Assessment of Two-Equation Turbulence Models for Rayleigh-Taylor and Richtmyer-Meshkov Mixing[1]

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The aim of the present work is to assess the accuracy of two-equation turbulence models against results obtained by high-resolution implicit large eddy simulations (ILES) of Richtmyer-Meshkov (RM) and Rayleigh-Taylor (RT) mixing. The eddy-viscosity models are the *k-L* [1]; the *k-ω* [2]; and the *k-ε* [3] models in conjunction with a transport equation for the mass fraction. The governing equations are solved in an Eulerian framework using the HLLC Riemann solver with the fifth-order MUSCL scheme for spatial discretisation, and a third-order TVD Runge-Kutta scheme for the time integration [4]. The same numerical methods used in the discretisation of the fluid flow and turbulence transport Reynolds-averaged equations, are also used in the ILES computer code CNS3D [4]. In addition to CNS3D, AWE's ILES code TURMOIL [5] has been used to provide high-fidelity data for turbulence modelling validation. The mixing problems include a multi-mode, double-planar RM, and a multi-mode RT. Comparisons between the ILES and the turbulence modelling results will be presented for the mass fraction, the total turbulence kinetic energy and the total mixing. The investigation includes 'linear' and 'non-linear' variants of the eddy-viscosity models. The turbulence model variants differ with respect to the calculation of the eddy-viscosity coefficient as the mixing evolves.

Indicative results are shown below for the double-planar RM case. A planar shock-wave generated in air passes through a slice of SF_6 (Fig. 1). The computational domain is a rectangular channel of dimensions *0.4m x 0.2m x 0.1m* and is discretised into 640 finite volumes in the streamwise direction. The turbulence modelling computations are one-dimensional. Figure 2 shows the time evolution of the total turbulence kinetic energy as obtained from the *k-L* turbulence model and two different ILES methods.

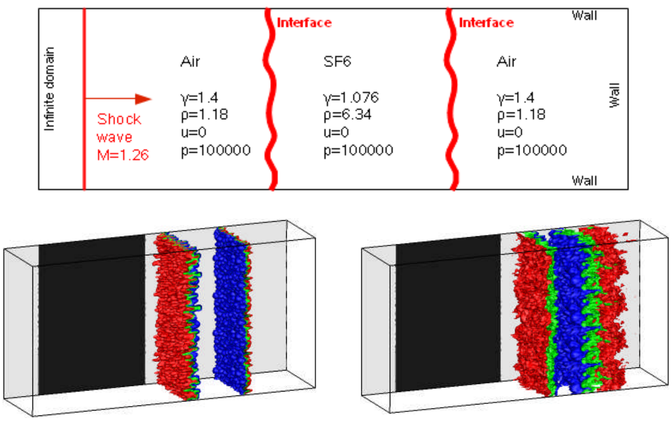

Figure 1: Geometry of the double-planar RM case and volume fraction visualisations at two different time instants using the ILES code (CNS3D) [4]. The dark region shows the initial position of the two planar interfaces.

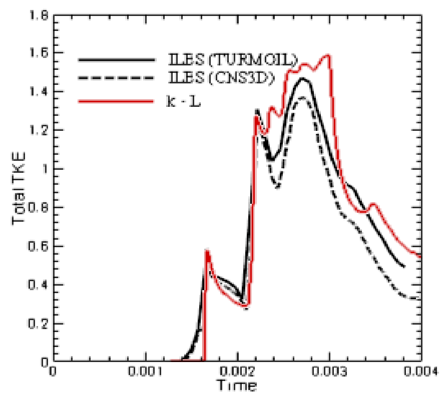

Figure 2: Evolution of the total turbulence kinetic energy in time: Comparisons of the *k-L* results with two ILES simulations using the CNS3D and TURMOIL methods.

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