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Effect of thermal energy storage material on the performance of double-pass solar air heater with cross-matrix absorber

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[Sharol A.F.](#)^a; [Razak A.A.](#)^a ; [Majid Z.A.A.](#)^b; [Azmi M.A.A.](#)^a; [Tarminzi M.A.S.M.](#)^a; [+5 authors](#)

^a Faculty of Mechanical and Automotive Engineering Technology, Universiti Malaysia Pahang, Pahang, Pekan, Malaysia

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Abstract

This study was to experimentally investigate the influence of thermal energy storage material inside the tube of a double-pass solar air heater with a cross-matrix absorber (DPSAH-CMA). The fabricated SAH was tested in both indoor and outdoor conditions under a variety of operating conditions. It was found that the DPSAH-CMA-with PCM achieve a better thermal buffer of $-0.81\text{ }^{\circ}\text{C}/\text{min}$ as compared to the one without PCM at a mass flow rate of 0.005 kg/s . PCM contributed to the increment of obtainable cumulative heat rate for DPSAH-CMA-with PCM as compared to the one without PCM with a maximum value of 1548.54 W at higher solar radiation of $900\text{ W}/\text{m}^2$. Storage efficiency of DPSAH-CMA-with PCM was maximum at a higher mass flow rate and directly proportional with solar radiation values. Performance comparison was conducted under the outdoor conditions in which the DPSAH-CMA-with PCM achieved higher thermal efficiency by 17% compared to DPSAH-CMA-without PCM. For the DPSAH-CMA-with PCM and without PCM, the exergy efficiency was 23% and 15%, respectively. The calculated cost-benefit ratio for DPSAH-CMA-with PCM was $0.17\text{ RM}/\text{kWhr}$, which is 22% lower than the one without PCM.

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Author keywords

Double-pass solar air heater; Integrated cross-matrix absorber; Phase change material; Solar thermal

Indexed keywords

Engineering controlled terms

Air preheaters; Cost benefit analysis; Heat storage; Heating equipment; Mass transfer; Solar absorbers; Solar equipment; Solar heating; Solar radiation; Storage (materials); Thermal energy

Engineering uncontrolled terms

Condition; Double pass; Double-pass solar air heater; Energy storage materials; Integrated cross-matrix absorber; Mass-flow rate; matrix; Solar air heater; Solar thermal; Thermal energy storage

Engineering main heading

Phase change materials

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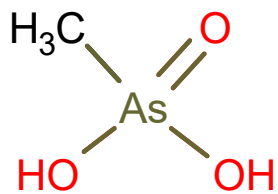
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Corresponding authors

Corresponding author	A.A. Razak
Affiliation	Faculty of Mechanical and Automotive Engineering Technology, Universiti Malaysia Pahang, Pahang, Pekan, Malaysia
Email address	amirrazak@ump.edu.my

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Abstract

Author keywords