ABSTRACT

THERMAL PERFORMANCE OF A SIMULTANEOUS CHARGING AND DISCHARGING PACKED BED ENERGY STORAGE SYSTEM

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One of the major challenges with the use of solar thermal energy is the intermittent nature. As such, present day research is geared towards energy storage systems in which thermal energy is stored during the day for later use. However, in many engineering applications there is a continuous steady demand for energy. Hence, this study is focused on a system to provide an uninterrupted continuous supply of energy in the absence of or availability of solar energy.

A mathematical model was developed from consideration of the basic phenomena of heat transfer to predict the thermal behavior of a simultaneous charging, storage and discharging system during a heating cycle. The mathematical model simulated an air packed bed storage system coupled to a flat plate solar collector which received intermittent solar radiation and supplied it in sinusoidal form to the packed bed.

Experiments were conducted by charging the packed bed system from a flat plate solar collector of area $1.5m^2$.

A comparison of the predicted and the experimental valuesfor discharged temperature from the packed bed at airflow rate of 0.0094, 0.013 and 0.019 m^3/s for spherical shaped concrete of diameter 0.065m, 0.08m and 0.11m were conducted over the time period of 7.00hr to 17.00hr.

Spherical shaped concrete of diameter 0.11m exhibited the highest thermal energy storage efficiency of 60.5% at airflow rate of 0.013 m^3/s and also produces the highest discharged temperature of 56.97°C.

Optimization and the economic analysis of the entire storage system were also carried out.

The overall results indicate that the packed bed thermal storage unit converts the intermittent energy received from the sun, stores and discharge it continuously and that it is possible to have a simultaneous charging, storage and discharging system.

Keywords: A. A. Adeyanju; Simultaneous charging and discharging; Thermal; Intermittent; Packed bed; Energy storage.