

Heat Pump System with Cascaded Integration of a Latent Heat Storage

Reference No: B76196

CHALLENGE

The increased use of renewable energy sources leads to a growing demand for storage systems facilitating an efficient and consistent use of these energies. The main advantages of a storage unit in heat pump systems are the possibility to compensate fluctuations of the energy consumption and the operation of the plant under favourable conditions. Moreover, storage systems allow the use of time frames of preferential rates for electricity.

INNOVATION

The innovation comprises the direct integration of a latent heat storage (LHS) in a heat pump system. Thus, useful heat can be provided at an almost constant temperature level meeting the characteristic of the heat pump. The technology works both for heating and cooling applications.

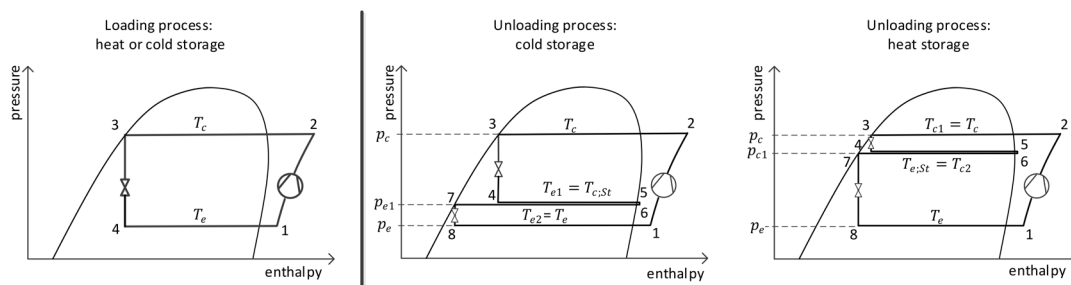
Loading and unloading of the LHS is realized by means of direct heat exchange with the refrigerant. Key aspect is the impact on pressure and temperature levels of the refrigerant cycle induced by conventional heat storage concepts. Within the novel concept, the loading and unloading processes of the LHS take place through direct evaporation and direct condensation of refrigerant in the heat exchanger embedded in the storage, respectively. The novel aspect of the proposed configuration is given by separation of the interconnected heat exchanger components in the unloading process into two parts and by switching of the hydraulic interconnection of the components. The loading process is realized in parallel connection of two evaporator units (EU) and the LHS which allows a loading process at the nominal evaporation temperature. To use the stored thermal energy with the provided temperature level of the storage, the unloading of a cold storage is effected with serial flow of the refrigerant through the EUs and the LHS, providing almost full capacity of the refrigeration system with substantially reduced operation of the compressor. The technology works analogously for heating applications.

COMMERCIAL OPPORTUNITIES

Renewable energy sources, heat pump systems, variable-refrigerant-flow heating and cooling systems (VRF systems), increased efficiency.

DEVELOPMENT STATUS

Pilot plant



Loading process of the latent heat storage (left): During loading of the LHS by direct evaporation (cold storage: state points 4-1) or direct condensation (heat storage: state points 2-3) of the refrigerant no adjustment of the nominal pressure level is required.

Cascaded unloading process of the cold storage (middle): A second evaporation stage of the refrigerant can be made use of (state points 4-5) by condensation of the refrigerant in the LHS afterwards (state points 6-7) and evaporation of the refrigerant on the original evaporation level (state points 8-1).

Cascaded unloading process of the heat storage (right): Condensation of the refrigerant on the original condensation level (state points 2-3) followed by evaporation of the refrigerant in the LHS (state points 4-5). Consequently, a second condensation stage of the refrigerant can be made use of (state points 6-7).

REFERENCES:

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