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Lumped Components Modeling of Double Pass Solar Collector with Porous Matrixes

M.W. Kareem[1, a], Khairul Habib[2,b] and S.I. Gilani[3,c]

[1,2,3]Department of Mechanical Engineering, Universiti Teknologi PETRONAS, Malaysia

[a]kareem_g01949@utp.edu.my, [b]khairul.habib@petronas.com.my,
[c]syedihtsham@petronas.com.my

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Abstract. In this report, the modeling and simulation of a double pass solar air absorber was carried out using combination of Simscape and Simulink modeling tools. The solar system air mass flow rate and the porous media were critically investigated by using local weather data of Seri Iskandar, Perak, Malaysia. Optimal inlet air flow rate of $0.034 kgm^{-2}s^{-1}$ was obtained and one of the packed beds, sandstone extended the thermal transfer period of solar collector system by 1150s which displayed good agreement with the reported model and experimental outcomes. The results obtained have shown that it is a promising alternative tool for solar thermal experimentation modeling.

Introduction

Modeling still remains a challenge in the field of engineering but a must step to take for critical analysis of any experimental based research, especially in solar thermal research which requires high level of precision and accuracy due to its dynamic nature. Series of modeling techniques used for solar thermal transfer were reported but the choice is usually based on the tool that is very robust in its functionality.

Recent comments made by various authors affirmed that the analysis of solar absorber is still a standing problem despite the contribution of many researchers on this subject [1-3]. A suggestion was made on the modeling of a solar collector which involved combination of algebraic and differential equations, that it is easy to solve through numerical technique [4].

Two methods of testing the thermal performance of a solar air dryer was underscored as steady and transient approaches which are based on recognized standards [5]. It was emphasized that the steady state method is costly and testing condition is strict, though it involves non-complicated mathematical model. It was then suggested that better option of investigating solar absorber heat transfer is by using dynamic test mode [6,7].

MATLAB built model of gas filled flat plate solar collector was investigated [8] and a reduction of heat loss to surrounding of about 20% was achieved with perfectly sealed collector in glass. Simulink tool was used to model the transient behaviour of a hybrid energy system [9]. Simscape was described as one of the physical modeling tools suitable for solar thermal investigations [10].

The choice of material to be considered for packed bed must be available locally and inexpensive was exemplified [11,12] whereas it was stressed that wide surface area should be considered for better selection [13]. Quasi-dynamic approach was used to model solar absorber performance [5].

It was emphasized that detail information on the performance of every component can be known through separate resolution of equations used in modeling a system [4]. But this feature is absent in algorithm of majority of known modeling techniques. Several transient simulations using MATLAB and Simulink have been reported but little has been said about the extended part of the latter tool. This study was carried out to investigate the efficacy of using Simscape part of Simulink tool for modeling of accessories of solar thermal collector system. Cheap and locally sourced energy storage media were considered with various flow rates of the working fluid in order to determine the optimum rate required.

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