Abstract

The Kelvin-Helmholtz Instability (KHI) is an instability that takes the form of repeating wave like structures. It forms on a shear layer where two fluids are moving at a relative velocity to one another. Such a shear layer forms as part of the Mach reflection. This dissertation focuses on experimentally visualising the presence of the KHI on the Mach reflection shear layer, as well as its evolution.

Experimentation was performed at Mach numbers of 1.34, 1.46 and 1.61. Plain and parabolic entrance test pieces with varying wedge angles of 30° to 38° were tested. Flow field visualisation was performed with a schlieren optical system. The camera-side knife edge orientation was altered to vary the axis of sensitivity of the optical system.

It was found that the KHI did form on the Mach reflection shear layer; more readily with increasing Mach number and wedge angle. The evolution of the instability was found to be almost scalable, with $M_0 = 1.46$ and $M_0 = 1.61$ achieving the best scaling of the length and average width of the KHI respectively. The KHI was best visualised with the camera-side knife edge perpendicular to the shear layer (i.e. the axis of sensitivity along the length of the shear layer), the visualisation of the KHI was completely obscured when camera-side knife edge was parallel to the shear layer.

Second order Euler, Navier-Stokes and k-ϵ numerical simulations of the flow field were also conducted using FLUENT 13. It was found that the Euler and Navier-Stokes solvers achieved very similar results, both producing the KHI but at a much less developed state than the experimental cases. The k-ϵ solver, however, did not produce the KHI.