AN EIGENVALUE FORMULATION FOR HEAT TRANSFER IN PERIODIC GEOMETRIES

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Abstract. In many heat exchange devices the main bottleneck in heat transfer is the conduction from the central core of the fluid in the channel to the walls. Passive devices such as Vortex Generators (VGs) can be used to increase heat transfer by promoting a secondary flow. Arrays of VGs tend to generate very complex geometries with the consecutive high computational cost for Computational Thermo-Fluid Dynamics (CTFD) computations. In this work, the heat transfer in periodic VG arrays is calculated by an eigenvalue problem in the Representative Volume Element (RVE). In this way, accurate calculations of the effective heat transfer coefficient can be calculated more efficiently, allowing optimization of the VG. Several approaches to the computation of this eigenvalue problem on top a standard CTFD code are presented. For small problems the involved matrices can be exported and a direct eigenvalue computation is possible. The size of the eigenvalue problem is the number of unknowns in the interface between consecutive RVEs. For larger problems the computation can be done in a reduced number of RVEs by feeding back the solution at the outlet to the input. Another possibility is to transform the problem to a periodic one by adding a source term and then to use standard periodic boundary problems. The technique can also be applied to periodic arrangements of tubes or fins, or combinations of them.

Keywords: Heat transfer, Vortex Generators, Computational Fluid Dynamics.

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