Alternative Energy

Edited by

A.K.M. Mohiuddin

Asif Hoda

IIUM Press

Published by:
IIUM Press
International Islamic University Malaysia

First Edition, 2011

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

A.K.M. Mohiuddin and Asif Hoda
Alternative Energy
A.K.M. Mohiuddin and Asif Hoda
Include index
Bibliography: p.

ISBN 978-967-418-158-1

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM
(Malaysian Scholarly Publishing Council)

Printed by :
IIUM PRINTING SDN. BHD.
No. 1, Jalan Industri Batu Caves 1/3
Taman Perindustrian Batu Caves
Batu Caves Centre Point
68100 Batu Caves
Selangor Darul Ehsan

Table of Contents

Chapter 32

Analyses of motion and drag coefficient of water droplets in a natural draught cooling tower

Liu Baomin* and M. N. A. Hawlader

*Department of Mechanical Engineering, National University of Singapore

Department of Mechanical Engineering, International Islamic University Malaysia

Abstract

Cooling towers have been widely used in power plants and space air conditioning systems. The rain region plays an important role in the operation of cooling towers. In this paper, four different models have been investigated that describe the motion of water droplets in the rain region of a cooling tower. Due to the non-uniformity of the flow, heat and mass transfer processes inside the cooling tower, the velocity field of water droplets is, at least, two-dimensional. Therefore, these models were tested with a numerical simulation program that accounts for the non-uniform flow. The velocity fields of water droplets, the variations of the drag coefficient with the relative velocity of water droplets have been predicted. The effect of drag and buoyancy force on the motion of water droplets were also studied numerically. The model based on Dreyer and Erens's correlation has been found to represent the actual situation reasonably well and is recommended for the modelling of water droplets motion in cooling towers.

Keyword: water drop, drag coefficient, cooling tower, and numerical simulation.

INTRODUCTION

In order to get the reasonable result of a practical system by numerical simulation, one needs to develop and adopt correct mathematical and physical models. However, this is very difficult to be accomplished because a real industrial process is often complicated. As to cooling towers and other exchange equipment, there exist rain areas where water drops interacts with air stream. The water drops motion in the air is quiet different from solid spherical particles due to the internal circulation, mechanical palpation, irregular vortex shedding, and the interaction between the drops (collision and disintegration). Water drops falling freely under gravity through air remain very nearly spherical for $E_o = gd_e^2\Delta\rho/\sigma < 0.4$. Because of the large viscosity ratio $k = \mu_p/\mu$, internal circulation tends to be very slow, and the drag on such spherical drops follows closely to the standard drag curve for rigid spheres [1,2]. If Eo increase above 0.4 as in the case of cooling towers, some distortion from the spherical shape can be detected. Flattening occurs primarily at the leading (lower) surface, so that the shape then lacks fore- and- aft symmetry. Drops accelerating in air streams may split up and it was