Experimental Investigation of a Sustainable Thermal Energy Storage Sand Battery

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Thermal energy storage (TES) is being considered worldwide as a solution to the reliability and intermittency of renewable energy sources. TES technologies utilize insulated large-scale tanks that use filler materials [sands, rock, or phase changing materials (PCMs)] to store clean thermal energy. TES technologies are being implemented into applications of heating residential spaces and domestic water supplies at the scales of individual homes up to whole districts. There is a pressing need to implement experimental testing systems that aim at understanding the performance of thermal storage tanks and quantifying the impact of tank size, type, and properties of the solid filler used, along with a better understanding of the impact of the type and properties of the heat transfer fluid on the efficiency and cost. The main objective of the work presented in this paper was to design and construct a laboratory-scale experimental testing system that investigates the performance and thermal efficiency of a thermal storage tank with a solid filler that is sized to provide clean energy for domestic hot water use. In the experimental setup, the type of heat transfer fluid, the density of the filler, and the magnitude of input thermal energy were varied to collect important experimental data about factors that affect the heat transfer mechanism and thermal efficiency. Experimental results showed that sunflower oil can be a sustainable cost-effective replacement of synthetic oil and that the performance and efficiency of a TES unit can be effectively analyzed with laboratory-scale configurations.