Abstract

Large eddy simulation (LES) of subsonic round jet impinging on a flat circular plate is performed using high order compact finite difference scheme and an explicit filtering based approximate deconvolution method for LES. The jets have a Mach number 0.9 and Reynolds number of 25000, based on inlet diameter and centerline velocity. The mean centerline velocity shows good agreement with the existing experimental data in literature. In the first part of the thesis, the effect of impingement distance on the flow field and coherent structures is studied. We consider two impingement distances of $6r_0$ and $8r_0$, where r_0 is the jet radius at inlet. The complex flow phenomena associated with the impinging jet flow field are studied. Power spectral density (PSD) of instantaneous pressure reveals a discrete impingement tone. Dynamic mode decomposition (DMD) of the velocity and pressure is also done for both cases to extract the most dominant modes. The fundamental impingement tone frequency obtained from PSD of pressure is identical to that of the first dominant pressure mode obtained from DMD. Both axisymmetric and semi-helical modes are present for $h = 8r_0$ case while only axisymmetric modes are present in $h = 6r_0$ case and it is noted that the modes corresponding to the fundamental tone have axisymmetric structure. Also, one dominant mode showing the wall jet structures denoting the lift-off of fluid from the wall after impingement at some radial distance away from the stagnation region is present in both impingement distance cases.

In the second part of the thesis, the effect of Mach number on impinging jets is studied. For this, two cases at Mach numbers 0.4 and 0.9 at Reynolds number 25000 are considered. The impingement distance for both cases is considered to be $8r_0$. In Mach the 0.9 case certain jumps are observed in the mean centerline axial velocity due to the presence of shocks but in the Mach 0.4 case the mean centerline velocity remains nearly constant throughout the free jet region. DMD for both cases is performed. From the DMD modes and also from PSD of pressure, it is observed that there is no feedback loop and impingement tone in the Mach 0.4 case which is in agreement with the existing literature. PSD of pressure for the

Mach 0.9 case shows the occurrence of impingement tone. The DMD modes for velocity and pressure corresponding to the impingement tone frequency show large ring-like coherent structures in the free jet region which appear to be responsible for the feedback loop observed in this case.