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List of Symbols

Nomenclatures

$2A$	Wavy height (m)
A_{fr}	Condenser frontal area (m^2)
A_i	Tube inside area (m^2)
A_o	Total outer surface area including fin and tube (m^2)
B_i	Biot number
c	Exergy cost per unit (\$/kWh)
c_{pam}	Specific heat of moist air (kJ/kg-K)
c_{pa}	Specific heat of dry air (kJ/kg-K)
c_{pv}	Specific heat of water vapor air (kJ/kg-K)
C_L	Cost of labor (\$)
C_L	Labor cost (\$)
C_m	Maintenance cost (\$)
C_{IC}	Initial investment cost (\$)
C_p	Energy requirement cost (\$)
\dot{C}_{RU}	Operating cost of drying system (\$)
C_{RM}	Fresh product cost (\$)
\dot{C}_{Total}	Total cost of drying system (\$)
C_F	Total profit (\$)
\dot{C}_x	Exergy cost rate (\$/h)
D_{ha}	Hydraulic diameter of air side (m)
DR	Drying rate (1/s)
D_{eff}	Effective diffusivity (m^2/s)

e_x	Specific exergy (kJ/kg)
E_{xin}	Exergy input (kW)
E_{xout}	Exergy output (kW)
E_{dest}	Exergy destruction (kW)
f	Friction factor of air
f_{ex}	Exergoeconomic factor
F_p	Fin pitch (m)
F_h	Fin height (m)
G_a	Mass velocity of air (kg/m ² -s)
h	Specific enthalpy (kJ/kg)
h_{fg}	Latent heat of vaporization (kJ/kg)
h_a	Air heat transfer coefficient (W/m ² -K)
h_m	Air mass transfer coefficient (kg /m ² -s)
i	Interest rate
k	Thermal conductivity (W/m-K)
k_c	Drying constant (1/s)
L	Half thickness of chips
L_f	Length between two wavy fin (m)
L_d	Length of fin (m)
LMTD	Log mean temperature difference (K)
\dot{m}_a	Air mass flow rate (kg/s)
m_p	Weight of drying product (kg)
m_{pt}	Mass of drying material at any time (kg)
\dot{m}_r	Refrigerant mass flow rate (kg/s)
M_i	Initial wet weight of the product (kg)

M_d	Final dry weight of product (kg)
M_o	Initial moisture content of material (wet basis)
M_t	Moisture content of product at any time (wet basis)
M_{eq}	Equilibrium moisture content (wet basis)
MC	Moisture content (wet basis)
MR	Moisture ratio
m_w	Mass of water in product (kg)
\dot{m}_{hw}	Mass flow rate of hot water (kg/s)
n	Time period of payment
N	Speed of compressor (rpm)
Nu	Nusselt number
P_p	Payback period
P	Pressure (bar)
Pr	Prandtl number
p_t	Transverse pitch of fin (m)
Q	Heat transfer rate (kW)
R_{ex}	Ratio of exergy destruction to purchased equipment cost
R_c	Return of capital
Re	Reynolds number
S_f	Fin spacing (m)
t_d	Drying time (hour)
t_{op}	Annual operation time (hour)
s	Specific entropy (kJ/kg-K)
T_o	Dead state temperature (K)
T	Temperature ($^{\circ}C$)

T_d	Dew point temperature ($^{\circ}\text{C}$)
T_f	Fin thickness (m)
UA	Product of overall heat transfer coefficient and area (W/K)
V_a	Air velocity (m/s)
V_s	Swept volume of compressor (m^3)
W	Power input (kW)

Greek symbols

α	Intermittency ratio
η_{ex}	Exergy efficiency
η_{en}	Energy efficiency
η_{isen}	Isentropic efficiency of compressor
η_f	Fin efficiency
η_o	Overall efficiency of fin
η_{fn}	Fan efficiency
η_v	Volumetric efficiency of compressor
ω	Specific humidity of drying air (kg water/kg dry air)
ε	Emissivity factor
σ	Stephan–Boltzman constant ($\text{W}/\text{m}^2\text{-K}^4$)
ϕ	Maintenance factor
μ	Dynamic viscosity ($\text{N}/\text{s}\text{-m}^2$)
ρ	Density (kg/m^3)
v	Specific volume (m^3/kg)

Abbreviations

COP_{hp}	Coefficient of performance of heat pump system
COP_{ws}	Coefficient of performance of the whole dryer system

CR	Cost ratio
CRF	System recovery factor
DC	Drying chamber
HP	Heat pump
HPD	Heat pump dryer
HE	Heat exchanger
IAHPD	Infrared assisted heat pump dryer
MER	Moisture extraction rate
MC	Moisture content
OHCOP	Overall-heating coefficient of performance
OCCOP	Overall cooling coefficient of performance
OSCOP	Overall system coefficient of performance
PEC	Cost of purchased equipment (\$)
RH	Relative humidity
SAHPD	Solar-assisted heat pump dryer
SIAHPD	Solar-assisted-infrared-assisted heat pump dryer
SMER	Specific moisture extraction rate
SEC	Specific energy consumption
SWH	Solar water heater
WHR	Waste heat recovery
SWHE	Solar water heat exchanger

Subscripts

a	air
abs	absorbed
comp	compressor

cond	condenser
evap	evaporator
exp	expansion device
in	input
IR	infrared
M	drying material
out	output
r	refrigerant
w	water
hw	hot water
wb	wet basis
wi	hot water inlet
wo	hot water outlet