Wed1.5 Schwaederlé et al.

Measurements of turbulent mixing within an air/SF_6 shocked and reshocked interface

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We observe in a vertical shock tube the behaviour of an air/SF_6 mixing zone induced by the Richtmyer-Meshkov instability and excited by two subsequent waves reflected from the upper end wall: a shock and a rarefaction. The 1 m long driver and 3.058 m long driven sections are filled with air, and are followed by the 250 or 300 mm long measurement section filled with SF_6, at local atmospheric pressure (1 bar). The nominal Mach numbers are 1.20, 1.06, 1.304 and 1.297 for the incident, reflected in air (from the interface), the transmitted into SF_6 and reflected in SF_6 (from the end wall) shock waves respectively. Here, the shock wave propagates upwards from air into SF_6. The discontinuous interface between the test gases air and SF_6, which after shock acceleration leads to the mixing zone, is materialized by a thin (0.5 μm) nitrocellulose film sandwiched between two stainless steel wire grids. The upper (respectively lower) grid has a wire spacing of 1.8 (1.0) mm, with a wire diameter of 0.23 (0.07) mm. The lower grid is needed to support the membrane. The role of the upper grid is to impose a non-linear three dimensional perturbation of fundamental wave length 1.8 mm in the transverse directions. The perturbation amplitude in the axial direction is estimated between 0.1 and 0.3 mm. This wavelength and amplitude combination leads to an early transition to turbulence. After incident shock (reflected shock) the mixing zone moves upwards (downwards) at 69.4 (-24.7) m/s with an Atwood of 0.70 (-0.72). We measure the mixing thickness and velocity variance evolution for comparison with calculated quantities from turbulent mixing models imbeded in one-dimensional hydrodynamic codes [1]. The mixing thickness evolutions obtained from Schlieren visualisation for two initial SF_6 lengths (300 and 250 mm) exhibit power law dependence on time with exponent θ equal to 0.23±0.05 before reshock, 0.60±0.32 and 0.83±0.15 after reshock, for 250 mm and 300 mm respectively. The measurements of the axial and transversal components of the velocity will be performed for 250 mm using a DANTEC two components laser doppler velocimeter [2] at the three axial locations: 30, 88 and 146 mm.

References

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