Effect of Geometrical Uncertainties on the Performance of Heat Exchangers Using an Efficient POD-Based Model Reduction Technique

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Abstract. The present paper aims at assessing the effect of manufacturing tolerances on the performance of heat exchangers. To this end, a two-dimensional square rib-roughened cooling channel is considered and uncertainties are introduced along the rib profile, using a Karhunen-Loéve expansion including 20 uncertainties. In order to break the curse of dimensionality and keep the overall computational cost within acceptable limits, an efficient uncertainty quantification strategy is followed. A sensitivity analysis is first performed on a coarse grid, enabling the most important dimension to be identified and to remove the ones which have not any significant effect on the output of interest. Afterwards, an efficient Proper Orthogonal Decomposition based dimension reduction technique is implemented in order to propagate uncertainties through the CFD model. It is shown that heat transfer predictions are strongly affected by geometrical uncertainties while no significant effect was found for the pressure drop.