

Review

Review of Developments in Plate Heat Exchanger Heat Transfer Enhancement for Single-Phase Applications in Process Industries

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Abstract: A plate heat exchanger (PHE) is a modern, effective type of heat transfer equipment capable of increasing heat recuperation and energy efficiency. For PHEs, enhanced methods of heat transfer intensification can be further applied using the analysis and knowledge already available in the literature. A review of the main developments in the construction and exploration of PHEs and in the methods of heat transfer intensification is presented in this paper with an analysis of the main construction modifications, such as plate-and-frame, brazed and welded PHEs. The differences between these construction modifications and their influences on the thermal and hydraulic performance of PHEs are discussed. Most modern PHEs have plates with inclined corrugations on their surface that create a strong, rigid construction with multiple contact points between the plates. The methods of PHE exploration are mostly experimental studies and/or CFD modelling. The main corrugation parameters influencing PHE performance are the corrugation inclination angle in relation to the main flow direction and the corrugation aspect ratio. Optimisation of these parameters is one way to enhance PHE performance. Other methods of heat transfer enhancement, including improving the form of the plate corrugations, use of nanofluids and active methods, are considered. Future research directions are proposed, such as improving fundamental understanding, developing new corrugation shapes and optimisation methods and area and cost estimations.

Keywords: plate heat exchanger; heat transfer; pressure drop; energy efficiency; heat recuperation



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1. Introduction

To satisfy the needs of the increasing population on our planet in terms of energy and rising standards of individual comfort, a steady increase in energy demand is inevitable. Even with the contemporary trend for the use of renewable energy sources, the main proportion of energy is generated from the combustion of fossil fuels. With this, significant volumes of greenhouse gases (GHGs) are generated. About 6 Gt CO₂ equivalent was generated during the year 2020 in the United States based on data from the US Environmental Protection Agency [1]. Of that amount, 89.0% was due to fossil fuel combustion in various sectors. The European Environmental Agency [2] reported a similar picture, with 77% of GHG generation in the energy sector and 9% added by the contribution of the industry. To mitigate GHG generation, the plans in the EU include a requirement to enhance the efficiency of energy usage by 32.5% by the year 2030 [2]. One of the measures enabling the fulfilment of these plans is improved recuperation of heat energy, which is possible with the wider use of efficient, compact heat exchangers in which modern methods of heat transfer intensification are implemented [3].

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