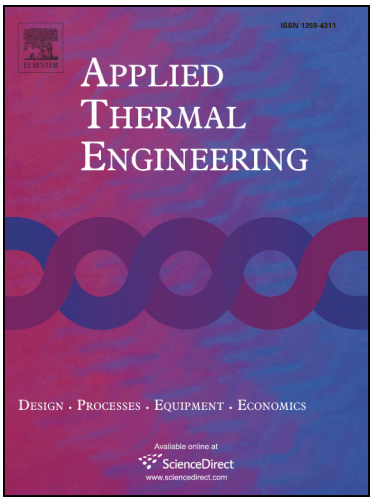

Research Paper

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Sulfur-based Thermal Energy Storage System using Intermodal Containment: Design and Performance Analysis

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ABSTRACT

Thermal energy storage (TES) can be coupled to intermittent energy sources to improve system dispatchability. Elemental sulfur is a promising candidate storage fluid for high temperature TES systems due to its high energy density, moderate vapor pressure, high thermal stability, and low cost. This study uses a transient, two-dimensional numerical model to investigate the design and performance of a thermal energy storage (TES) system that uses sulfur stored isochorically in an intermodal shell and tube thermal battery configuration. Parametric analyses of key design and operating parameters show that there is a preferred tube diameter based on the competing influence of system-level energy storage utilization, exergetic efficiency, and cost. The results show that designs with smaller tube dimensions in the range of 2″ NPS to 4″ NPS provide exergetic efficiencies close to 95% while tube dimensions in the range of 4″ NPS to 8″ NPS meet the Department of Energy cost target of $15/kWh with costs being as low as $8.41/kWh. Finally, a table of preferred designs that meet the DOE cost goals is presented in anticipation of future design and experimentation.

Keywords: Thermal Energy Storage (TES), Elemental sulfur, Exergetic efficiency, System model, Intermodal container

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