CLAIMS

1. Energy storage plant, comprising:

a casing storing a working fluid other than atmospheric air, in a gaseous phase and in equilibrium of pressure with the atmosphere, wherein said casing is a pressure-balloon or has the structure of a gasometer;

a tank storing said working fluid in liquid or supercritical phase with a temperature close to the critical temperature; wherein said critical temperature is close to the ambient temperature;

wherein the plant is configured to perform a closed cyclic thermodynamic transformation (TTC), first in one direction in a charge configuration and then in an opposite direction in a discharge configuration, between said casing and said tank; wherein in the charge configuration the plant stores heat and pressure and in the discharge configuration generates energy.

2. Plant according to claim 1, wherein the working fluid has the following chemical-physical properties: critical temperature between 0°C and 200°C, density at 25°C between 0.5 kg/m^3 and 10 kg/m^3; and/or is chosen in the group including: CO_2, SF_6, N_2O.

3. Plant according to claim 1 or 2, comprising:

- a compressor and a motor mechanically connected to each other;
- a turbine and a generator mechanically connected to each other;
- said casing externally in contact with the atmosphere and delimiting inside a volume configured to contain the working fluid at atmospheric pressure or substantially atmospheric pressure, wherein said volume is selectively in fluid communication with an inlet of the compressor or with an outlet of the turbine;
- a primary heat exchanger selectively in fluid communication with an outlet of the compressor or with an inlet of the turbine;
- said tank in fluid communication with the primary heat exchanger to accumulate the working fluid;

- a secondary heat exchanger operationally active between the primary heat exchanger and the tank or in said tank;

said plant being configured to operate in the charge configuration or in the discharge configuration;

wherein, in the charge configuration, the casing is in fluid communication with the inlet of the compressor and the primary heat exchanger is in fluid communication with the outlet of the compressor, the turbine is at rest, the motor is operating and drives the compressor to compress the working fluid coming from the casing, the primary heat exchanger works as a cooler to remove heat from the compressed working fluid, cool it and store thermal energy, the secondary heat exchanger works as a cooler to remove additional heat from the compressed working fluid and store additional thermal energy, the tank receives and stores the compressed and cooled working fluid, wherein the working fluid stored in the tank has a temperature close to its own critical temperature;

wherein, in the discharge configuration, the casing is in fluid communication with the outlet of the turbine and the primary heat exchanger is in fluid communication with the inlet of the turbine, the compressor is at rest, the secondary heat exchanger works as a heater to release heat to the working fluid coming from the tank, the primary heat exchanger works as a heater to release further heat to the working fluid and heat it, the turbine is rotated by the heated working fluid and drives the generator generating energy, the working fluid returns in the casing to atmospheric or substantially atmospheric pressure.

4. Plant according to claim 3, comprising an additional heat exchanger operationally placed between the casing and the compressor and between the casing and the turbine to pre-heat the working fluid before compression in the compressor, in the storage configuration, or to cool the working fluid from the turbine, in the discharge configuration.

5. Plant according to one of the above claims 3 or 4, wherein the motor and the generator are separate elements; or wherein the motor and the generator are defined by a single motor-generator and the plant comprises connection devices

between said motor-generator and the compressor and the turbine to connect mechanically and alternately the motor-generator to the compressor or to the turbine.

6. Plant according to one of the above claims 3, 4 or 5, wherein the secondary heat exchanger and the primary heat exchanger are configured to operate a super-critical transformation of the working fluid so that said working fluid is accumulated in the tank in super-critical phase.

7. Plant according to the previous claim, wherein the tank comprises a separating membrane configured to internally separate the tank into a first chamber with variable volume for the working fluid in super-critical phase and into a second chamber with variable volume in fluid communication with a compensation circuit containing a non-compressible fluid.

8. Plant according to one of the above claims from 3 to 5, wherein the secondary heat exchanger and the primary heat exchanger are configured to operate a sub-critical transformation of the working fluid so that the working fluid is accumulated in the tank in liquid phase.

9. Plant according to one of the above claims 3 to 8, wherein the primary heat exchanger is a fixed or moving bed heat regenerator or comprises a water, oil or salt primary circuit with at least one primary storage chamber.

10. Plant according to one of the above claims from 3 to 9, wherein the secondary heat exchanger comprises a secondary air or water circuit with at least one secondary storage chamber and is configured to remove heat from the working fluid, in the charge configuration, or to transfer heat to the working fluid, in the discharge configuration, at a temperature below 100°C.

11. Process for energy storage comprising:

carrying out a closed thermodynamic cyclic transformation (TTC), first in one direction in a charge configuration/phase and then in an opposite direction in a discharge configuration/phase, between a casing for the storage of a working fluid different from atmospheric air, in a gaseous phase and in pressure equilibrium with the atmosphere, and a tank for the storage of said working fluid in a liquid or supercritical phase with a temperature close to the critical temperature; wherein said critical temperature is close to the ambient temperature; wherein, in the charge phase, the process accumulates heat and pressure and, in the discharge phase, generates energy.

12. Process according to claim 11, wherein the charge phase comprises:

- compressing said working fluid, coming from said casing externally in contact with the atmosphere and delimiting inside a volume configured to contain the working fluid at atmospheric pressure or substantially atmospheric, absorbing energy;
- injecting the compressed working fluid through a primary heat exchanger and a secondary heat exchanger placed in series to bring a temperature of the working fluid close to its own critical temperature; wherein the primary heat exchanger works as a cooler to remove heat from the compressed working fluid, cool it and store thermal energy, wherein the secondary heat exchanger works as a cooler to remove further heat from the compressed working fluid and store further thermal energy;
- accumulating the cooled working fluid in said tank; wherein the secondary heat exchanger and the primary heat exchanger carry out a super-critical transformation of the working fluid so that said working fluid is accumulated in the tank in super-critical phase or wherein the secondary heat exchanger and the primary heat exchanger carry out a sub-critical transformation of the working fluid so that said working fluid is accumulated in the tank in liquid phase; wherein a temperature of the working fluid accumulated in the tank is between 0 °C and 100 °C and

wherein a pressure of the working fluid accumulated in the tank is between 10 bar and 150 bar.

13. Process according to claim 11 or 12, wherein said working fluid has the following physical-chemical properties: critical temperature between 0 °C and 200 °C, density at 25 °C between 0,5 kg/m^3 and 10 kg/m^3; and/or it is chosen in the group including: CO_2, SF_6, N_2O.

14. Process according to claim 12 or 13, wherein the phase of discharge and generation of energy comprises:

- passing the working fluid from the tank through the secondary heat exchanger and the primary heat exchanger; wherein the secondary heat exchanger works as a heater to transfer heat to the working fluid coming from the tank, wherein the primary heat exchanger works as a heater to transfer further heat to the working fluid and heat it;
- passing the heated working fluid through a turbine, wherein the turbine is rotated by the heated working fluid and drives the generator generating energy, wherein the working fluid expands and cools down in the turbine;
- re-injecting the working fluid coming from the turbine into the casing at atmospheric or substantially atmospheric pressure.

15. Process according to claim 14, wherein in the discharge phase and energy generation, between the primary heat exchanger and the turbine, it is provided to further heat the working fluid through an additional heat source.