting configuration, the inlet 48a of the first heat exchanger 46a is coupled to water supply 80 and the outlet 50a of the first heat exchanger 46a is connected to a domestic warm water demand. A first TES inlet conduit 54 and a second TES inlet conduit 56 couple the HVAC&R system 10 to the inlet 48b of the second heat exchanger 46b. In one embodiment, the first TES inlet conduit 54 includes a valve 58 and the second TES inlet conduit 56 includes an expansion device 60. The outlet 50b of the second heat exchanger 46b may similarly include a first TES outlet conduit 62 and a second TES outlet conduit 64 arranged substantially in parallel. The second TES outlet conduit 64 may include a valve 66. In one embodiment, the first TES outlet conduit 62 is coupled to the expansion device 28 to complete the vapor compression cycle and the second TES outlet conduit 64 is connected to conduit 38 such that refrigerant R flowing there through is provided to the inlet 14 of the compressor 12, thereby bypassing the expansion device 28 and evaporator 32.

To charge the TES unit using refrigerant from the HVAC&R system 10, valves 52 and 58 are generally closed such that liquid refrigerant R passes from the outlet 24 of the condenser 20 to the inlet 48b of the second heat exchanger 46b, through the second TES inlet conduit 56. The cool, reduced pressure liquid and vapor refrigerant mixture from the expansion device 60 absorbs heat from the phase change material 44 in the tank 42. Because the refrigerant R vaporizes within the heat exchanger 46b, valve 66 of conduit 64 is open, so that the refrigerant R is configured to bypass the evaporator 32.

The system 10 is also configured to operate in a “discharge” mode, wherein the phase change material 44 is generally converted from a solid to a liquid. In the discharge mode, valves 52 and 66 are closed and valve 58 is open. In addition, the blower 21 (see FIG. 1) positioned adjacent the condenser 20 is off, such that the superheated vaporized refrigerant R passes through the condenser 20 generally without experiencing a change in temperature and/or pressure. In the discharge mode, all of the superheated vapor refrigerant passes from the conduit 26 through the first TES inlet conduit 54. The second heat exchanger 46b operates in a manner similar to a condenser such that heat from the refrigerant R transfers to the phase change material 44 in the storage tank 42. In one embodiment, the refrigerant R provided to the second heat exchanger 46b generally has a temperature above the melting temperature of the phase change material 44. Cooled liquid refrigerant R from the outlet 50b of the second heat exchanger 46b passes through the first TES outlet conduit 62 to the evaporator 32 to complete the vapor compression cycle within the HVAC&R system. In one embodiment, when the system 10 is in a discharge mode and refrigerant R flows through the second heat exchanger 46b, water from the water source 80 is simultaneously pumped through the first heat exchanger 46a. The cool temperature of the water supplied from source 80 absorbs heat from the phase change material 44 in the tank 42. During such a mode of operation, the phase change material 44 is configured to transfer the thermal energy absorbed from the refrigerant R to the water.

Though a particular configuration of a thermal energy storage unit 40 fluidly coupled to a water supply 80 and an HVAC&R system 10 is illustrated, other configurations, such as the configurations illustrated in FIGS. 3-5 are within the scope of the invention.

The various configurations of the HVAC&R system 10 described herein allow a TES unit 40 to be designed as an add-on component which may be incorporated into a conventional HVAC&R system during installation or as a retro-fit component. With proper selection, a single phase change material 44 having a higher phase change temperature and energy density than conventional thermal energy storage materials may be used for heating, cooling, and refrigeration applications. As a result, the HVAC&R system 10 configurations are generally more efficient and a lower cost than conventional HVAC&R systems including energy storage components.

While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

What is claimed is:

1. A system comprising:
   a vapor compression cycle including an operably coupled compressor, condenser, first expansion device, and evaporator through which a refrigerant circulates; and
   a thermal energy storage unit including a heat exchanger arranged within a phase change material, the heat exchanger being fluidly coupled to the vapor compression cycle with a plurality of conduits and valves such that refrigerant flows through the heat exchanger in a heat transfer relationship with the phase change material, wherein when the HVAC&R system is in a first mode, the heat exchanger is configured to replace to the evaporator and the phase change material is configured to store thermal energy, wherein when the HVAC&R system is in a second mode, the heat exchanger is configured to replace the condenser and the phase change material is configured to release thermal energy.

2. The system according to claim 1, wherein the vapor compression system includes at least three valves.

3. The system according to claim 1, wherein a first inlet conduit and a second inlet conduit extend from an outlet of the condenser to an inlet of the heat exchanger.

4. The system according to claim 3, wherein the first inlet conduit includes a valve.

5. The system according to claim 3, wherein the second inlet conduit includes a second expansion device.

6. The system according to claim 1, wherein a first outlet conduit extends from an outlet of the heat exchanger to the first expansion device of the vapor compression cycle and a second outlet conduit extends from the outlet of the heat exchanger to an inlet of the compressor.
7. The system according to claim 6, wherein at least one of the first outlet conduit and the second outlet conduit includes a valve.

8. The system according to claim 6, wherein the first outlet conduit includes a first valve and the second outlet conduit includes a second valve.

9. The system according to claim 1, wherein the condenser includes a fan and when the phase change material is configured to release thermal energy, the fan is inoperative.

10. The system according to claim 1, wherein when the system is in a third mode, the heat exchanger is configured to function similar to the evaporator and the phase change material is configured to store thermal energy, and a first portion of the refrigerant is configured to flow through the thermal energy storage unit, and a second portion of the refrigerant flows through the vapor compression cycle to provide air of a desired temperature to a space.

11. The system according to claim 1, wherein the thermal energy storage unit includes a first heat exchanger and a second heat exchanger arranged within the phase change material.

12. The system according to claim 11, wherein refrigerant flows through the first heat exchanger when the system is in the first mode and refrigerant flows through the second heat exchanger when the system is in the second mode.

13. The system according to claim 12, wherein a flow of refrigerant through the first heat exchanger is controlled independently of the flow of refrigerant through the second heat exchanger.

14. A system comprising: a water source; a water demand; and a thermal energy storage unit including a first heat exchanger arranged within a phase change material, the first heat exchanger being fluidly coupled to the water source and the water demand such that water flows through the first heat exchanger in a heat transfer relationship with the phase change material.

15. The system according to claim 14, wherein the phase change material is configured to store thermal energy.

16. The system according to claim 14, further comprising a pump configured to circulate water from the water supply through the heat exchanger and to the water demand.

17. The system according to claim 14, further comprising: a vapor compression cycle including an operably coupled compressor, condenser, first expansion device, and evaporator through which a refrigerant circulates, wherein the at least heat exchanger is fluidly coupled to the vapor compression cycle with a plurality of conduits and valves such that refrigerant is configured to flow through the heat exchanger in a heat transfer relationship with the phase change material.

18. The system according to claim 17, wherein the phase change material is configured to transfer thermal energy from the refrigerant to the water.

19. The system according to claim 17, wherein when the HVAC&R system is in a first mode, the heat exchanger is configured to function similar to the evaporator and the phase change material is configured to store thermal energy.

20. The system according to claim 17, wherein when the HVAC&R system is in a second mode, the heat exchanger is configured to function similar to the condenser and the phase change material is configured to release thermal energy.

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