Karlsruher Institut für Technologie

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Master thesis

RANS modelling of plate heat exchangers using OpenFOAM

Background:

Heat exchangers, in which the working fluids flow in between a stack of metallic plates, are classified as plate heat exchangers. They have been in practice for over a century; however, due to the design complication and limitations, their use has been confined to a limited number of industries until the recent decades. Since the 1980's, parallel to the increase of global concerns about energy efficiency and environment, plate heat exchangers started to receive an increasing amount of attention from the industry because of their obvious advantages: compared to shell-and-tube heat exchangers, plate heat exchangers are considerably compacter and their overall heat transfer coefficient is around ten times as high at the same Reynolds number. Presently, they are considered as an economical alternative to the conventional heat exchanger choices in a variety of industries such as heating and air-conditioning, refrigeration, power generation, transport and food industries to name a few.

Content of the thesis:

This project is aimed at CFD simulation of turbulent flow and heat transfer in plate heat exchangers with cross-corrugated plate pattern (the most widely used plate design in the industry) and evaluation of different RANS models for that purpose. The project will consist of the following steps: (1) Creating the geometric model and multi-block structured computational grids for the geometries of interest. To make the simulation feasible in terms of computational time, a unitary cell approach will be exercised. (2) Solving the flow and temperature fields using the open-source Navier-Stokes solver OpenFOAM and obtaining the values of heat transfer coefficient and friction factor, in a range of Reynolds number. In this step, standard k-epsilon model will be used. (3) Step 2 will be repeated using alternative turbulence modeling options. In the beginning, some common low-Reynolds number k-epsilon models will be examined, and depending on the achieved results, more complex models may also be included. (4 – optional) Depending on the progress of the last three steps, some additional parametric study on the effect of other geometric parameters will be carried out.

Figure 1. Flow distribution in a plate heat exchanger (picture reproduced from www.technoserviceco.com).

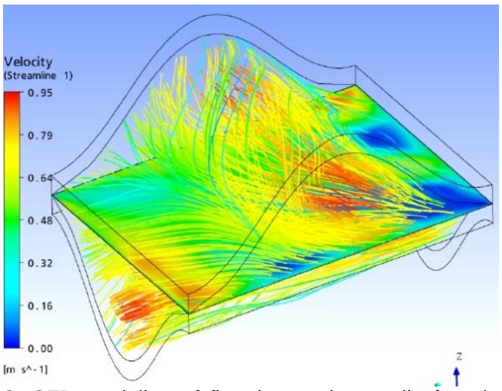

Figure 2. CFD modeling of flow in a unitary cell of a plate heat exchanger (Freund & Kabalec, Int. J. Heat Mass Transfer 53)

Requirements:
Fair knowledge of fluid mechanics and heat transfer

Beneficial Skills:
Experience with OpenFOAM

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