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Research Paper

CFD modelling of entropy generation in turbulent pipe flow: Effects of temperature difference and swirl intensity

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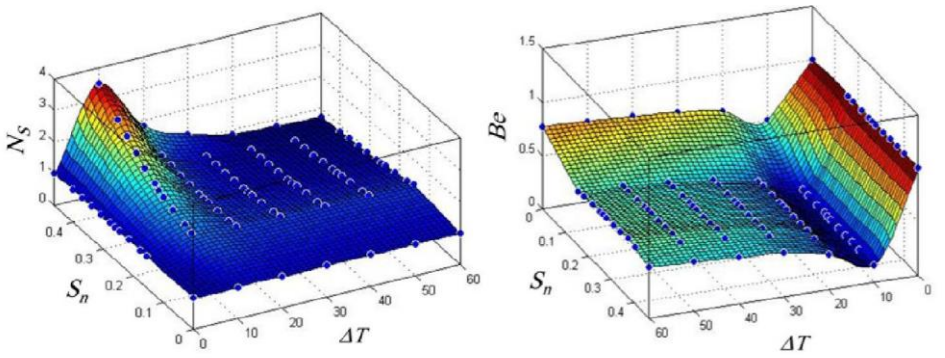
HIGHLIGHTS

- The effects of swirl number and temperature difference on entropy generation in pipe flow were investigated.
- A CFD model was established and validated with experimental LDV measurements.
- The CFD model was used to simulate 77 cases representing $0 \le S_n \le 0.454$ and $0 \le T \le 60$
- Matlab was used to establish empirical correlations based on the CFD results.
- The empirical correlations predict entropy generation and Bejan number as functions of S_n and T

GRAPHICAL ABSTRACT



Surface plots for the nonlinear regression of the CFD results of entropy augmentation number (N_S) and Bejan number (Be) as functions of S_n and ΔT

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ABSTRACT

This article extends the recent study by Saqr and Wahid *(Applied Thermal Engineering 70 (2014) 486– 493)* on the criteria of heat transfer enhancement in swirl pipe flow based on the entropy generation minimization principle. The effects of wall–fluid temperature difference (T) and swirl intensity (S_n) on entropy generation are considered in the present work. A Computational Fluid Dynamics (CFD) model of non-isothermal swirl pipe flow was developed, validated with established LDA measurements, and then used to study the Nusselt (Nu), entropy augmentation (N_s) and Bejan (Be) numbers in 77 different scenarios related to swirl-enhanced heat exchangers. Critical values of T and S_n that correspond to unity N_s were identified. Then, based on the CFD results, two computer codes were developed in MATLAB soft-ware to correlate N_s and Be as functions of T and S_n. These computer codes are openly provided in this article's appendix in order to contribute to the design and optimization tools of swirl-enhanced heat exchangers.