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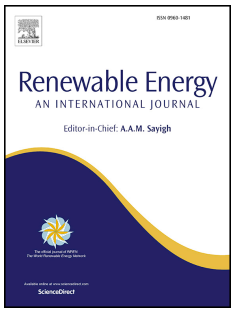

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Nusselt number and friction factor correlation of solar air heater having twisted-rib roughness on absorber plate

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Abstract- A study is carried out providing integrated roughness over absorber plate of solar air heater to improve its potential for heat transfer augmentation. A number of experiments are conducted with twisted roughness to pursuit test results for heat transfer augmentation along with friction factor phenomena. The experiments stand with a relevant range of flow parameters as Reynolds number from 3500 to 21000, and geometric parameters such as relative roughness pitch from 6 to 10, rib inclination angle domain from 30°–90° and twist ratio from 3 to 7. Finally, the correlations are developed for the Nusselt number and the friction factor in terms of flow parameter and roughness geometries and compared with experimental results which are reasonable and eventually satisfactory. The enhancement of heat transfer as well as friction factor are obtained and compared with smooth conventional duct for the same flow circumstances. The results are analyzed to pursuit optimum condition of roughness parameters to achieve the best performance.

Keywords- Solar air heater; twisted rib; Regression analysis;

Nomenclature			
A_o	Orifice plate area, m^2	Q	Heat gain by air, W
A_p	Area of heated plate, m^2	Re	Reynolds number, dimensionless
C	Conversion factor (= 0.18)	RGB	Red, Green, Blue primaries, dimensionless
C_d	Coefficient of discharge of orifice plate	S_i	Solar intensity, W/m^2
C_{pa}	Specific heat of air, J/kg-K	T_i	Air inlet temperature, K
d_o	Orifice plate diameter, m	T_o	Air outlet temperature, K
d_p	Pipe diameter, m	T_{mf}	Air mean temperature, K
D	Duct depth, m	T_{mp}	Plate mean temperature, K
D_h	Hydraulic diameter, m	TLC	Thermo-chromic liquid crystal
F_{hr}	Collector heat removal factor, dimensionless	U_L	Overall heat loss coefficient, W/m^2K
F_{pe}	Plate efficiency factor, dimensionless	V	Air velocity through duct, m/s
fr	Friction factor, dimensionless	W	Duct width, m
g	Acceleration due gravity, m/sec^2	y/e	Twist ratio, dimensionless
h	Heat transfer coefficient, W/m^2K		***Greek characters***
Δh_o	Change in limb height, m	α	rib inclination angle, degree
HSI	Hue, Saturation, Intensity, dimensionless	ρ_a	Air density, kg/m^3
k_a	Thermal conductivity of air, W/m K	ρ_w	Water density, kg/m^3
L	Duct length, m	μ	Dynamic viscosity of air, N/m^2-s
m	Mass flow rate, kg/s	ν	Kinematic viscosity of air, m^2/s
Nu	Nusselt number, dimensionless	$\tau\alpha$	Transmissivity- absorptivity product
Pr	Prandtl number, dimensionless	η_{th}	Thermal efficiency, dimensionless
P/e	Relative roughness pitch, dimensionless	η_{eff}	Effective efficiency, dimensionless