Claims

1. A vapour compression apparatus comprising:

   a pumping device (1) which is configured to pump a refrigerant;
   a condenser (8) which is configured to condense the refrigerant;
   an evaporator (7) which is configured to evaporate the refrigerant;
   a heat battery (4) comprising a phase change material (PCM) (5);
   at least one or a series of temperature and/or pressure sensors (23) configured to monitor the temperature and/or pressure of the phase change material (PCM) in the heat battery;
   wherein the heat battery is configured to be connected to the condenser (8) and/or evaporator (7) to release charge (i.e. discharging) energy and/or be charged during the operation of the vapour compression apparatus, whereby the heat battery (4) is capable of controlling the temperature of a heat source and/or heat sink temperature in a vapour compression cycle;
   characterised in that the vapour compression apparatus is configured for the at least one or the series of temperature and/or pressure sensors (23) ~~is~~ to be immersed in the phase change material (PCM) (5) ~~which~~ to provide~~s~~ a real-time indication of the temperature and pressure of the heat battery and to provide~~s~~ an indication when the refrigerant flow should be switched.

2. A vapour compression apparatus according to claim 1, wherein the vapour compression apparatus is configured such that, the temperature and/or pressure measurements are conducted constantly and/or continuously or periodically such as every 30 seconds or every minute, during the operation of the vapour compression apparatus.

3. A vapour compression apparatus according to any preceding claim, wherein, during the operation of the vapour compression apparatus, the at least one or a series of temperature and/or pressure sensors (23) provide real-time temperature and/or pressure measurements which allows the temperature and pressure of the phase change material (PCM) (5) to be monitored along with a measurement of the level of charge in the phase change material (PCM) (5).

4. A vapour compression apparatus according to any preceding claim, ~~wherein~~ configured for the heat battery (4) comprising phase change material (PCM) (5) ~~is~~ to be located intermediary between the condenser (8) and evaporator (7); and wherein the heat battery (4) provides an intermediary stage between the condenser (8) and evaporator (7) which are functioning as either a heat source and/or heat sink during the operation of the vapour compression apparatus.

5. A vapour compression apparatus according to any preceding claim, wherein during a first stage the heat battery pre-cools or pre-heats and during a second stage the heat battery discharges cooling or discharges heating; and wherein the heat battery functions as an intermediary located heat exchanger during the operation of the vapour compression apparatus.

6. A vapour compression apparatus according to any preceding claim, wherein the apparatus is configured to be disposed in a vertical or substantially vertical orientation ~~wherein~~ and for a liquid containing vessel containing refrigerant ~~is~~ to be located above or substantially above the pumping device (1) in the form of a compressor and the liquid containing vessel is to be located vertically or substantially vertically between the evaporator (7) and the condenser (8); and wherein the pumping device (1) in the form of a compressor is configured to compress and/or pressurise the refrigerant around a system of pipes around the apparatus.

7. A vapour compression apparatus according to any preceding claim, wherein the phase change material (PCM) (5) ~~used~~ includes any one of or combination of the following:

   a paraffin material, such as decane e.g. forming a PCM with a phase change transition temperature of about 25°C to 35°C or about -30°C, with optionally additives to improve nucleation, crystallisation rates and/or cyclability;
   a salt-water eutectic, such as sodium chloride and water e.g. forming a PCM with a phase change transition temperature of about 20°C to 25°C or about -22°C, with optionally additives to improve nucleation, crystallisation rates and/or cyclability;
   a salt-water eutectic, such as magnesium sulfate and water e.g. forming a PCM with a phase change transition temperature of about -10°C to 0°C or about - 5°C, with optionally additives to improve nucleation, crystallisation rates and/or cyclability;

a salt-water eutectic, such as sodium sulfate and water e.g. forming a PCM with a phase change transition temperature of about -5°C to +5°C or about -1°C, with optionally additives to improve nucleation, crystallisation rates and/or cyclability;
an organic ester, such as methyl laurate e.g. forming a PCM with a phase change transition temperature of about 0°C to 10°C or about 5°C, with optionally additives to improve nucleation, crystallisation rates and/or cyclability;
a clathrate hydrate, such as tetrahydrafuran (THF) and water e.g. forming a PCM with a phase change transition temperature of about 0°C to 10°C or about 5°C, with optionally additives to improve nucleation, crystallisation rates and/or cyclability;
an ester such as dimethyl succinate e.g. forming a PCM with a phase change transition temperature of about 15°C to 25°C or about 18°C, with optionally additives to improve nucleation, crystallisation rates and/or cyclability;
a fatty alcohol, such as dodecanol e.g. forming a PCM with a phase change transition temperature of about 15°C to 25°C or about 22°C, with optionally additives to improve nucleation, crystallisation rates and/or cyclability;
a salt hydrate, such as sodium sulfate decahydrate e.g. forming a PCM with a phase change transition temperature of about 25°C to 35°C or about 32°C, with optionally additives to improve nucleation, crystallisation rates and/or cyclability;
a salt hydrate, such as sodium acetate trihydrate e.g. forming a PCM with a phase change transition temperature of about 0°C to 10°C about 5°C, with optionally additives to improve nucleation, crystallisation rates and/or cyclability; a polyol with a solid-solid phase change, such as trimethyloethane e.g. forming a PCM with a phase change transition temperature of about 70°C to 95°C or about 81°C, with optionally additives to improve nucleation, crystallisation rates and/or cyclability; and
a polyol, such as erythritol e.g. forming a PCM with a phase change transition temperature of about 100°C to 150°C about 121°C, with optionally additives to improve nucleation, crystallisation rates and/or cyclability.

8. A vapour compression apparatus according to any preceding claim, wherein the phase change material (PCM) (5) is selected from a temperature range neither as low as a user wants to cool to or as high as a user wants to reject heat to; or
wherein the phase change material (PCM) (5) is selected which has a phase change temperature of about 1°C - 20°C or about 10°C - 15°C above the temperature that we require to cool to and/or the phase change temperature that causes a refrigerant to

condense with a pressure 1 - 10 BarG or preferably about 1 - 5 BarG above the pressure of the required evaporation pressure.

9. A vapour compression apparatus according to any preceding claim, wherein the phase change material (PCM) (5) selected has a phase change temperature of about 1°C - 20°C or about 10°C - 15°C above the temperature of the ambient condition in which the heat pump is sourcing it's heat energy and/or the phase change temperature that causes a refrigerant to evaporate with a pressure of about 1 – 10 BarG or about 1 - 5 BarG above the pressure refrigerant would evaporate at given the design conditions minimum ambient temperature.

10. A vapour compression apparatus according to any preceding claim, wherein located within the heat battery there is a series of tubes; and
the evaporator (7) is a fan coil evaporator.

11. A vapour compression apparatus according to any preceding claim, wherein the functionality of the evaporator (7) and condenser (8) is reversible during different cycles during the operation of the vapour compression apparatus.

12. A vapour compression apparatus according to any preceding claim, wherein the apparatus comprises a reversing valve (9) to reverse the flow of refrigerant when required and switch between charging and/or discharging; and

wherein the vapour compression apparatus is configured for the switching to occurs manually or electronically and ~~is~~ to be dependent on the temperature and/or pressure being measured and when switching is required; and
wherein when heating is required, refrigerant flows from the heat battery and when cooling is required refrigerant flows into the heat battery (4) during the operation of the vapour compression apparatus; and
wherein connected to the condenser (8) and a liquid containing vessel (13) there is a further valve which is configured to function~~s~~ as a check valve.

13. A vapour compression apparatus according to preceding claim, wherein the apparatus also comprises a dryer such as a filter dryer which is configured to be located vertically below the liquid containing vessel;

expansion devices (e.g. expansion valves) suitable for pre-cooling;

at least one solenoid valve configured to be located between the heat battery (4) and a reversing valve (9) suitable for isolating the heat battery (4) when required; and

a suction vessel accumulator (19) which is configured to direct the refrigerant flow.

14. A vapour compression apparatus according to any preceding claim, further comprising a solenoid valve (22) configured to be connected to the heat battery (4) and a liquid containing vessel (13) suitable for hot gas defrosting.

15. A method for controlling the temperature of a heat source and/or heat sink temperature in a vapour compression cycle using apparatus according to any of claims 1 to 14.