

An Investigation of Air-Side Heat and Mass Transfer Performance of the Fin-and Tube Heat Exchangers

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Abstract

The present study tested the fin-and-tube heat exchangers with slit fin and plain fin geometry. A totals of twenty-four different specifications of heat exchangers were tested both in open type wind tunnel and close type wind tunnel. The effects of the number of rows, fin pitches and fin pattern of the airside heat and mass transfer performance were experimentally investigated. The results were compared and presented as Colburn j factor and fanning friction factor f against Reynolds number Re_{D_c} based on the fin collar diameter D_c in the range from 300 to 8,000 in open type wind tunnel and from 500 to 4,500 in close type wind tunnel, respectively.

In open type wind tunnel, the test results indicated that the heat transfer performance

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increased as the fin pitch decreased for one row configuration. However, when row number was more than four, the effect of fin pitch on the heat transfer performance was reversed. In addition to the effect of fin pitch, the heat transfer performance decreased as the number of tube row increased. But the friction characteristic was relatively independent of the number of tube row. Based on the present results and those from the former investigation by Nakayama, a general correlation is proposed to describe the airside performance of slit fin configuration. The mean deviation of the proposed heat transfer and the friction correlation are 5.23% and 3.59%, respectively.

In close type wind tunnel, the test results indicated that the heat transfer performance was relatively independent of inlet relative humidity. However, when $Re_{Dc} > 2,000$ with smaller fin pitch, the heat transfer performance slightly increased with inlet relative humidity. The test results showed that the heat transfer performance in close type wind tunnel had a similar trend compared with open type wind tunnel. Friction factor f increased with decreasing fin pitch, and also as the function of the slit fin geometry. The humidity of the inlet conditions in one row configuration showed as the function of the inlet relative humidity under high frontal velocity condition.

Keyword : Fin-and-Tube Heat Exchanger, Heat Exchanger, Slit fin, Plain fin, Correlation

摘要

本文針對 24 組鰭管式熱交換器，分別使用平板型鰭片和狹縫型鰭片製造。在開放式風洞和循環式風洞設備中，分別進行乾盤管與濕盤管測試。討論管排數、鰭片間距、鰭片型式對於鰭管式熱交換器的影響。測試的結果是以科本因子 j （或稱熱傳因子）和摩擦因子 f 相對於雷諾數 Re_{DC} 的變化來表示。乾盤管測試的雷諾數範圍由 300 到 8,000。濕盤管測試的雷諾數範圍由 500 到 4,500

從乾盤管測試結果發現，狹縫型鰭片熱交換器的熱傳效率會隨鰭片的減小而增加，當管排數大於 4 時，鰭片間距的影響在中低風速的情況是相反的。空氣側的熱傳效率會隨管排增加而減少，但摩擦因子 f 卻和管排數幾乎沒有關係。最後找出狹縫型鰭片的熱傳因子 j 和摩擦因子 f 的經驗公式，在誤差 10% 以內的數據分別有 83.09% 和 92.81%；其平均誤差分別為 5.5% 和 3.8%。