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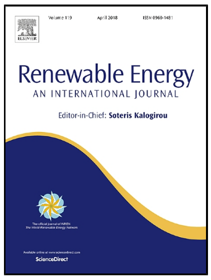

Black-box model for solar storage tanks based on multiple linear regression

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Abstract

Developing easy-to-use mathematical models for describing temperatures of solar storage tanks is important for the practice, since solar storages are unavoidable elements in solar heating systems, where some heat should be stored in the form of hot fluid. In this paper, a new, general and easy-to-apply black-box model, called LR model (where LR is the abbreviation of linear regression), is proposed for solar storages on the basis of multiple linear regression. This linear model may be the simplest black-box type model, which can follow the transient processes of solar storages precisely. Accordingly, the LR model proves to be more precise than a slightly modified version of a physically-based storage model used successfully for different applications in the literature. The modified physically-based model accounts for the short circuit effect occurring in storages. Comparing measured and simulated data on a real solar storage, both models are validated and their efficiency is discussed in details. The general and simple usability of the LR model is mentioned and future research proposals are given.

Keywords:
Solar storage tanks; Modelling; Black-box; Linear regression; On/off operation

Nomenclature

t : time, s;

Time-dependent variables

T_{cold} : inlet temperature of the cold fluid to be heated in the storage, °C;

T_e : temperature of the environment of the storage, °C;

T_{in} : inlet temperature to the storage from the heating loop, °C;

T_{load} : temperature of the outlet fluid discharged from the storage by the consumer, °C;

T_s : geometrical average temperature inside the storage, °C;

$T_{s,meas}$: measured geometrical average temperature inside the storage, °C;

$T_{s,\mathrm{mod}}$: modelled geometrical average temperature inside the storage, °C;

T_{out} : outlet temperature from the storage to the heating loop, °C;

v : pump flow rate in the heating loop (according to on/off operation), m^3s^{-1};

v_{load} : flow rate of the consumption load, m^3s^{-1}

Constant parameters

A : outside area of the storage, m^2;

c : specific heat capacity of the fluid in the storage, $Jkg^{-1}K^{-1}$;