中文摘要

本研究為描述測試之程序及敘述在熱環境控制應用下替代水牆材質的性能受到厚度與材質的影響。本實驗中測試的水牆材料包括黑色粗纖 PVC 發泡棉網材質(孔徑為 2.5mm)與米黃色細纖 PVC 發泡棉網材質(孔徑為 7.5mm)等兩種，將其製作成三種不同厚度的替代水牆材質，經由風洞實驗操作之蒸發冷卻過程可求得熱與質傳係數方程式。熱與質傳係數經無因次數化且根據試驗各點資料可推求出操作方程式為：(1)黑色粗纖發泡棉網水牆材質： $hH/hM = 1.33\ \rho a\ Cpa\ Le^{2/3}\ (Les / Le)^{1/4}$，及(2)米黃色細纖發泡棉網水牆材質：$hH/hM = 2.76\ \rho a\ Cpa\ Le^{2/3}\ (Les / Le)^{1/4}$；其中 hH 為熱傳係數，hM 為質傳係數，ρa 為空氣密度，Cpa 為空氣比熱，Le 為路易士數，而 Les 為在水溫之路易士數。在風洞系統實驗中測定水牆材質的蒸發冷卻效率，並研究討論冷卻效率、水牆表面空氣速率及橫過水牆靜壓力差之相關性。當操作空氣速率的範圍在 0.75 m/s 至 1.5 m/s 時，15cm 厚之黑色 PVC 發泡棉網水牆材質產生的靜壓力差範圍從 26.5 Pa 至 116 Pa，蒸發冷卻效率為 81.75 % 至 84.48 %，而米黃色 PVC 發泡棉網水牆材質產生的靜壓力差範圍從 23.1 Pa 至 73.5 Pa，蒸發冷卻效率則為 76.68 % 至 91.64 % 。

關鍵詞：蒸發冷卻；水牆；水牆材質；熱與質傳；風洞

Abstract

This research outlines the test procedure and describes how the alternative pad performance is affected by pad thickness and pad materials in the thermal environmental control applications. Many experimental pads were tested including one black coarse fabric polyvinyl chloride sponge mesh pad (pinhole size = 2.5mm diameter) and one cream-colored fine fabric polyvinyl chloride sponge mesh (pinhole size = 7.5mm diameter) material. A wind tunnel experiment was performed to obtain equations for heat and mass transfer coefficients for the evaporative process through various thickness of alternative pad media. Heat and mass transfer coefficients are nondimensionalized and curve fitted to yield the working equations for (1) black sponge mesh pad： $hH/hM = 1.33\ \rho a\ Cpa\ Le^{2/3}\ (Les / Le)^{1/4}$, and (2) cream-colored sponge mesh pad：$hH/hM = 2.76\ \rho a\ Cpa\ Le^{2/3}\ (Les / Le)^{1/4}$；where is heat transfer coefficient, is mass transfer coefficient, ρa is air density, Cpa is specific heat of air, Le is Lewis number, and Les is Lewis number at water temperature. A determination for cooling efficiency in a wind tunnel system is also developed to relate efficiency, face velocity, and static pressure drop across pads. For a 15cm pad, static pressure drops across the black pad and cooling efficiencies varied from 26.5 to 116 Pa and 81.75 to 84.48 %, while 23.1 to 73.5 Pa and 76.68 to 91.64 % for cream-colored material pads respectively under operating air velocities of 0.75 to 1.5 m/s.

Keywords：Evaporative cooling; Pad and fan; Pad material; Heat/mass transfer; Wind tunnel