Background and objectives

Study of the Performance of an Adiabatic Cooling Pad in a Cooling Tower Setup

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Numerical Model

Two different numerical models have been developed: the first one consists on a representation of a portion of the real pad, a complex geometry meshed with 2 million tetrahedral elements; and the second numerical model is a simplification of the first one, taking into account the pad compactness. This model is formed by 430,000 hexahedrons and its results validated with the complex model.

- Steady DPM model.
- k-ε turbulent model.
- Air velocity, temperature and Water mass fraction as boundary conditions at inlet.
- Water drops injected at wet bulb air temperature (recirculating water).

Analytic model

Input variables: air and water injected characteristics

NTU. Number of Transfer Units

Dry bulb temperature and water mass fraction obtained for the outlet section of the pad.

\[ NTU = \frac{h_{1}}{m_{a}} \cdot C_{p,\text{a}} \]

\[ \eta = \frac{(T_{db1} - T_{db2})}{(T_{db1} - T_{db1})} = 1 - e^{(-1.037 \cdot \text{NTU})} \]

\[ \omega_{2} = \frac{0.62198 \cdot P_{\text{ev},2}}{P_{\text{atm}} - P_{\text{ev},2}} \]

Experimental Validation and results

Real geometry: complexity and huge computational cost.

Porous media: equivalent model regarding on the pressure drop and air velocity. However, water droplets are dragged by the air flow due to the lack of impacts on solid surfaces.

Simplified geometry: parallel tubes with the same wetted area than the real geometry. Accurate results with a 75% reduction on the number of elements. Model chosen for the numerical simulations.

Plan including difference between inlet and outlet section for air temperature and water mass fraction in air at four different cases.