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A Second-Law Based Comparison of the Air-Side Thermal-Hydraulic Performance of Flat-Tube and Round-Tube Heat Exchangers

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ABSTRACT

Using the energy conservation equations and appropriate correlations for Colburn j- and f-factors from the literature, a rate-limited second-law measure of heat exchanger performance will be developed and used to evaluate flat-tube and round-tube heat exchangers. The approach follows prior work by DeJong and co-workers, in which a finite-time, finite-size thermodynamic model is used to cast thermal-hydraulic performance into a single measure of destroyed availability. The ultimate aim of this study is to contrast the flat-tube heat exchanger performance to that of round-tube exchangers, under dry-surface conditions.

This work is important because it provides an even-handed, unambiguous comparison of these heat exchanger configurations. Heat exchanger cost, volume, weight, and performance concerns continue to drive designs toward higher compactness, and the flat-tube geometry appears to hold promise in achieving greater compactness. Before this heat exchanger technology pursued for application, it is imperative to understand its thermal-hydraulic performance relative to current round-tube exchangers.

The novelty of this work rests in the use of finite-size, finite-time thermodynamics, applied directly to the comparison of flat-tube and round-tube heat exchangers, for the purpose of understanding whether performance advantages exist in real systems, and to quantify such differences if they exist. To our knowledge, such a comparison has not been reported in the open literature.

Our findings will provide a thermodynamic assessment of flat-tube heat exchanger performance and may point to preferred design features in both flat- and round-tube heat exchangers.

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