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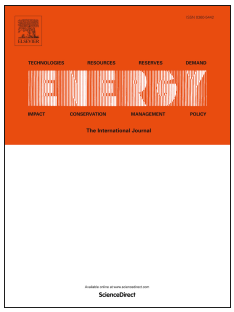

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Smart Adaptive Model for Dynamic Simulation of Horizontal Thermally Stratified Storage Tanks

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Abstract

Although, the horizontal thermally stratified storage tanks (TSST) are nowadays the most popular, especially in the domestic solar water heaters, most of the literature is oriented towards the vertical tanks. Recently, a smart adaptive model for TSST was proposed, where the grid segments size and location changes automatically according the different variations in the tank. It showed good agreement with experimental work, however the model and its validation was presented for the vertical configuration only. In this work, the adaptive-grid model is extended to the horizontal cylindrical tank orientation while accounting for the changes in grid segments cross-section during moving in the vertical direction as to be aligned with the thermocline region; the proposed model is validated with experimental data available in the literature. The results show an excellent agreement with the literature and yield a significant reduction in the number of nodes needed for the modeling (~32.7% reduction) when compared to other horizontal tank models while accounting for the changes tank geometry in the vertical direction.

Introduction

Solar energy importance is increasing at a very intense rate due to ever-increasing demand on energy and the changing costs of conventional energy resources [1]. Solar water heaters incorporating thermal storage tanks (TST) are used to provide convent hot water for domestic and industrial usage. The storage systems are added to offset the difference between transient nature of both the demand on hot water and the solar radiation. TST with high performance will effectively boost the solar system efficiency [2].

Thermal stratified storage Tanks (TSST) do employ the stratification technique which depends on the natural layering of water vertically in a tank depending on density differences due to the temperature profile inside the tank. Stratification ensures that the highest and the lowest temperatures are at the top and the bottom of the tank respectively [3] [4] [5]. Stratification is critical in thermosiphon solar water heaters as it controls the water flow rate. TSST can be utilized so one storage tank is used instead of having two tanks (one for hot and the other for cold water) or the use of single tank with baffles and barriers. TSST can be set vertically or horizontally, though vertical tanks offers less degradation to the thermocline region as it has a longer vertical dimension. However,

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