FLOW AND HEAT TRANSFER IN CROSS-STREAM TYPE T-JUNCTIONS:
A COMPUTATIONAL STUDY

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The present computational study is concerned with the thermal mixing of flow-crossing streams in a T-shaped junction, focusing primarily on a configuration subjected to temperature dependent fluid property conditions. The reference experimental investigation is conducted by Hirota et al. (2010). Preliminary, a quasi-two dimensional configuration with constant fluid properties, for which the reference DNS (Direct Numerical Simulation) database is made available by Hattori et al. (2014), is simulated. Fig. 1 shows a schematic depiction of the geometry.

The presently applied computational model is based on a VLES (Very Large Eddy Simulation) formulation of Chang et al. (2014). The residual turbulence is modeled employing the RANS-based (Reynolds-Averaged Navier-Stokes) elliptic-relaxation eddy viscosity model of Hanjalić et al. (2004). In addition to the VLES, both flow configurations are computed applying the background RANS model representing the constituent of the VLES method. Whereas the eddy viscosity model describes fully-modeled turbulence in the RANS framework, it relates to the unresolved sub-scale turbulence within the VLES methodology. Unlike the RANS method, the VLES method is capable of capturing the spectral dynamics of turbulence to an extent complying with the underlying grid resolution.

The results obtained with the present VLES model follow closely the reference DNS data for both flow and thermal fields in the Hattori et al. (2014) case. In the more complex Hirota et al. (2010) configuration, the flow field is captured reasonably well, as displayed in terms of the mean velocity profile development in Fig. 2. The computationally obtained thermal fields however, suggest a more intensive mixing relative to the reference experiment. An impression of the temperature field is given by Fig. 3.

REFERENCES