INVESTIGATION OF INTERACTION OF COHERENT STRUCTURES ON HEAT TRANSFER IN RIBBED DUCT

Soledad Le Clainche Martínez, Spain
Supervisors: Prof. C. Benocci & A. Parente

The main goal of this project is to evidence and quantify the effect of the coherent structures on the thermal field in the case of a ribbed duct of square cross section, where the ribbed wall is heated.

This project is a part of three years of investigation. During the first year of the program, the flow field and the thermal field have been investigated with LES technique and the produced flow field was validated against the experimental data obtained by TU department. In order to point out the possible interaction between heat transfer at the heat wall and the coherent structures extracted using Q criterion, the existing LES solution have been post-processed in this DC project. To study in depth the process, coherent structures visualization in the mean and instantaneous field coloured by different turbulent variables have been performed. They put in evidence the correlation between the coherent turbulent motion, the flow background and the heat transfer process.

To evidence and quantify the effect of the coherent structures on the thermal field some correlations between flow and turbulent variables have been constructed while correlation analysis and the most relevant turbulent variables in the heat transfer process have been identified while Principal Component Analysis. The results show that coherent structures are strongly correlated with temperature and they are a mechanism of temperature transmission from the bottom surface to the fluid with convective movement.

Finally, to see the effects of coherent structures in the fluid, turbulence events have been averaged while 'Conditional Averaging method using Q criteria'; where turbulence variables and correlations are averaged only if a specific prescribed condition is satisfied. Such condition is function of Q, which quantifies the coherent structures presents in the flow field; therefore, the effects of the rib in the turbulent background have been put in evidence.

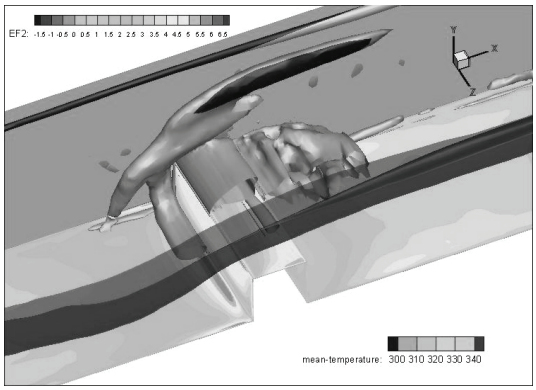

Figure 1: Left: Q averaged 0.24 v2/h2 coloured by <T>. Right: Iso-surface <T>=300K

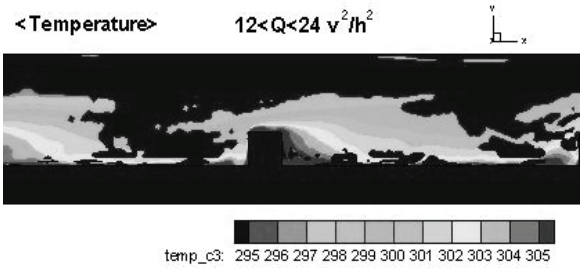

Figure 2: Conditional Averaging of the flow filed. Mean temperature in symmetry plane.