RADIAL FLOW PACKED BEDS WITH INTERNAL SEGMENTATION FOR THERMAL ENERGY STORAGE

Abstract

A common design for packed bed thermal energy storage is a cylindrical container filled with storage media where fluid moves through the bed axially. This work numerically analyzes a radial flow system with segmentation via internal insulation that allows discrete zones within the bed to be charged or discharged. In radial flow, flow moves from center to wall in charging, perpendicular to traditional systems. Results are given for a system with five segments/zones for a full charge-discharge cycle with charging at 600°C and discharging at 20°C. Fluid charges the first zone, and then heated flow goes to the next zone. This process is repeated and then reversed for the full charge-discharge cycle. Results show the segment charged last/discharged first has the highest exergetic efficiency at 89.4%. The segment charged first/discharged last had the lowest exergetic efficiency of 74.9% due to significant spreading of the thermal front in that zone due to conduction. The average exergetic efficiency for the full cycle with segments was 80.2%. This average value is lower than but similar to 82.8% for radial flow without segments and 81.6% for axial flow. While these thermal results may be reasonable compared to current systems, the pressure drop is excessively high. To maintain equal time in the charge/discharge cycle, each segment received the full mass flow rate. High velocities in the segments led to pressure drops over 1 bar, which represents a high parasitic power loss in the system.

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