Experimental Investigations of the Droplet Entrainment in Finned Tube Heat Exchangers for Air Cooling

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Abstract

In finned tube heat exchangers used in air-conditioning systems for cooling humid air below dew point, water may condense on the surfaces of fins and tubes. In general, the cooled air leaving the cooler outlet is not intended to carry any water droplets. In order to remove these from the airflow, droplet separators have to be used, which require additional costs as well as additional space.

The aim of this study was to determine, for different condensate volumes and fin spacings, the critical minimum air velocity that provides an entrainment of droplets from the finned tube heat exchanger outlet.

For this purpose, different condensate volumes have been set in measurements by varying the boundary conditions (inlet air condition as well as temperature and mass flow of the coolant). The following operating points have been set: 3 g/kg, 5 g/kg, 7 g/kg and 10 g/kg. An in-house software was used to calculate the necessary boundary conditions to obtain these operating points. In the experiments, the condensate volume was determined by weighing the water condensate. All operating points were each tested in three finned tube heat exchangers with different fin spacings (1.8 mm, 2.5 mm and 3.5 mm).

For the detection of droplet entrainment, sensitive paper was used which changes its color when hit by a droplet. Thus, critical minimum air velocities could be determined depending on the respective fin spacing and condensate volume. For the above-mentioned range of investigated fin spacings and condensate volumes, this air velocity is between 1.3 and 2.3 m/s. In case of higher velocities, the risk of droplet entrainment from the heat exchanger outlet is high and thus, droplet separators are necessary.