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Prof. Jahar Sarkar
(Supervisor)
Department of Mechanical Engineering
IIT(BHU) Varanasi

Dr. Amitesh Kumar
(Co-supervisor)
Department of Mechanical Engineering
IIT(BHU) Varanasi

DECLARATION BY THE CANDIDATE

I, **Sarvesh Kashyap,** certify that the work embodied in this thesis is my own bonafide work carried out by me under the supervision of **Prof. Jahar Sarkar** and **Dr. Amitesh Kumar** for a period of 5 years from December 2016 to December 2021 at IIT (BHU), Varanasi. The material contained in this thesis has not been submitted for the award of any other degree. I declare that I have faithfully acknowledged and given credits to the research workers wherever their works have been cited in my work in this thesis. I further declare that I have not willfully copied any others' work, paragraphs, text, data, results, etc. reported in journals, books, magazines, reports, dissertations, theses, etc. or available at websites and have not included them in this thesis and have not cited as my own work.

Date: 30/12/2021

Place: IIT (BHU), Varanasi **(Sarvesh Kashyap)**

CERTIFICATE BY THE SUPERVISORS

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Prof. Jahar Sarkar **Dr. Amitesh Kumar**

(Supervisor) (Co-supervisor)

Head of the Department

Mechanical Engineering Department, IIT (BHU), Varanasi

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Date: 30/12/2021

Place: IIT (BHU), Varanasi **(Sarvesh Kashyap)**

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LIST OF SYMBOLS

Nomenclature

A	Heat transfer area, m^2
C	Cost, USD
C_{el}	Electricity consumption cost, USD/ kWh
Cf_{net}	Yearly net cash flow, USD
$C_{o\&m}$	Operation and maintenance cost, USD/ kWh
c_p	Specific heat of the air, J/kgK
$c_{p,v}$	Specific heat of water vapor, J/kgK
d_h	Hydraulic diameter, m
$\dot{E}_x$	Exergy, W
g	Channel gap, m
h	Specific enthalpy of air, J/kg
h_{fg}	Latent heat of evaporation, J/kg
İ	Exergy destruction rate, W
k	Thermal conductivity, W/mK
L	Channel length, m
$\dot{m}$	Mass flow rate of air, kg/s
M	Device operating years
n	Number of channels
Nu	Nusselt number
p	pressure, Pa
P	Power, W
Pr	Prandtl number

p_p	Plate pitch, mm
p_c	Corrugation pitch, mm
Q	Cooling capacity, W
r	discount factor
Re	Reynolds number
R_a	Specific gas constant of air, J/kgK
R_v	Vapor specific gas constant, J/kgK
RH	Relative humidity, %
T	Temperature of air, °C
t_{plate}	Thickness of cooling plate, m
U	Heat transfer coefficient between water film and primary air, W/m^2K
u	Velocity of air, m/s
V	Volume flow rate, m^3/s
W	Channel width, m
Y_e	Yearly refrigeration production, kWh
Y_{el}	Yearly power consumption, kWh

Greek symbols

α	Convective heat transfer coefficient, W/m^2K
Γ	Mass flow velocity of water (kg/m.s)
δ	Thickness, m
ε	dew-point effectiveness
ζ	Minor loss coefficient
η_{ex}	Exergy efficiency

κ_m	Coefficient of mass transfer in the wet channel, kg/m^{2}s
μ	Dynamic viscosity, kg/ms
ν	Kinematic viscosity, m^2/s
ρ	Density of air, kg/m^3
ϕ	Particle volume fraction
Φ	Exergy ratio
Ψ	Flow exergy per kg of dry air (J/kg)
ω	Humidity ratio, kg/kg
ω_{ws}	Saturation humidity at water film temperature, kg/kg
Δp	pressure drop, Pa

Subscripts

0	Reference dead state
exhaust	Exhaust air to ambient
in	Intake air (outdoor condition)
out	Outgoing air (supply air)
p	Nanoparticle
pa	Primary air
pump	Water circulating pump
ra	Relative
sa	Secondary air
supply-air	Air supplied to conditioning space
w	Water

Abbreviations

COP	Coefficient of performance
DEC	Direct evaporative cooler
DPE	Dew point effectiveness
HMX	Heat and mass exchanger
IEC	Indirect evaporative cooler
IRR	Internal rate of return
NPV	Net present value
PP	Payback period
REC	Regenerative evaporative cooler
SI	Sustainability index
SPP	Simple payback period
STC	Specific total cost