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Design and thermal performance evaluation of an air heater with low cost thermal energy storage

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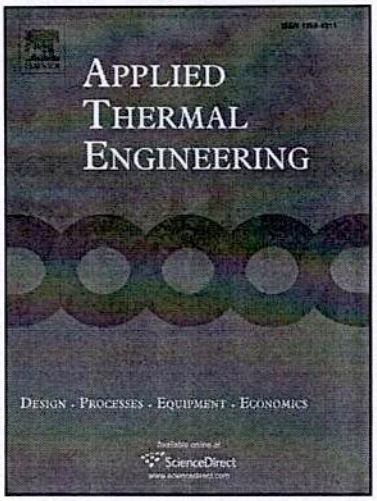

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Design and thermal performance evaluation of an air heater with low cost thermal energy storage

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Abstract- In the present experimental study a modified solar air heater (SAH) has been tested which integrated with cylindrical copper tube carrying low cost thermal energy storage (TES) material. The blackened copper tube is flexible to integrate with any flat plate type thermal system for performance enhancement especially for providing the hot air for long deliberating hours in low ambient conditions. Total, three low cost TES materials namely; granular carbon powder (GCP), paraffin wax and a unique combination of these two has been tested to evaluate its significance on the performance of SAH in geographical location of Moradabad city, India. Total three different models of air heater (SAH-B, SAH-C and SAH-D) have been developed and experimentally tested on TES encapsulated flexible copper tubes for performance enhancement. Flexibility of the tube is that it can be easily placed on the solar absorber of SAH whenever required by filling any desired TES material. Results show that all the new developed air heaters have been found better over the conventional air heater (SAH-A) but the model SAH-D has been found the best among all models in terms of heat transfer (485.31 W/m^{2}K), thermal efficiency (78.31%) and exhaust temperature (50^{o}C). The overall cost of the modified system is only $67.75 which is much economical to the other studied models.

Keywords- air heater, energy storage, low cost, heat transfer, performance enhancement

Nomenclature-

SAH- Solar air heater
LHS- Latent heat storage
SHS- Sensible heat storage
PCM- Phase change material
SAC- Solar air collector
SAHS- Solar air heating systems
GCP- Granular carbon powder
TES - Thermal energy storage material
NTU – Number of transfer units
T_{melt} - Melting temperature of PCM (^{o}C)
T_{amb} - Ambient temperature (^{o}C)
h - Heat transfer coefficient (W/m^2^{o}C)
h_{rd} - Radiative heat transfer rate (W)
h_{cv} - Convection heat transfer rate (W)
h_{cd} - Conduction heat transfer rate (W)
U_{over} - Overall heat loss transfer coefficient (W/m^2^{o}C)