Okong'o, Nora A.; **Bellan, Josette**

Direct numerical simulation of a transitional supercritical binary mixing layer: Heptane and nitrogen. (English) Zbl 1062.76029

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From the summary: Specific aspects characterizing the behaviour of supercritical mixing layers have been elucidated through direct numerical simulations. The conservation equations contain the full transport matrix according to fluctuation-dissipation theory, incorporating thermal diffusion effects. The real gas equation of state used in conjunction with dynamic conservation equations was also employed to calculate the mass diffusion factor which quantifies a mixture's departure from non-ideality. The boundary conditions were periodic in the streamwise and spanwise directions, and were based on real-gas characteristic waves exiting the domain without reflection in the cross-stream direction.

Three simulations were conducted for a heptane (lower stream) and nitrogen (upper stream) configuration, having initial Reynolds numbers of 400, 500 and 600. All simulations were fully resolved, and for the largest Reynolds number the calculation encompassed in excess of 17×10^6 grid points. The three simulations were carried for mixing transition states obtained after two pairings of the initial four spanwise vortices present in the layer. The transitional state was identified by global manifestations such as rapid and sustained momentum thickness growth, high rate of positive spanwise vorticity evolution, increased enstrophy, large product thickness, and large momentum-thickness-based Reynolds number.

MSC:

76F65 Direct numerical and large eddy simulation of turbulence
76F25 Turbulent transport, mixing

Keywords:

Peng-Robinson equation of state; fluctuation-dissipation theory; mass diffusion factor

Full Text: DOI