Abstract

The diffraction of a one-dimensional expansion wave over a 90° corner was explored using experiment and simulation methods. Unlike studies in shock diffraction, expansion wave diffraction was hardly explored in the literature and therefore is considered as novel. Two independent parameters were identified for the present study: 1) the initial diaphragm shock tube pressure ratio, and 2) the position of the diaphragm from the apex of the 90° corner. The experimentation only considered variation in the shock tube pressure ratio whereas the simulation varied both independent parameters. A Navier-Stokes solver with Menters SST k-ω turbulence model was found to adequately model the flow field.

A number of major flow features were identified, that occurred in the vicinity of the 90° corner. The flow features identified were: a shear layer which originated by flow separation near the apex of the 90° corner, a separation bubble that remained attached to a wall boundary in absence of rig-dependent effects, and a reflected compression wave due to perturbation signals generated by diffraction of the expansion wave.

For a narrow-width expansion wave existing prior to diffraction, it was found that after diffraction a reflected compression wave developed which would steepen into an outwardly propagating, weak, cylindrical shock wave. Other major flow features identified were a strong indication of an oblique shock located near the separation bubble and a large wake region immediately downstream of the separation bubble. The wake region, through schlieren imaging, was found to consist of two distinct layers.

The experimental results through shadowgraph and schlieren imaging have indicated large-scale turbulent structures within the separation bubble and the shear layer. Shear layer instability and vortex shedding off the separation bubble were also evident. The Navier-Stokes solver was found not to resolve the experimentally observed turbulence, the wake region and the vortex shedding.