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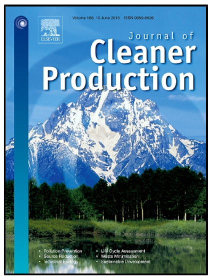

Numerical analysis on solar air collector provided with artificial square shaped roughness for indirect type solar dryer

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Numerical analysis on solar air collector provided with artificial square shaped roughness for indirect type solar dryer

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Abstract

Drying agricultural food products in an indirect type solar dryer (ITSD) is a topic of frequent research. Heat transfer rate to the fluid flow in the solar collector can be enhanced by providing artificial roughness on the surface of the absorber plate. The present work concentrates on air flow and heat transfer characteristics in a solar air collector provided with roughness of square shaped rib over the absorber of ITSD. 2D numerical simulations are performed for flow through the solar air collector for relevant Reynolds number (Re) which ranges from 3800 to 18,000. The Re, relative roughness pitch (P/e), relative roughness height (e/D) and thermo-hydraulic performance parameter (THPP) are chosen as design variables. The governing equations for turbulent flow field are solved using RNG k–ε turbulence model. The simulation results are compared with smooth duct which shows that the duct with roughened surface enhances the heat transfer and friction factor (f_r) by 2.13 and 3.54 times, respectively. The solar air collector with roughness of square shaped rib with P/e = 7.14 gives better THPP of 1.45 at Re of 15000. It is found that the additional drying chamber temperature of 4K and heat gain of 106% when the dryer is upgraded to roughened surface from smooth surface. The present simulation model is validated with experimental outcomes of existing literature and good agreement is noticed.

Keywords: Solar air collector, finite volume method, turbulence model, Nusselt number ratio, friction factor ratio, thermo-hydraulic performance parameter.

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1. Introduction

The energy required for drying is retrieved from fossil fuel, natural gas, solar etc. Use of fossil fuel and natural gas creates the pollution, environmental problems etc. Also their rising prices, diminishing availability in future, force the society to find alternate solution for the fossil fuel. Future energy requirement for drying can be fulfilled by improving the performance of existing