TES Applications

Demand orientated steam generation from phase change material by using a rotating drum heat exchanger

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Introduction: During the discharge process of a latent heat storage, phase change material solidifies at the heat transfer surface, which decreases the heat transfer. In the presented rotating drum heat exchanger for latent heat storage a rotating drum is partially immersed in liquid phase change material. While water evaporates as it passes through the drum, the liquid phase change material solidifies at the outer surface of the drum. The solidified layer is removed by a fixed scraper at each rotation and the solid phase change material is stored in a separate tank. This leads to a high surface specific heat transfer and a separation of power and capacity. In the presentation, a complete heat storage system based on a rotating drum heat exchanger and sodium nitrate as phase change material for the demand-oriented generation of steam for industrial processes as well as for electrical power generation is discussed based on theoretical and experimental research conducted with a laboratory pilot of the rotating drum heat exchanger.

Methods: Three different designs of the drum are discussed: a drum completely filled with water, a drum with concentric annular gap and a drum with several individual tubes drilled into the drum wall. The concepts are examined analytically and numerically with respect to heat transfer capacity, maximum operating parameters and technical feasibility.

Results: While a drum completely filled with water is predestined for the generation of low-pressure saturated steam for industrial processes, superheated steam can be reached with a concentric gap. High-pressure steam can be generated by using several individual tubes within the drum wall. The achievable heat transfer during the discharging process is exceeding 0.5 MW per meter of drum length at a drum diameter of 1 m. The storage system can be charged directly either by electric heaters or by using suitable heat pumps.

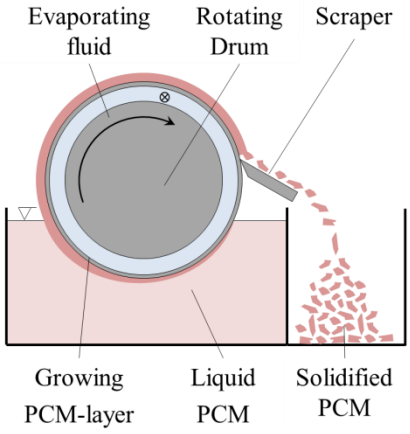

Figure 1: Concept of the rotating drum heat exchanger for latent heat storage

Conclusions: With the rotating drum heat exchanger for latent heat storage, steam can be generated with constant power and high heat flux densities of above 200 kW/m^2 based on the drums outer surface. The design can be realized on an industrial scale in the MW range.