Numerical modelling of multi-pass solar dryer filled with granite pebbles for thermal storage enhancement

M W Kareem[1,3]**, K Habib**[1] **and M H Ruslan**[2]
[1]Department of Mechanical Engineering, Universiti Teknologi PETRONAS, 31750 Tronoh, Perak, Malaysia
[2]Solar Energy Research Institute (SERI), Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor Darul Ehsan, Malaysia

E-mail: kareem_g01949@utp.edu.my

Abstract. In this paper, a theoretical modelling of a cheap solar thermal dryer for small and medium scale farmers with multi-pass approach has been investigated. Comsol Multiphysics modelling tool was employed using numerical technique. The rock particles were used to enhance the thermal storage of the drying system. The local weather data were used during the simulation while parameters and coefficients were sourced from literature. An improvement on efficiency of up to 7% was recorded with error of 10^{-5} when compared with the reported double pass solar collector. A fair distribution of hot air within the cabinets was also achieved. Though the modelling tool used was robust but the characterization of the system materials need to be done to improve the system accuracy and better prediction.

1. Introduction

The United Nations has constantly monitoring its targets set for renewable energy sector under renewable energy for all by the year 2050 [1]. Therefore effort to improve the efficiency of the renewable energy systems is a major concern for researchers and this has made the use of latest modelling tools a must in the research on solar energy, in order to accomplish the noble goal of reducing the carbon content of our atmosphere due to the frequent usage of energy sourced from fossil fuels.

Carbonell et al. [2] examined both modified correlation model and an improved Duffie-Beckman model under a transient condition. Unsteady parameters such as solar irradiance, mass flow rate and inlet temperature of fluid were employed to get better system performance. These models were validated by virtual test approach that was based on numerical technique. However, it was difficult to determine the physical behaviour of the system through this approach.

Wu and Wang [3] developed a model using numerical technique to study the dynamic behaviour of volumetric solar thermal air absorber when subjected to different working conditions. A two dimensional discretization of solar absorber made of ceramic material was generated and analysed using CFD software. This dynamic model was confirmed to be accurate in predicting the volumetric solar hot air absorber. It was also affirmed that the ceramic solar absorber has smooth reaction to variation in thermal flux during the cause of operation. Ceramic porous absorber was investigated

[3] To whom any correspondence should be addressed.

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