Dataset on validation of double U-tube borehole and seasonal solar thermal energy storage system TRNSYS models

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Abstract

This dataset includes data from the validation of double U-tube borehole and seasonal solar thermal energy storage system TRNSYS models. The simulated transient temperatures at various points of the systems were compared with the measured ones. To quantify the agreement between each simulated and measured temperature of interest, mean bias error (MBE), root mean square error (RMSE) and correlation coefficient (CC) were applied.

Keywords: validation; modelling; space heating; seasonal thermal storage; solar energy

Specifications Table

<table>
<thead>
<tr>
<th>Subject</th>
<th>Renewable Energy, and Built Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific subject area</td>
<td>Solar heat storage, Computer Simulation, Complex systems, and Heat Pump system</td>
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<tr>
<td>Type of data</td>
<td>Text, Tables</td>
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<tr>
<td>How data were acquired</td>
<td>Measuring instruments: DataTaker models: DT85 &amp; DT605, and HOBO weather station</td>
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<td></td>
<td>Software tool: TRNSYS I7 [1]</td>
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<td></td>
<td>Weather source: Bureau of Meteorology (BOM), Commonwealth of Australia [2]</td>
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<td></td>
<td>Two data loggers: DataTaker model DT605 and DT85 with compatible expansion modules were used to collect the temperatures at various point of the seasonal solar thermal energy storage (SSTES) experimental rig. DT605 also recorded the outlet water temperature of the solar collector and the ground temperature. DT605 expansion module recorded the monitoring borehole temperatures. DT85 with an extension module recorded the fluid flow rates, the power consumptions of the heat pump and the circulating pump, and the heat charging and space heating loop temperatures at various points. An onsite weather station with a wind speed sensor (model S-WSA-M003), a pyranometer (model S-LIB-M003), and temperature and relative humidity sensors (model S-THB-M00X) was used to collect the global solar radiation on the horizontal plane, dry bulb temperature, relative humidity, rainfall, wind speed, and wind direction. Then, the collected input data were used in the TRNSYS projects for the validation of the double U-tube borehole model and the SSTES system model including component models.</td>
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<tr>
<td>Data format</td>
<td>Raw and processed</td>
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<tr>
<td><strong>Parameters for data collection</strong></td>
<td>The raw and processed data for the validation of the SSTES system TRNSYS model developed in [3] are provided. Descriptions of all parameters and assumptions are presented in [3].</td>
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</table>
| **Description of data collection** |  <WeatherData.xlsx>: The weather data were collected from an onsite HOBO weather station (2 min frequency).  
<GDNDtempOperation.xlsx>: The ground temperature at 21 m depth during operations (both heat charging and space heating modes) were measured (hourly average values provided).  
<HeatChargingOutput.xlsx>: Simulated and measured temperatures of Solar collector and Buffer tank, Buffer tank outlet to Solar collector, Solar collector outlet to Heat storage borehole, Heat storage borehole outlet to Buffer tank during heat charging mode (measured and recorded at 2 min frequency).  
<SpaceHeatingOutput.xlsx>: Simulated and measured temperatures of Heat pump outlet air, Heat pump outlet water (condenser), Room air, Heat storage borehole outlet water, Heat storage borehole outlet to Heat pump (HP EWT), Heat pump outlet water to Heat storage borehole (HP LWT) (2 min frequency).  
<GDNDtempUGT.xlsx>: Undisturbed ground temperatures [4] measured in monitoring borehole at three depths (2 m, 21 m, 40 m) were recorded at 20 min frequency and calculated daily average values were provided.  
<HeatChargingInput.xlsx>: Water flow rates, the status of Pump 1, temperatures (Ambient air, Solar collector inlet water, Solar collector outlet water, Borehole Tube 1 inlet water, Borehole Tube 1 outlet water, Wind speed, Buffer tanks inlet water, Buffer tank bottom water), Total solar radiation on the horizontal plane, Borehole Tube 2 inlet water temperature, Borehole Tube 2 outlet water temperature, and the status of charging control were measured and recorded at 2 min intervals during heat charging period.  
<SpaceHeatingInput.xlsx>: Water flow rates, temperatures (Borehole Tube 1 inlet water, Borehole Tube 1 outlet water, Heat pump inlet water, Heat pump outlet water, Return Air inlet, Air outlet, Room air, Outside ambient air), Total solar radiation on the horizontal plane, Outside ambient air relative humidity, Borehole Tube 2 inlet water temperature, Borehole Tube 2 outlet water temperature, and the status of heating control were measured and recorded at 2 min intervals during space heating period.  
To validated the double U-tube borehole model:  
<HeatCharging2U.xlsx>: Simulated and measured Borehole outlet temperatures during heat charging operation.  
<SpaceHeating2U.xlsx>: Simulated and measured Borehole outlet temperatures during space heating operation. |
<table>
<thead>
<tr>
<th>Data source location</th>
<th>The location is in Australia and climate zone [3]: Burnley Campus, The University of Melbourne (37.829800° S, 145.024049° E), Oceanic (Cfb).</th>
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</thead>
<tbody>
<tr>
<td>Data accessibility</td>
<td>CC BY 4.0 You can share, copy, and modify this dataset so long as you give appropriate credit, provide a link to the CC BY license, and indicate if changes were made, but you may not do so in a way that suggests the rights holder has endorsed you or your use of the dataset. Note that further permission may be required for any content within the dataset that is identified as belonging to a third party.</td>
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**Value of the Data**

This dataset adds to the credibility of the methods and discussions provided in [3] while maximising the usefulness of the conducted research. With free access to the data, the users may benefit from a more in-depth understanding of the methods and results. The users may gain insight into the methods of data preparation and processing applied in [3] and may also conduct further analysis of the results. The user is able to identify the required dataset to validate an energy system model.

**Data Description**

The data provided in <WeatherData.xlsx>, <GNDTempOperation.xlsx>, <GNDTempUGT.xlsx>, <HeatCharging2U.xlsx>, <HeatChargingInput.xlsx>, <HeatChargingOutput.xlsx>, <SpaceHeating2U.xlsx>, <SpaceHeatingInput.xlsx>, and <SpaceHeatingOutput.xlsx> are the data tables used for generating the illustrations in [3].

**Steps to reproduce**

1. Set local time and recording time steps of the loggers.
2. Collect temperatures for the duration.
3. Download the recorded data.
4. Obtain weather data from the onsite weather station and Australian Government BOM. Also, verify the data from the weather station by comparing with data from BOM.
5. Aggregated weather data and measurement data from DT605 and DT85.
6. Generate input data files (2 min interval) in TRNSYS Type9.
7. Develop a building model <*.bl7> in Rebuild and TRNSYS project files <*.tpf> in Simulation Studio.
9. Compare the simulated data with measured data for a double U-tube borehole, and quantify the agreement by using MBE, RMSE, CC.
10. Compare the simulated data with measured data for each component, and quantify the agreement by using MBE, RMSE, CC.
Experimental Design, Simulation Design, Materials and Methods

Experiment and simulation design, materials, methods, assumptions made, and their justifications are provided in [3].

Ethics Statement

Not applicable.

Contributor Roles Taxonomy (CRediT) author statement

Sheikh Khaleduzzaman Shah: Software, Validation, Formal analysis, Investigation, Data Curation, Writing - Original Draft & Editing, Visualisation. Lu Aye: Conceptualisation, Methodology, Validation, Resources, Data Curation, Writing - Review & Editing, Supervision, Project administration, Funding acquisition. Behzad Rismanchi: Supervision.

Acknowledgments

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this dataset.

References


