DIRECT NUMERICAL SIMULATIONS OF HEAT TRANSFER FROM A CYLINDER IMMERSED IN THE PRODUCON AND DECAY REGIONS OF GRID TURBULENCE

George Papadakis
Dept. of Aeronaucs, Imperial College London, England

ABSTRACT We consider a cylinder immersed in the turbulent wake of a grid-element and explore the effect of cylinder locaon on heat transfer usingdirect numerical simulaons (DNS). Three locaons downstream of the grid-element, inside the producon, peak and decay regions, are invesgated. Theturbulence intensies at the locaon of the cylinder in the producon and decay regions are almost equal at 11%, while in the peak locaon theturbulence intensity is 15%. Although the oncoming turbulent intensies are similar in the two regions, we noce a peculiar behaviour: in the produconregion the stagnaon point heat transfer is increased by 63%, while in the decay region it is enhanced by only 28% (compared to the baseline case ofapproaching flow without turbulent fluctuaons). Also, exisng correlaons for the stagnaon point heat transfer coefficient are found to be invalid in theproducon and peak locaons, while they are sasfied in the decay region. In order to explain these findings, we study the flow structures and find that inthe producon and peak regions the flow is dominated by shedding events, in which the predominant vorcity component is in the azimuthal direcon.This leads to increased heat transfer from the cylinder, even before vorcity is stretched by the accelerang boundary layer. Also, the frequency ofoncoming turbulence in the producon and peak locaons lies close to the range of frequencies that can penetrate inside the boundary layer developingon the cylinder, and therefore the laer is very responsive to the impinging disturbances. The highest Nusselt number along the circumference of thecylinder is shifted 45 degrees from the front stagnaon point. This shift is due to the turbulence-generang grid-element bars that result in the prevalenceof intense events at the point of maximum Nusselt number compared to the stagnaon point.