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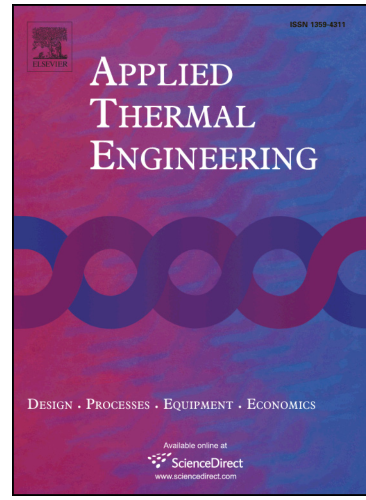


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# Implications of fin profiles on overall performance and weight reduction of a fin and tube heat exchanger

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## Abstract

Fin and tube heat exchangers are being used in several industrial applications by means of novel design and optimized performance. Improvements in geometric design may deliver energy efficient and cost-effective heat exchanger performance with reduced weight. In this paper, a systematic study on a cross-flow type fin and tube heat exchanger design for a waste heat recovery application is conducted. The geometric profile of the fin is characterized by a dimensionless design variable named aspect ratio which is parametrically varied to obtain different profiles. Two cases, case-I, and case-II with constant fin-base thickness and variable fin-base thickness, respectively, are studied considering the 'rectangular' fin profile as a 'reference'. Heat transfer and pressure loss characteristics based on the parametric fin profiles are investigated numerically for a Reynolds number range from 5000 to 13000 using computational fluid dynamics. The numerical results obtained for the reference fin profile are verified with the experimental correlations. Dimensionless parameters such as Nusselt number, Euler number, and efficiency index are calculated to predict the overall performance of the heat exchanger design. Results show that the overall performance improves by approximately 6.76% and 17.33% with a reduction in net unit weight by approximately 27.58% and 6.82% on changing the aspect ratio from 1.0 to 0.1 in case-I and case-II, respectively. In addition, feasible fin profile for a waste heat recovery application is predicted using Pareto optimality in each case. The study, therefore, helps to reveal the potential of different fin profiles in furnishing enhanced overall performance along with the net material cost benefits to the design engineers and manufacturers.

## Keywords:

Fin and tube heat exchanger; fin profile; heat transfer; turbulent flow; overall performance; weight reduction.

## 1. Introduction

Fins are the extended surfaces that can increase the heat transfer area by a factor of 5–30 depending on the application [1]. The increase in the heat transfer surface area of a fin and tube heat exchangers consecutively increases the heat transfer rate between heating surface and the flowing fluid [2]. In addition, it is well

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