Performance analysis of a solar heat collector through experimental and CFD investigation

ABSTRACT

In order to attain maximum efficiency in a solar drying system, continuous effort is made to the key component of solar dryer – solar heat collector (SHC). This research aimed to evaluate the thermal performance of SHC with different flow configuration in the air passage, namely single-pass (S-SHC) and multiple-pass (M-SHC), under natural convection (average air velocity = 0.2 m/s). In order to study the flow and heat transfer characteristics across the SHC, performance analysis was carried out by Computational Fluid Dynamic (CFD) simulation and later validated by experimental results. From the simulation model, the collector outlet temperature and efficiency of M-SHC at maximum solar radiation were 67.4 °C and 10.04%, respectively with percentage error of 8.6% and 17.79% to the experimental results. The presence of recirculation region indicated extended drying air residence time in the M-SHC, resulting in high temperature growth from 8.8% to 12.1% across the air passage compared to S-SHC. In addition, heat transfer enhancement in M-SHC was achieved by compensating radiation heat loss observed in S-SHC through the modification of airflow configuration. Both experimental and theoretical analysis in this study showed that the proposed enhancement significantly improved the performance of SHC having air passage made from recycled aluminium cans