Fin efficiency calculation in enhanced fin-and-tube heat exchangers in dry and wet conditions

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Fin efficiency calculation is of the greatest importance in liquid-to-air heat exchanger engineering, for the evaluation of the finned surface performance or for the determination of the air-side heat transfer coefficient from experimental data. High efficiency heat exchangers use enhanced fin geometry (louvered and slit fins) and fin efficiency is in general overestimated by usual formulations and more precisely the conventional 1-D sector method. Because the slits (or louvers) alter the conduction path through the fin, the assumption of radial heat flow pattern is no more valid, and the actual fin efficiency could only be determined by numerically solving the multi-dimensional heat conduction equation. SimTherm, a software developed by the Center for Energy Studies, is used for this purpose (2-D) and results are compared to commonly used fin efficiency equations. Temperature differences from tube to tube are also taken into account and the impact on the fin efficiency is discussed. Another important assumption in usual fin efficiency analysis is to consider a uniform heat transfer coefficient over the fin surface whereas for enhanced fin geometry, the heat transfer coefficient is strongly variable due to interactions between the fluid dynamics and the heat transfer. The effects of variations of the heat transfer coefficient on the fin efficiency are discussed and the analysis is performed with the commercial CFD code STAR-CD v3.15.