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Department of Mechanical Engineering,
Delhi College of Engineering, Delhi- 110 042

CERTIFICATE

This is to certify that the major project entitled **“Analysis of an Induced Draft Counter Flow Cooling Tower”** which is being submitted by Shri **GAURAV AGGARWAL**, is the authentic record of student’s own work carried by him out under our guidance and supervision for partial fulfilment of the award of the degree of Master of Engineering in Thermal Engineering, Department of Mechanical Engineering, Delhi College of Engineering, University of Delhi.

The matter embodied in this project has not been submitted for the award of any other degree.

(Dr. R.S.Mishra)
Professor,
Department of Mechanical Engineering,
Delhi College of Engineering, Delhi

(Dr. S.S. Kachhwaha)
Assistant Professor,
Department of Mechanical Engineering,
Delhi College of Engineering, Delhi

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GAURAV AGGARWAL

College Roll No. 03/Thr/2006

Roll No.10232

ABSTRACT

Induced draft counter flow cooling towers are widely used in power plants and air conditioning installations to reduce the temperature of circulating water so that it may be reused in condensers and other heat transfer equipments.The performance prediction of induced draft cooling towers requires the understanding of the fluid dynamics and heat and mass transfer mechanism between hot water and ambient air.

In the present work, a simple and efficient mathematical model has been developed in which energy equation, draft equation and pressure equation are solved. The main initial conditions required in the model are inlet air/water conditions, geometric parameters and fan parameters. The model predicts outlet air conditions, inlet mass flow ratio, evaporation loss, fan power requirements and various performance evaluation parameters like thermal efficiency, exergy destruction and second law efficiency.

It was observed that wet bulb temperature of inlet air plays a significant role on parameters such as evaporation loss, fan shaft power, thermal efficiency, exergy destruction and second law efficiency.

Key words: Induced draft cooling tower, draft equation, first and second law analysis.

NOMENCLATURE

A	area (m^2)
a	surface area per unit volume, m^2/m^3
B	breadth of cooling tower, m
c_p	specific heat at constant pressure, J/kg K
D	diffusion coefficient
d	differential element ; droplet
G	mass velocity, kg/m^2 s
H	height, m
h	heat transfer coefficient, W/m^2 K ; enthalpy, J/kg
h_d	mass transfer coefficient, kg/m^2 s
i	enthalpy, J/kg
i_{ma}	enthalpy of dry air at wet bulb temperature, J/kg
i_{masw}	enthalpy of saturated air at the local bulk water temperature, J/kg
K	loss coefficient
L	length, m
m	mass flow rate, kg/s
M	Merkel method, also molecular mass, kg/mole
N	rotational speed, r/min
NTU	number of transfer units
P	power, W
p	pressure,N/m^2
q	heat transfer rate, W
R	characteristic gas constant J/kg K
R_y	characteristic flow parameter,m^{-1}
r	rounding, m
s	entropy, J/kg K
t	temperature, ℃ or K
U	overall heat transfer coefficient, W/m^2 K
V	volume, m^3,also volume flow rate,m^3/s

v	velocity, m/s
W	width of cooling tower, m
w	humidity ratio, kg water vapor/kg of dry air
X	exergy, W
x	mole fraction
z	elevation, m

GREEK SYMBOLS

ρ	air density, kg/m^3
Δ	differential
η	efficiency
μ	dynamic viscosity, kg/sm
θ	relative humidity
σ	surface tension, N/m
Ψ	specific exergy, J/kg

DIMENSIONLESS GROUPS

Le_f	dimensionless Lewis factor, $h/(c_p h_d)$
Me	Merkel number, $h_d\, a_{fi}\, L_{fi} / G_w$
Sc	Schimdt number,($\mu/ \rho D)$

SUBSCRIPTS

a	air
abs	absolute
av	mixture of dry air and water vapor
C	Chebyshev method
c	casing of fan

ct	cooling tower
ctc	cooling tower contraction
d	destruction,diameter(m)
da	dry air
db	dry bulb
de	drift eliminator
dif	diffuser
e	e-NTU method, effective
evap	evaporated
F	fan
F/ dif	fan/ diffuser
fd	frictional and drag
fi	fill
fr	frontol
fs	fill support
H	height,m
h	hot
II	second law
i	inlet
il	Inlet louvers
m	mean, or mass transfer
max	maximum
min	minimum
norz	normalized
o	outlet
pl	plenum chamber
r	reference
rz	rain zone
s	saturation
sp	spray
T	total

th	thermal
up	upstream
v	vapor
w	water
wb	wet bulb
wd	water distribution system
wv	water vapor

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