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Determination of Optimum Height for Counter Flow Cooling Tower

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ABSTRACT

A model for counter flow cooling tower is present with treatments to recover the simplifications in the literature. The Bosnjakovic formula, mutative water and air properties are used to relax the constraints. The finite volumes of water and moist air are defined separately in opposite flow directions. Mass and energy balances are evaluated for control volume; heat and mass transfer are considered between control volumes. The model is validated with experimental data from literature. The model determines the cooling tower optimum height, evaporation rate and distribution of air and water temperatures, humidity, water flow and Lewis factor along the tower height. It is concluded that: the height is affected by the inlet air humidity; the heat transfer mode is dominated by evaporation, and Lewis factor ranges from 0.91 to 0.924.

Key Words: Cooling Tower, Height, Evaporation Rate, Lewis Factor, One Dimensional

1 INTRODUCTION

A cooling tower is heat rejection equipment. Its main function is to extract waste heat from warm water to the atmosphere. Heat rejection in cooling tower is specified as convection between the fine droplets of water and the surrounding air, and also as evaporation which allows a small portion of water to evaporate into moving air, the process involves both heat and mass transfer.

Cooling towers are widely used in the power generation units, refrigeration and air conditioning industries [1]. Cooling towers can be classified by the movement of water and air as counter-flow and cross-flow types. Moreover, they can also be classified by means of air flow into mechanical draft and natural draft types.

A lot of work has been done for modeling cooling towers mathematically in the past century. *Walker* [22] proposed a basic theory of cooling tower operation. *Merkel* [15] developed the first practical theory including the differential equations of heat and mass transfer, which has been well received as the basis for most work on cooling tower modeling and analysis [1-10-5-18-14].

In *Merkel'* smodel, the *Lewis* factor is assumed as unity, this assumption may cause *Merkel*'s model to underestimate the effective tower volume by 5-15% [20]. The influence of the *Lewis* factor diminishes when the inlet ambient air is relatively hot and humid [8]. For

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