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Solar Cooling in Residential, Small Scale Commercial and Industrial Applications with Adsorption Technology

Oral presentation - Abstract

Solar Cooling – Large Opportunities but Lack of Industrialized Products

Solar Cooling is a highly promising renewable solution for the world's large and strongly growing air conditioning needs. So far, however, the market for solar cooling is still very young and mainly characterized by pilot or demonstration installations. The lack of compact, high performing and cost-effective chillers has been one of the main barriers for market development. Only a few manufacturers of adsorption and absorption chillers for solar cooling applications are on the edge of industrialisation. Additionally, planning and installation costs are still high compared with standard solar thermal systems due to the lack of standardized systems. New small scale adsorption chillers based on innovative coating technologies offer a solution for a market break-through of solar cooling.

Functional Principle of Adsorption Chillers

Adsorption technology is based on the thermal compression of water vapour through the cyclical ad- and desorption on adsorbent surfaces like silica gel or zeolite. Cold water is generated by evaporating the water (the refrigerant) at low pressures. Heat is required for the desorption process in order to expel the prior adsorbed water vapour (see explanatory page).

Innovations and Products by SorTech AG

SorTech AG has been the first company to bring compact adsorption chillers in the small scale performance range to the market. Key innovations include innovative coating technologies for the adsorbents silica gel and zeolite as well as an innovative, very compact design of the vacuum chamber. In 2007 a prototype series ACS 05 with 5.5 kW nominal cooling capacity was successfully tested in various installations. In 2008 a first product generation was introduced to the market in two capacity classes: the ACS 08 with 7.5 kW nominal cooling capacity and the ACS 15 with 15 kW cooling capacity. The offering of an integrated subsystem consisting of the chiller and a tailored hybrid re-cooler ensures high efficiency of the overall system, low energy consumption and easy system integration.

Outlook

Adsorption chillers have shown their suitability for daily use in various applications and can enable substantial savings in electricity consumption when driving heat, e.g. solar heat is available. However, further R&D is necessary in order to reduce costs, simplify system integration and broaden the range of meaningful applications. SorTech pursues two thrusts in this direction: the rapid industrialization of its existing product generation and the development of zeolite-based adsorption chillers using a breakthrough coating innovation: the direct crystallization of zeolite on aluminium surfaces.

Explanatory Page

Functional Principle of Adsorption Technology (more detailed)

The basic process of cold generation is the compression of a refrigerant fluid, which causes evaporation of the liquid at low temperatures and pressures and condensation of the vapour at higher temperatures and pressures. Instead of mechanical compressors like in electrical air-conditioners, thermally driven chillers use thermal energy for the compression of the fluid.

The basic principle of the thermal compression is the ab- or adsorption of the refrigerant in a liquid or solid material. Whereas absorption chillers use liquids such as lithium-bromide, in adsorption chillers solid adsorbents like silica gel or zeolites are used. In both technologies the refrigerant is most often water, which results in the challenge that the machine has to be operated at very low pressures in a vacuum tight containment.

SorTech ACS chillers use silica gel as adsorbent. Silica gel is a porous glass with a high capacity of adsorbing water vapour. For that reason it is widespread used as desiccant.

The working process of the adsorption chiller is described below (compare figure 1).

Step 1: Desorption – Drying of the adsorbent

The adsorbent is dried by heat input. Water vapour is set free, flows in the condenser and is liquefied there under heat emission. When the material is dry, the heat input in the adsorber is stopped and the upper check valve closes.

Step 2: Adsorption – water vapour is adsorbed at the surface of the adsorbent

After a cool down phase the reverse reaction and the evaporation of the liquid condensate starts. The lower check valve to the evaporator opens and the dry adsorbent aspirates water vapour. In the evaporator, water evaporates and generates cold, which can be used for air-conditioning. During the adsorption process heat is rejected which has to be dissipated.

Step 3: Return of condensate

In a final step the condensate is returned to the evaporator and the circuit closed.

In order to achieve a continuous cold production two adsorbers work in combination, i.e. one adsorber desorbs while the other adsorber generates cold by adsorbing in the meantime.