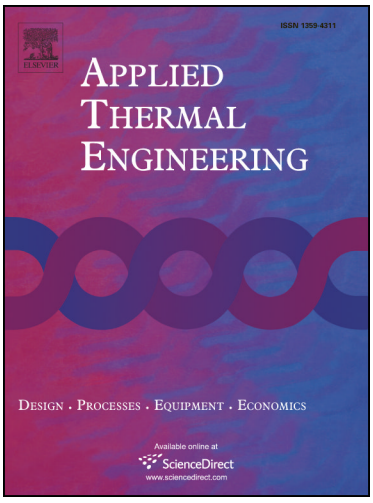

Research Paper

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Theoretical and experimental analyses of mist precooling for an air-cooled chiller

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Abstract

This study analyses the cooling effectiveness of mist in precooling condenser air for an air-cooled chiller. The chiller had a capacity of 282 kW and operated with a mist system under dual modes: conventional head pressure control (normal mode) and variable speed control for condenser fans (VSD mode). Extensive operating variables at the condenser side were logged at 5-min intervals. Stepwise regression models for mist precooling were developed and validated with a robust R^2 of over 0.7 for the two modes. Under the normal mode, the wet bulb temperature had the highest magnitude in the regression coefficient (1.5734), followed by the relative humidity (-1.2495) and the dry bulb temperature (-0.1745). Under the VSD mode, variables with the three highest magnitudes in the regression coefficients were the wet bulb temperature (0.6314), the temperature difference across the condenser (0.3357) and the dry bulb temperature (-0.3224). This indicates that cooling effectiveness depended more on the weather variables than the controlled variables of the chiller. The actual cooling effectiveness deviated greatly from the theoretical ones because mist carrying over the condenser fins would outperform the complete evaporation of mist by air. Yet mist dispersing away from the air stream would lower the cooling effectiveness. Based on the subtropical climate in Hong Kong, precooling the condenser air by mist brought an increase of 0.36 – 8.86% and 0.34 – 10.19% in the coefficient of performance of the chiller under the normal mode and the VSD mode, respectively.

Keywords: Air-cooled chiller; cooling effectiveness; mist precooling; stepwise regression

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