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Deliverable D5.2 - System configuration for concrete module

ABSTRACT

A wide range of simulations that assess the performance of a prototype concrete thermal storage module are presented. The simulations presented were carried out using an existing heat transfer module that was adapted for this purpose. The adaptations are briefly presented and the adapted model is validated using published, experimental data of an existing concrete thermal storage unit, showing good agreement. Using the model, the influence of various parameters on performance is discussed, such as number of tubes, surface area to volume ratio, mass flow rate, void fraction, thermal conductivity of concrete, heat transfer enhancements within tube, potential air gap between steel tube and concrete. A 1 × 1 × 9 m prototype module is presented; the simulations predict a low performance for the prototype module with the originally intended operation parameters. However, a study on variable maximum outlet temperatures during charging and mass flow rates reveals that utilization factors and capture efficiencies above 40 % are achievable with the prototype. For example, a utilization efficiency of 46.4 % and a capture efficiency of 46.7 % are obtained for a mass flow rate of 0.4 kg/s and maximum outlet temperature during charging of 510 °C.