LES of Richtmyer-Meshkov Mixing for inclined material interfaces with realistic surface finish[1]

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In practical ICF applications, the shock wave may be inclined to the material surface. It is therefore important to understand the effects of interface perturbations along the inclined interface on turbulent mixing. This paper investigates Richtmyer-Meshkov (RM) mixing through an inclined interface with realistic surface finish. The flow geometry considered here is based on the inverse chevron experiments conducted by Holder & Barton [1]. Figure 1 illustrates the quasi two-dimensional setup featuring a block of the dense gas sulphur hexafluoride (black region) encased in air and the three-dimensional flow development. As an incident shock wave of Mach 1.26 passes from left to right, the membranes separating the two fluids rupture and RM instabilities induce turbulent mixing. This effect is amplified further by shock reflections from the end wall of the tube.

Implicit Large Eddy Simulations (ILES) have been performed using the high-resolution solver CNS3D [2, 3] which is based on the HLLC Riemann solver, a 5th-order MUSCL scheme and the quasi-conservative multi-species model of Allaire et al. [3]. Computations are performed for two interface perturbations with the same standard deviation and wavelength range: (i) a power spectrum proportional to the mode number k and (ii) an interface more typical of ICF materials based on a power spectrum of the form $P(k) \propto k^{-2}$.

Figure 2 presents the evolution of the integral turbulence kinetic energy (TKE) during simulations using the two different interface perturbations. More TKE is produced by the k-spectrum because the mixing layer is faster developed at 1.5ms in comparison to the k^{-2}-spectrum. However, this effect is compensated for by increasing the grid resolution as demonstrated by the k^{-2} results obtained on a finer mesh. After 2.2ms, a fairly grid converged level of TKE emerges, which is dependent on the initial interface perturbation. On the same grid resolution, the k^{-2}-spectrum leads to more TKE at late times because it contains more energetic large scales than the k-spectrum.

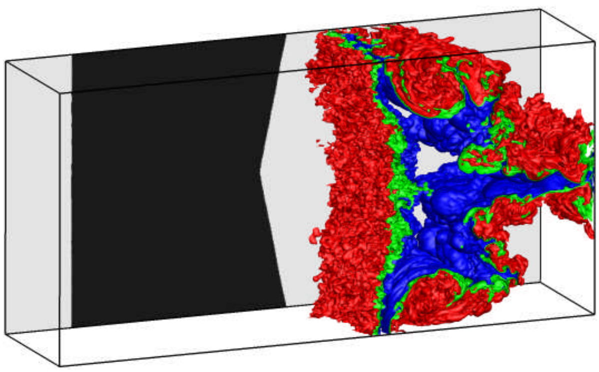

Fig. 1: Quasi 2D setup and flow after 3.3ms

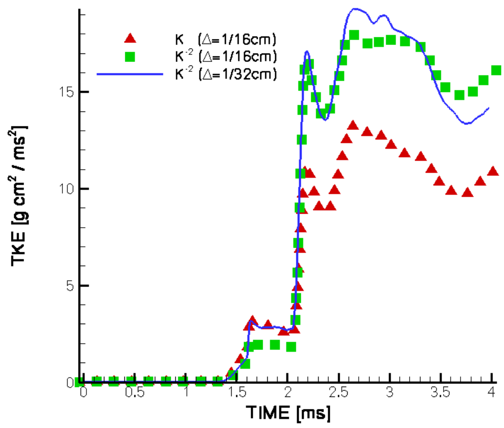

Fig. 2: Integral turbulence kinetic energy.

References

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