INVESTIGATION OF FLOW AND HEAT TRANSFER IN RIBBED SQUARE DUCT APPLYING LES

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Since temperature in high-pressure turbines gas exceeds the melting point of blade material, blade cooling plays an indispensable role. In case of internal-cooling, turbulence generators are used for the enhancement of heat-transfer on the surface of the cooling channels. In the present project a Large Eddy Simulation (LES) of the flow and heat transfer was performed in a square cross-sectioned duct restricted by a rib. This geometry is representative of a cooling channel of a turbine blade. These simulations have been performed applying the commercial code FLUENT.

The geometry analyzed has the following features: rib perpendicular to the wall with height to hydraulic diameter ratio of 0.3, pitch to rib height ratio of 10 and thickness of the solid to hydraulic diameter ratio of 1/3. Only one wall is ribbed; which is coupled with the solid region via heat-transfer. The Reynolds number of the flow is 40000, the Prandtl number is 0.7. The cooling fluid is air, which is considered to be incompressible. In the simulation buoyancy and viscous heating effects are neglected. The side and top walls of the duct are considered to be adiabatic; the heat-flux is only studied at coupled surfaces between fluid and solid region. Computations where performed for two different rotation numbers: Ro = 0 and 0.2.

In the present research, an alternative is offered to the use of periodic boundary conditions simulating the flow around three successive ribs. Comparison with the results of the simulation using periodic conditions will be provided with validation against experimental data (obtained in previous research works carried out at VKI) to allow a full assessment of the two approaches. Connection between flow-topology, coherent structures and heat-transfer is studied invoking advanced flow visualization methods. The effects of rotation on the flow-field and heat transfer are also investigated.

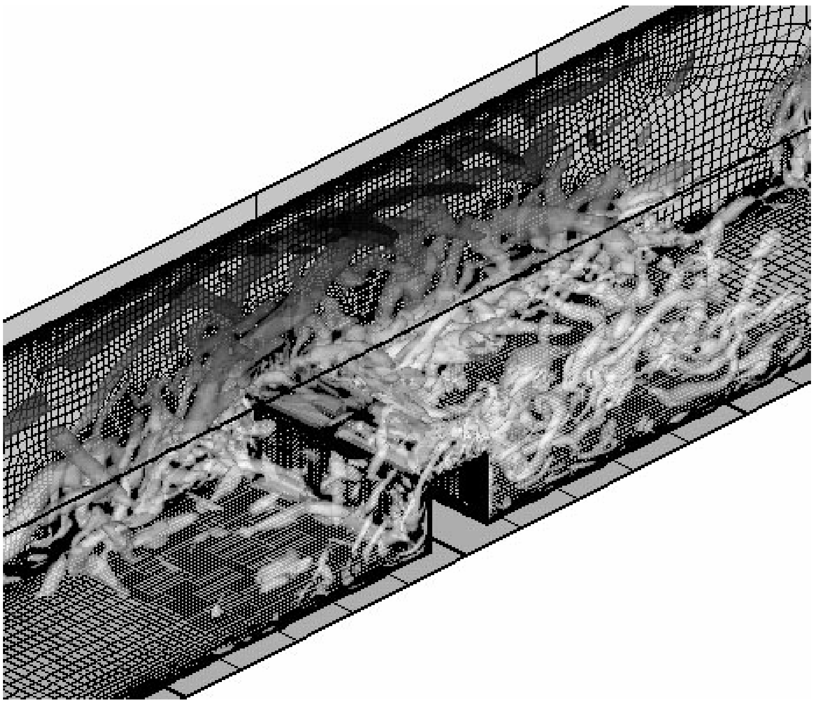

Figure 1: Coherent structures in a turbulent channel flow