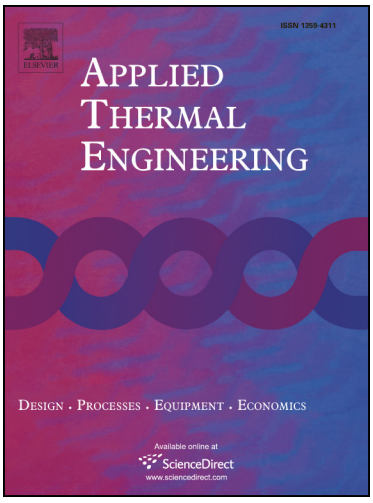

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Abstract

Evaporative spray cooling is widely used to increase heat transfer of air exchangers and improve their efficiency. However, exchanges inside the spray mixture are difficult to express as combined mass and heat are transferred between phases, resulting in difficulties for the design of spraying systems. In this paper, a model describing the 3D distribution of temperature and liquid content during the dispersion of a thermal spray was developped. A spray model was used to describe the first stage of water fragmentation. A Gaussian model including sedimentation of particles and wall effects was added to handle the dispersion process of the total water content . The microphysical part of the model results from energy and mass balances of water and air allowing local splitting between vapor and liquid content. Simulation results, comparing with temperature and humidity measurements for spray dispersion in a wind tunnel are in good agreement in various conditions of air temperature, humidity, velocity and water flow rate . Further analysis shows that the cooling is higher when the spray radius is close to the wind tunnel dimensions. The model was then used to compute the optimal distance between nozzle and exchanger in order to reach the highest efficiency. This position depends upon the nozzle hole and water-and-air flow rates. As evaporation is slow down when air becomes wetter, the remaining liquid droplets are deposited on the exchanger surface. The wet area was defined assuming a threshold value beyond which liquid flux clogs exchanger fins. Results showed that this area is sensitive not only to the dispersion radius, but also to the evaporation rate.

keywords: spray cooling; wet area; thermal spray dispersion; vapor/liquid equilibrium; hygroscopic capacity of moist air