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C2Or1A-05: Experimental Investigations on the Cold Recovery-Efficiency of a Packed-bed in a Cryogenic Energy Storage System

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Cryogenic Energy Storage (CES) system has large power generation capability, and comparable cost with respect to the non-cryogenic technologies (pumped-hydro, compressed air energy storage systems) while not being location specific unlike the non-cryogenic energy storage systems. It also is environment friendly. High-energy requirement for liquefaction process in the CES system, however, leads to low turnaround efficiency of the system. Efforts have been made to reduce the specific work-requirement in the liquefaction process by thermal energy storage at temperature below 100 K as available during power generation stage of the system. One of the methods of storing the thermal energy at such low temperature is using packed-bed of pebbles. A few studies have been reported in the open literature that indicated a reduction in storage efficiency during continuous operation of such packed-beds that would reduce the turnaround efficiency of the CES system. Therefore, in the present paper, experimental findings would be reported to get better insight into the packed bed behavior that dictate the turnaround efficiency. An experimental setup of packed-bed thermal energy storage has been built using granite pebbles as bed material for this purpose. The setup includes a double walled, vacuum insulated vessel filled with granite pebbles. The cool-down operations have been performed using air/nitrogen at 100 K. The bed has been warmed up by flowing air/nitrogen through it. Both these processes have been repeated several times to determine the thermocline behavior in both axial and radial directions inside the bed. The results will help in understanding the heat transfer inside the bed at cryogenic temperature.

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