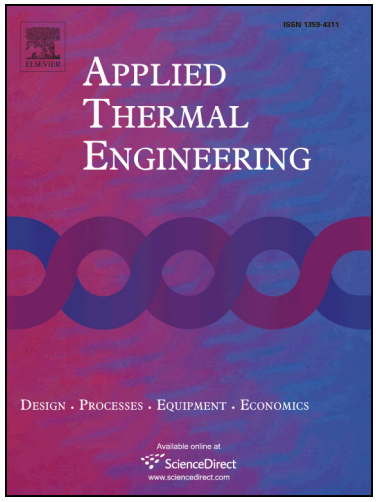

Research Paper

Performance evaluation of plastic solar air heater with different cross sectional configuration

A.S. Abdullah, Y.A.F. El-Samadony, Z.M. Omara

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Performance evaluation of plastic solar air heater with different cross sectional configuration

A.S. Abdullah[a, b], Y.A.F. El-Samadony[b], Z.M. Omara[c]

[a] *College of Engineering, Prince Sattam bin Abdulaziz University, KSA,*
[b] *Mechanical power engineering department, Faculty of Engineering, Tanta University, Egypt*

[c] *Faculty of Engineering, Kafrelsheikh University, Egypt.*
zm_omara@yahoo.com

Abstract

Solar air heaters, SAHs, represent the primary component of solar energy usage systems. The SAHs are able to absorb the solar energy and convert it into thermal energy at the absorbing surface, and then transfer the thermal energy to an air flowing through the SAH. In this work, an experimental investigation was performed on three SAHs with different cross sectional shape to find the best configuration. The shapes are circular, semi-circular and half-circle plus isosceles triangle. All SAHs have an identical absorber with a half-circle shape. The mass flow rate of air was changed from 0.05 to 0.25 kg/s. Results indicated that the highest efficiencies were accomplished for the circular configuration and reached to about 80% at a mass flow rate of 0.18 kg/s. On the other hand, for the same conditions, the thermal efficiency reached about 64% and 48% for half-circle plus isosceles triangle and semi-circular shapes, respectively.

Keywords: Solar air heater, air heater, plastic solar collectors, Thermal efficiency

1. Introduction

Solar air heater is one of the basic equipment through which solar energy is transformed into thermal energy. The main applications of SAH are seasoning of timber, space heating [1], curing of industrial products, and drying processes in several applications [2, 3]. In addition, in order to generate heat for crop drying, marine products, building's heating, textile dyeing and water desalination, solar air heaters have been used. SAHs offer many advantages. The simple design contributes to favourable economics and reliabilities. This results in lower production and operating costs due to smaller number of parts and longer maintenance intervals. The systems operate smoothly and noiselessly. They are environmentally sustainable. However, the value of the heat transfer coefficient between the air and the absorber plate reduces the thermal efficiency of solar air heaters. Another reason for the low thermal performance of solar air heaters is heat loss through the top cover (the glazing), as all the sides and the bottom of the collector are thermally insulated. Various studies were performed in order to increase the thermal performance of the solar collectors by modifying the configuration of the absorber plate. The convective heat transfer coefficient in SAH can be increased by: (1) using turbulators or fins (extended surfaces), (2) using a packed bed material and (3) surface artificially roughened (to break the laminar sub-layer in turbulent boundary layer regions).