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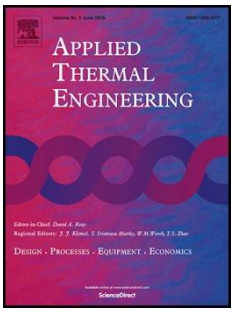

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MANUFACTURING COST MODEL FOR HEAT EXCHANGERS OPTIMIZATION

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Highlights

Analytical-generative costing model for shell and tube heat exchangers is developed
The method is sensitive to detailed geometrical features and manufacturing processes
Method allows to compare alternative configurations and optimize equipment design
Misuse of parametric costing methods for optimal equipment design is demonstrated

ABSTRACT

In the field of shell and tube heat exchangers traditional costing methods rely on simple parametric functions. Such correlations are usually based on the sole overall heat transfer surface, and are applicable to traditional equipment configurations only, and in limited size ranges, to estimate the equipment purchase price. This makes them unsuitable for utilization as an economical design tool, particularly when the equipment configuration is not standard, or when the manufacturer uses proprietary manufacturing processes, and in case computerized design optimization procedures are adopted. In order to provide a more precise costing approach, to be used during the design phase, in this paper na analytical – generative cost estimation procedure for shell and tube heat exchangers is developed, based on detailed geometrical features and manufacturing processes of the equipment. It can also be used for precise cost estimation during competitive bidding in make-to-order manufacturing context. In the paper existing cost estimation methods are reviewed and criticized at first. The new mathematical model for heat exchanger manufacturing cost estimation is developed and a parametric analysis is carried out showing that an optimal length-to-diameter ratio exist. Then numerical examples are included detailing the relative magnitude of cost items and showing the superiority of the suggested method in optimized design of heat exchangers when compared to traditional methods. Results show that exchangers configurations obtained according to this new costing procedure are cheaper that optimal configurations obtained resorting to traditional parametric costing methods.

KEYWORDS

Shell and tube heat exchanger, cost function, economic optimization, cost estimating.

1. INTRODUCTION

Cost estimation is a major activity during new products development since a large part of the product life-cycle costs are defined during the design stage (Dewhurst and Boothroyd, 1989). Moreover, the capability of rapidly and correctly estimating manufacturing costs for bidding purposes is critical for engineering-to-order manufacturers of non standard equipment with customer-defined designs and specifications (Kingsman et al., 1996). In this case, a cost overestimation implies a non competitive bid causing customer loss, while underestimating the cost leads to winning a contract but incurring a financial loss, thus determining the so called "curse of the winner". Furthermore, in both the preliminary and detailed design phases, being able to estimate future costs before the actual production takes place, allows cost-based decision making, and enables designers to assess the economic effects of their choices before product architecture or manufacturing methods are finalized, thus implementing a concurrent engineering approach allowing early economic justification (Noble and Tanchoco, 1990), economic evaluation of design decision (Oh and Park,