

HEAT EXCHANGER SYSTEM

TECHNICAL FIELD

[0001] The present disclosure relates to a heat exchanger system.

BACKGROUND

[0002] The following discussion of the background is intended to facilitate an understanding of the present disclosure only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or is part of the common general knowledge of the person skilled in the art in any jurisdiction as of the priority date of the invention.

[0003] Various forms of heat exchanger systems such as air-conditioners or temperature regulating devices have been contemplated. However, most air-conditioners produce heat energy, which is typically dissipated into the surrounding environment. In addition, the refrigerant used/utilized by air-conditioners may adversely affect the environment and cause pollution.

[0004] There exists a need for an improved device and/or system to alleviate one or more of the aforementioned problems.

SUMMARY

[0005] The disclosure was conceptualised to reduce the need for a conventional/chemical refrigerant by using water as a coolant for part of the heat exchanger system and/or as part of the heat exchange cycle. An arrangement of heat exchangers provides for the exchanging of heat, and in some embodiments there includes one or more auxiliary devices arranged to effectively recycle heat energy within the heat exchanger system.

[0006] The disclosure further contemplates the use of a solar powered assembly and a power supply configured to receive solar-generated power, to reduce consumption of electricity. Such solar powered components may include solar panels arranged in series and/or parallel to effectively regulate power to the

heat exchanger system.

[0007] According to one aspect of the disclosure, there is a heat exchanger system comprising a compressor unit, a first valve arrangement, a second valve arrangement, a first heat exchanger, a second heat exchanger and a third heat exchanger, arranged in direct or indirect fluid communication; wherein the compressor unit is arranged to direct a refrigerant to the first valve arrangement; the first valve arrangement configured to direct the refrigerant to either the second valve arrangement or the third heat exchanger; and wherein the second valve arrangement is configured to direct the refrigerant to the first heat exchanger, receive the refrigerant from the first heat exchanger, direct the refrigerant on a return path to the compressor unit; or direct the refrigerant to the third heat exchanger.

[0008] In some embodiments, the compressor unit is a DC inverter compressor.

[0009] In some embodiments, the heat exchanger system further includes a solar-powered control assembly arranged to control and provide electrical power to the heat exchanger system.

[0010] In some embodiments, the solar-powered control assembly includes a solar panel assembly, a balance of solar PV system (BOS), and a power supply. The power supply may be configured to obtain electrical input from at least one of an electrical mains and the BOS.

[0011] In some embodiments, the power supply is configured to supply electrical power to at least one of: the compressor unit, the first valve arrangement, the second valve arrangement, and a fan proximate to the second heat exchanger.

[0012] In some embodiments, the heat exchanger system may operate as an air-conditioner in a cooling mode. In the cooling mode, the first valve arrangement is configured to direct the refrigerant to the second valve arrangement, the second valve arrangement is configured to direct the refrigerant to the first heat exchanger to release heat to the environment, and the first heat exchanger is configured to direct the refrigerant to the second heat exchanger for absorbing heat.

[0013] In the cooling mode, there may further comprise a water-based air-conditioner unit arranged in fluid communication with the second heat exchanger. The second heat exchanger is configured to facilitate heat exchange between the refrigerant and water. The water may be used to release heat to the refrigerant to facilitate the temperature regulation of an enclosed space via the water-based air-conditioner unit.

[0014] In some embodiments, the heat exchanger system may operate as an air-conditioner in a heating mode. In the heating mode, the first valve arrangement is configured to direct the refrigerant to the second valve arrangement, the second valve arrangement is configured to direct the refrigerant to the second heat exchanger to release heat, and the second heat exchanger is configured to direct the refrigerant to the first heat exchanger for absorbing heat.

[0015] In the heating mode, there may further comprise a water-based air-conditioner unit arranged in fluid communication with the second heat exchanger, wherein the second heat exchanger is configured to facilitate heat exchange between the refrigerant and water. The water may be used to absorb heat from the refrigerant to facilitate the temperature regulation of an enclosed space via the water-based air-conditioner unit.

[0016] In some embodiments, the heat exchanger system is operating as an air-conditioner in a cooling mode with a heating capability, the first valve arrangement is configured to direct the refrigerant to the third heat exchanger, the third heat exchanger is configured to release heat to an auxiliary device, and the third heat exchanger is configured to direct the refrigerant to the second heat exchanger for absorbing heat.

[0017] In some embodiments, the heat exchanger system is operating as a heater, the first valve arrangement is configured to direct the refrigerant to the third heat exchanger, the third heat exchanger is configured to release heat to an auxiliary device, and the third heat exchanger is configured to direct the refrigerant to the first heat exchanger for absorbing heat.

[0018] In some embodiment, at least one of the first valve arrangement and the

second valve arrangement is a four-way valve.

[0019] In some embodiments, the heat exchanger system further comprises an electronic expansion valve assembly arrangement between the first heat exchanger and second heat exchanger for controlling a pressure of the refrigerant flowing therebetween.

[0020] According to another aspect of the disclosure there is a method for providing heat exchanging between a compressor unit, a first valve arrangement, a second valve arrangement, a first heat exchanger, a second heat exchanger and a third heat exchanger, arranged in direct or indirect fluid communication, comprising the steps of:- (a.) directing a refrigerant to the first valve arrangement; (b.) directing the refrigerant from the first valve arrangement to either the second valve arrangement or the third heat exchanger; (c.) directing the refrigerant from the second valve arrangement to the first heat exchanger; receiving the refrigerant from the first heat exchanger, directing the refrigerant on a return path to the compressor unit; or directing the refrigerant to the third heat exchanger.

[0021] According to another aspect of the disclosure there is a solar-powered control assembly for providing control and power signals to a heat exchange system, the solar-powered control assembly includes a solar panel assembly, a balance of solar PV system (BOS), and a power supply, wherein the heat exchange system includes a compressor unit, a first valve arrangement, a second valve arrangement, a first heat exchanger, a second heat exchanger and a third heat exchanger, arranged in direct or indirect fluid communication; wherein the compressor unit is arranged to direct a refrigerant to the first valve arrangement; the first valve arrangement configured to direct the refrigerant to either the second valve arrangement or the third heat exchanger; and wherein the second valve arrangement is configured to direct the refrigerant to the first heat exchanger, receive the refrigerant from the first heat exchanger, direct the refrigerant on a return path to the compressor unit; or direct the refrigerant to the third heat exchanger.

[0022] Other aspects and features of the present invention will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF DRAWINGS

[0023] In the figures, which illustrate, by way of example only, embodiments of the present invention,

[0024] Figure 1 shows an embodiment of a heat exchange system operating as an air-conditioner device in a cooling mode;

[0025] Figure 2 shows an embodiment of the heat exchange system operating as an air-conditioner device in a heating mode;

[0026] Figure 3 shows an embodiment of the heat exchange system operating as an air-conditioner device in a cooling mode with heating function of an auxiliary device;

[0027] Figure 4 shows the heat exchanger system operating in a water heater mode;

[0028] Figure 5 shows an example of a solar panel and assembly for use with the four operating modes as depicted in Figure 1-4; and

[0029] Figure 6 shows an embodiment where multiple solar panel assemblies are arranged in parallel to provide power to multiple heat exchanger systems.

DESCRIPTION OF EMBODIMENTS

[0030] Throughout the description, the term 'heat exchanger' may refer to a system and/or device to transfer heat between two or more fluids. Some heat exchangers described in the various embodiments may be used in both cooling and heating processes. It may be appreciated that a heat exchanger may include one or more interfaces. An interface of a heat exchanger may include medium to facilitate heat exchange, the interface may include a wall to achieve separation

between the fluids. Such wall may be a solid wall. In some embodiments, the interface may allow the two or more fluids to be in direct contact with one another to facilitate heat exchange.

[0031] Throughout the description, the term 'refrigerant' broadly includes heat exchange medium and/or fluid for facilitating heat exchange.

[0032] Throughout the description, the term 'air-conditioner' may include temperature regulators for heating or cooling an environment, such as within an enclosed space/area. The term 'air-conditioner' may also include an outdoor system having a compressor unit and an indoor device for the regulation of temperature and/or humidity in an enclosed area.

[0033] Figures 1 to 4 illustrate embodiments of a heat exchanger system 100 operating in various modes.

[0034] The heat exchanger system 100 comprises the following components: - a compressor 1, an oil separator 2, a first valve arrangement 3, a second valve arrangement 4, a evaporator/condenser 5, a fluid storage 6, a heat exchanger 7, a first expansion valve 8, a second expansion valve 9, a one way valve (check valve/non-return valve) 10, a heater 11, an air-conditioning pump 12, a switch 13, a water pump 14 and gas-liquid separator 15.

[0035] It is contemplated that the components may be arranged in fluid communication to provide effective heat exchange so as to provide for at least four operating modes as illustrated in the Figures 1 to 4. The fluid communication is typically facilitated by physical pipes, such as water pipes or gas pipes.

[0036] As may be appreciated, the evaporator/condenser 5, heat exchanger 7, and heater 11 function as heat exchangers and may be regarded as a first, second and third heat exchangers respectively. In each of the following exemplary modes illustrated in Figure 1 to Figure 4, at least two of the first, second and third heat exchangers may be activated for heat exchange or heat transfer.

[0037] In some embodiments, the compressor 1 may be a DC inverter compressor.

[0038] The oil separator 2 is configured to separate oil from the refrigerant (typically in gaseous form) in a return path back to the compressor 1 so as to improve the performance of the heat exchange system to save energy. The oil separator 2 may include a filter and baffle device for making the oil particles aggregate and drop to a bottom portion of the oil separator.

[0039] The first and second valve arrangements 3, 4 may preferably be four-way valves suitable for use with an air-conditioner and temperature regulators. The four-way valves may include, but not limited to, four-way reversing valves. The four-way reversing valves may be activated by electronic/electrical signals such as application of electrical voltages or electrical current.

[0040] The evaporator/condenser 5 may be an integrated device that can function both as an evaporator and a condenser.

[0041] The heat exchanger 7 may be a brazed plate heat exchanger arranged to provide efficient heat transfer with minimal carbon footprint. The heat exchanger 7 facilitates heat transfer between conventional refrigerant, and an environmentally friendly coolant, such as water. In some embodiments, the heat exchanger system 100 may be arranged to transfer heat from/to a water-based air-conditioner unit in an indoor enclosed space 200. In such an arrangement, the heat exchanger 7 may be suitably positioned as a heat exchange interface between the refrigerant and water. A water pump 12 and a water flow switch 13 may be arranged to facilitate flow of water to the water-based air-conditioner unit.

[0042] The first and second expansion valves 8, 9 may be electronic expansion valves (EEV) for the control of the direct or indirect flow of refrigerant entering a heat exchanger.

[0043] The heater 11 may be a circulation heater, and preferably a circulation heater having a spiral casing to maximize surface area for heat transfer.

[0044] Referring to the embodiment shown in Figure 1, with arrows indicating the flow of refrigerant, the heat exchanger system 100 operates as an air-conditioner device in a cooling mode for cooling an enclosed space 200. The

enclosed space 200 may be part of a residential home and may be a room or part thereof.

[0045] In the cooling mode, the output of the DC inverter compressor 1 is joined to an input of the oil separator 2, the output/outlet of the oil separator 2 is in turn joined to port 31 (D port) of multi-way/four-way valve 3. An electrical voltage signal is applied to the four-way valve 3, such as to direct the flow of gaseous refrigerant from the port 33 (E port) to port 41 (D port) of four-way valve 4. No electrical voltage signal is applied to the four-way valve 4, and the refrigerant is directed from port 42 of four-way valve 4 to the input of the evaporator/condenser 5. As may be appreciated, the output of the DC inverter compressor 1 emits high temperature high pressure refrigerant or coolant, which in turn is directed to the four-way valves 3 and 4. The heated coolant/refrigerant emitted by the DC inverter compressor 1 passes through the four-way valves 3 and 4, and enters the evaporator/condenser 5 to be cooled.

[0046] The cooled refrigerant, typically in a liquid form, is then passed through the arrangement comprising the electronic expansion valve 9 and electronic expansion valve 8. The valves 8 and 9 work in tandem to control the flow of the cooled refrigerant depending on a predetermined parameter, such as a pre-set temperature, and direct the low pressure liquefied refrigerant to the brazed plate heat exchanger 7 for absorption of heat. In some embodiments, a storage tank 6 may be used to store any water before the same is directed to the brazed plate heat exchanger 7 for circulation into the water-based air-conditioner unit in the enclosed space 200. The refrigerant absorbs heat at the heat exchanger 7 via an aqueous medium, and turns into a gaseous state. The gaseous refrigerant is directed to port 43 (E port) of the four-way valve 4 and is directed, via port 44 (S port) to the gas-liquid separator 15 (to remove any residual liquid), before being directed back to the compressor 1 in the form of a low pressure gas.

[0047] It is contemplated that water may be used as a refrigerant/coolant for heat exchange with the conventional refrigerant at the brazed plate heat exchanger 7. Water can be supplied, as a coolant, to an internal air-conditioner unit (not shown). This may be via pipes/tubes/conduits to provide cooling to the enclosed

space 200. Water cooled at the heat exchanger 7 may be directed via a pump 12 and a water flow switch 13. Such an arrangement advantageously provides for a reduced amount of conventional refrigerant required for the heat exchange system. In case of leakage of refrigerant in the enclosed space 200, the leaked refrigerant, in the form of water, is non-toxic and pose minimal danger to the occupants of the enclosed space 200. The air-conditioning pump 12 and the water flow switch 13 may be controlled according to one or more actual operating states, and the cooled water medium at the heat exchanger 7 is delivered to the end device (typically an indoor air-conditioner unit) to achieve a cooling effect according to a preset temperature. In this process, the frequency conversion controller controls the operating frequency of the DC inverter compressor 1 to the optimal operating state according to the collected temperature signal(s) and through a control algorithm to achieve rapid cooling and energy saving effect. The collected temperature signal(s) may be received via one or more temperature sensors positioned or disposed at suitable location(s) at, in or around the heat exchanger system 100. The control algorithm may be configured to provide one or more control signals to direct more refrigerant to locations that has a higher temperature based on the temperature signal(s) received.

[0048] In the embodiment shown in Figure 2, with arrows indicating the flow of refrigerant, the heat exchanger system 100 operates as an air-conditioner device in a heating mode for heating an enclosed space 200.

[0049] In the heating mode, the output of the DC inverter compressor 1 is joined to an input of the oil separator 2, the output/outlet of the oil separator 2 is in turn joined to port 31 (D port) of multi-way/four-way valve 3. An electrical voltage is applied to the four-way valve 3, such as to direct the flow of gaseous refrigerant from the port 33 (E port) to port 41 (D port) of four-way valve 4. An electrical voltage is applied to the four-way valve 4, and the refrigerant is directed from port 41 of four-way valve 4 to port 43 (E port) of the four-way valve 4. From port 43, the refrigerant is directed to the heat exchanger 7. The high temperature high pressure refrigerant or cooler undergoes heat exchange with the aqueous medium of the heat exchanger 7, which increases the temperature of the aqueous medium in the vicinity of the heat exchanger 7. The cooled refrigerant, in liquid form, flows pass

the storage tank 6, and pass the electronic expansion valves 8 and 9, according to the parameters, such as water temperature, predetermined by the system, the opening of the expansion valves 8 and 9 may be controlled to achieve the desired outcome. The cooled refrigerant, which is a relatively low pressure liquid, is passed to the evaporator/condenser 5 for evaporation. The refrigerant takes in heat at the evaporator/condenser 5 and transits into the gaseous state. The gaseous refrigerant is directed to port 42 (C port) of the four-way valve 4 and directed to the gas-liquid separator 15 before being returned to the compressor 1.

[0050] It is contemplated that the air-conditioning pump 12 and the water flow switch 13 may be controlled according to an actual operating state, and the heated aqueous medium at the heat exchanger 7 is delivered to an end device (typically an indoor unit) to achieve a cooling effect according to a preset temperature. In this process, the frequency conversion controller controls the operating frequency of the DC inverter compressor 1 to the optimal operating state according to the collected temperature signal(s) and through intelligent control to achieve rapid heating and energy saving effect. The collected temperature signal(s) may be received via one or more temperature sensors positioned or disposed at suitable location(s) at, in or around the heat exchanger system 100. The control algorithm may be configured to provide one or more control signals to direct more refrigerant to locations that has a higher temperature based on the temperature signal(s) received.

[0051] In the embodiment shown in Figure 3, with arrows indicating the flow of refrigerant, the heat exchanger system 100 operates as a temperature regulation device in a cooling mode for heating an enclosed space 200, and additionally provides for heating of an auxiliary device, such as a water heater.

[0052] In the cooling mode, the output of the DC inverter compressor 1 is joined to an input of the oil separator 2, the output/outlet of the oil separator 2 is in turn joined to port 31 (D port) of multi-way/four-way valve 3. No electrical voltage is applied to the four-way valve 3, and as such the flow of gaseous refrigerant is directed from the port 31 (D port) to port 32 (C port) of four-way valve 3. Port 32 is connected to the circulating heater 11 for directing the high pressure gaseous

refrigerant to the circulating heater 11 for heat exchange. The water pump 14 is operable to pump water from a hot water tank 300 to the vicinity of the circulating heater 11 so as to absorb heat from the circulating heater 11, which in turn heats up the water. The heated water may be stored in the hot water tank 300. In some embodiments, the hot water tank 300 may be configured to directly or indirectly dispense heated water for use.

[0053] The cooled refrigerant, after undergoing heat exchange at the circulating heater 11, is directed to the one-way valve 10 and in turn directed to the arrangement comprising the electronic expansion valve 9 and electronic expansion valve 8. The valves 8 and 9 work in tandem to control the flow of the cooled refrigerant depending on a pre-set temperature, and direct the low pressure liquefied refrigerant to the brazed plate heat exchanger 7 for absorption of heat. The storage tank 6 may be used to store any excess liquefied refrigerant before the same is directed to the brazed plate heat exchanger 7. The refrigerant absorbs heat at the heat exchanger 7 via an aqueous medium, and turns into a gaseous state. The gaseous refrigerant is directed to port 43 (E port) of the four-way valve 4 and is directed, via port 44 (S port) to the gas-liquid separator 15 (to remove/minimize any liquid), before being directed back to the compressor 1 in the form of a low pressure gas.

[0054] In the embodiment shown in Figure 4, with arrows indicating the flow of refrigerant, the heat exchanger system 100 operates as a heater device for heating of an auxiliary device, such as a water heater.

[0055] In the heating mode, the output of the DC inverter compressor 1 is joined to an input of the oil separator 2, the output/outlet of the oil separator 2 is in turn joined to port 31 (D port) of multi-way/four-way valve 3. No electrical voltage is applied to the four-way valve 3 (or no electrical current is configured to flow pass the four-way valve 3), and as such the flow of gaseous refrigerant is directed from the port 31 (D port) to port 32 (C port) of the four-way valve 3. Port 32 is connected to the circulating heater 11 for directing the high pressure gaseous refrigerant to the circulating heater 11 for heat exchange. Like the embodiment shown in Figure 3, the water pump 14 is operable to pump water from a hot water tank 300 to the

vicinity of the circulating heater 11 so as to absorb heat from the circulating heater 11, which in turn heats up the water or increase the temperature of the water. The heated water may be stored in the hot water tank 300. In some embodiments, the hot water tank 300 may be configured to directly or indirectly dispense heated water for use.

[0056] The cooled refrigerant, after undergoing heat exchange at the circulating heater 11, is directed to the one-way valve 10 and in turn directed to the arrangement comprising the electronic expansion valve 9 and electronic expansion valve 8. The electronic expansion valve 8 is closed (i.e. this may correspond to an OFF state), and the cooled refrigerant is directed pass electronic expansion valve 9 and directed to the evaporator/condenser 5 to be absorb heat and be evaporated.

[0057] The evaporated refrigerant is directed to port 42 (C port) of four-way valve 4, and in turn to port 44 (S port). From port 44, the refrigerant (now in low pressure, gaseous form) is directed to the gas-liquid separator 15, the gaseous refrigerant being fed back into the compressor 1 as input.

[0058] In some embodiments, the refrigerant may include energy efficient or environmentally friendly refrigerant such as R-32.

[0059] Figure 5 illustrates a possible arrangement of a power supply circuit for providing power to one or more electrical components of the heat exchanger system. The electrical components may include the compressor 1, a DC fan for use with the evaporator/condenser 5, the electronic expansion valves 8, 9, and/or indoor controller circuit for the indoor air-conditioner unit for the regulation of temperature and/or humidity level.

[0060] The power supply circuit shown in Figure 5 may be configured to receive electrical power from conventional electrical mains, and/or from a photovoltaic system having a plurality of solar panels, the plurality of solar panels arranged in series with each other to convert solar energy into electricity via photovoltaic cells and a balance of solar PV system (BOS) circuit to convert DC electrical power into AC electrical power.

[0061] As shown in Figure 5, two to nine (2-9) solar panel blocks 520 may be connected in sequence or in series with each other. The number of solar panel blocks 520 to be used may depend on space availability for installation of the same. In some embodiments, the voltage across all the solar panel blocks arranged in series may provide a combined voltage of about 324V. For example, in Figure 5, each of the four solar panels provides 81V (4x81V). In some embodiments a total power generation of 920W may be expected.

[0062] Each solar panel 520 may adjoin an adjacent solar panel 520 (via connectors or otherwise) to form a solar panel assembly. The solar panel assembly is then connected to a balance of solar PV system (BOS) circuit 540, via connectors into the P_{VIN} positive and negative terminals.

[0063] The BOS can include electrical components such as wirings, switches, a mounting system, one or more solar inverters, a battery bank and a battery charger. The connectors include dedicated photovoltaic connectors and/or lines. An example of such photovoltaic connector/line is the MC4 connectors and/or wires.

[0064] The BOS comprises six (or more) connectors in alternating polarities. Two terminals (P_{VIN}) are connected to the solar panel assembly, and two terminals (AIRCON) are connected to the variable frequency controller 560 of the heat exchanger system 100. The other two connectors may be connected internally to batteries and rechargeable such as to provide an alternative power supply, functioning as an uninterruptible power supply (UPS).

[0065] In some embodiments, the BOS may include one or more circuit breakers and surge protection circuits. The BOS may also include a high powered diode arrangement for current or voltage rectification.

[0066] The power supply circuit may include a variable frequency controller 560. The variable frequency controller 560 provides for circuits/circuitry to provide input to control the compressor 1. In some embodiments, the variable frequency controller 560 may be configured to include power factor correction (PFC) devices/circuit components for controlling a bus voltage of the compressor 1. The

variable frequency controller 560 may include one or more voltage regulators for achieving the power factor correction (PFC). The voltage regulators may include software, hardware or a combination thereof to achieve the power factor correction.

[0067] In operation, the bus voltage may be regulated based on a voltage regulation ratio, taking into account both relatively high voltage and relatively low voltage. In a relatively low voltage operation, it is necessary to ensure that a high frequency operation of the compressor 1 is within a normal operating conditions/range, i.e. there is a stable power supply within a tolerable range of voltage fluctuation. In a relatively high voltage operation, the bus voltage is regulated such that there will be no overvoltage phenomenon. In operation, the solar panel converts solar energy into electric energy. After being processed by electronic control software, the converted electric energy is maximized for the energy consumption of the inverter compressor, and the load of the mains is reduced.

[0068] In some embodiments, the electrical energy generated by the photovoltaic connector passes through the control of the BOS 540, and may be connected to an intelligent power module (IPM). The IPM can be external to the heat exchanger system. The IPM may be part of the control circuits or logic to control or direct refrigerant as a response to temperature signal(s) received as described.

[0069] Figure 6 shows an arrangement 600 where multiple solar panel assemblies are arranged to provide electrical power to multiple heat exchanger systems, wherein the multiple heat exchanger systems may be identical to the heat exchanger system 100 described in the earlier embodiments. Three solar panel assemblies (each having four solar panels 520 arranged in series), may be arranged in a parallel configuration to provide electrical power to multiple heat exchanger systems. The arrangement 600 includes multiple solar panel assemblies 620 arranged in parallel with respect to each other. Each solar panel assembly comprises multiple solar panels arranged in series, akin to the arrangement shown in Figure 5. Each solar panel assembly 620 may be arranged in electrical connection with one or more BOS 640. In general, for N number of

solar panel assemblies, there are N number of corresponding BOS 640. The N BOS 640 may be in turn connected to N power supply circuits to provide electrical power to electrical components of N heat exchanger systems.

[0070] It should be further appreciated by the person skilled in the art that variations and combinations of features described above, not being alternatives or substitutes, may be combined to form yet further embodiments falling within the intended scope of the invention.

CLAIMS

1. A heat exchanger system comprising
a compressor unit, a first valve arrangement, a second valve arrangement, a first heat exchanger, a second heat exchanger and a third heat exchanger, arranged in direct or indirect fluid communication;
wherein the compressor unit is arranged to direct a refrigerant to the first valve arrangement; the first valve arrangement configured to direct the refrigerant to either the second valve arrangement or the third heat exchanger; and
wherein the second valve arrangement is configured to direct the refrigerant to the first heat exchanger, receive the refrigerant from the first heat exchanger, direct the refrigerant on a return path to the compressor unit; or direct the refrigerant to the third heat exchanger.
2. The heat exchanger system of claim 1, wherein the compressor unit is a DC inverter compressor.
3. The heat exchanger system of claim 1 or 2, further includes a solar-powered control assembly arranged to control and provide electrical power to the heat exchanger system.
4. The heat exchanger system of claim 3, wherein the solar-powered control assembly includes a solar panel assembly, a balance of solar PV system (BOS), and a power supply.
5. The heat exchanger system of claim 4, wherein the power supply is configured to obtain electrical input from at least one of an electrical mains and the BOS.
6. The heat exchanger system of claim 5, wherein the power supply is configured to supply electrical power to at least one of: the compressor unit, the first valve arrangement, the second valve arrangement, and a fan proximate to the second heat exchanger.

7. The heat exchanger system of claim 1, wherein when the heat exchanger system is operating as an air-conditioner in a cooling mode, the first valve arrangement is configured to direct the refrigerant to the second valve arrangement, the second valve arrangement is configured to direct the refrigerant to the first heat exchanger to release heat to the environment, and the first heat exchanger is configured to direct the refrigerant to the second heat exchanger for absorbing heat.

8. The heat exchanger system of claim 7, further comprises a water-based air-conditioner unit arranged in fluid communication with the second heat exchanger, wherein the second heat exchanger is configured to facilitate heat exchange between the refrigerant and water.

9. The heat exchanger system of claim 1, wherein when the heat exchanger system is operating as an air-conditioner in a heating mode, the first valve arrangement is configured to direct the refrigerant to the second valve arrangement, the second valve arrangement is configured to direct the refrigerant to the second heat exchanger to release heat to the environment, and the second heat exchanger is configured to direct the refrigerant to the first heat exchanger for absorbing heat.

10. The heat exchanger system of claim 9, further comprises a water-based air-conditioner unit arranged in fluid communication with the second heat exchanger, wherein the second heat exchanger is configured to facilitate heat exchange between the refrigerant and water.

11. The heat exchanger system of claim 1, wherein when the heat exchanger system is operating as an air-conditioner in a cooling mode with a heating capability, the first valve arrangement is configured to direct the refrigerant to the third heat exchanger, the third heat exchanger is configured to release heat to an auxiliary device, and the third heat exchanger is configured to direct the refrigerant to the second heat exchanger for absorbing heat.

12. The heat exchanger system of claim 1, wherein when the heat exchanger system is operating as a heater, the first valve arrangement is configured to direct the refrigerant to the third heat exchanger, the third heat exchanger is configured to release heat to an auxiliary device, and the third heat exchanger is configured to direct the refrigerant to the first heat exchanger for absorbing heat.

13. The heat exchanger of any one of the preceding claims, wherein at least one of the first valve arrangement and the second valve arrangement is a four-way valve.

14. The heat exchanger of any one of the preceding claims, further comprises an electronic expansion valve assembly arrangement between the first heat exchanger and second heat exchanger for controlling a pressure of the refrigerant flowing therebetween.

15. A method for providing heat exchanging between a compressor unit, a first valve arrangement, a second valve arrangement, a first heat exchanger, a second heat exchanger and a third heat exchanger, arranged in direct or indirect fluid communication, comprising the steps of:-

- (a.)directing a refrigerant to the first valve arrangement;
- (b.)directing the refrigerant from the first valve arrangement to either the second valve arrangement or the third heat exchanger;
- (c.)directing the refrigerant from the second valve arrangement to the first heat exchanger; receiving the refrigerant from the first heat exchanger, directing the refrigerant on a return path to the compressor unit; or directing the refrigerant to the third heat exchanger.

16. A solar-powered control assembly for providing control and power signals to a heat exchange system, the solar-powered control assembly includes a solar panel assembly, a balance of solar PV system (BOS), and a power supply, wherein the heat exchange system includes

a compressor unit, a first valve arrangement, a second valve arrangement, a first heat exchanger, a second heat exchanger and a third heat exchanger, arranged in direct or indirect fluid communication;

wherein the compressor unit is arranged to direct a refrigerant to the first valve arrangement; the first valve arrangement configured to direct the refrigerant to either the second valve arrangement or the third heat exchanger; and

wherein the second valve arrangement is configured to direct the refrigerant to the first heat exchanger, receive the refrigerant from the first heat exchanger, direct the refrigerant on a return path to the compressor unit; or direct the refrigerant to the third heat exchanger.