Contribution ID: **12** Type: **Short Talk**

SYNERGISTIC EFFECTS OF TURBULENCE AND THERMODIFFUSIVE INSTABILITIES ON EARLY FLAME KERNEL PROPAGATION IN A LEAN HYDROGEN-AIR MIXTURE

Tuesday, July 30, 2024 1:40 PM (20 minutes)

A comprehensive series of direct numerical simulations (DNS) is performed to investigate the early flame kernel development (EFKD) in a lean premixed H2-air mixture in decaying homogeneous isotropic turbulence and engine-relevant thermodynamic conditions. Systematic variations of turbulent intensity and integral length scale were assessed, resulting in Karlovitz number between 1.9 and 21. The main objective of this study is to explore the variations induced by turbulence during the EFKD phase in lean hydrogen-air mixtures across various turbulent regimes and assess their influence on the evolution of flame kernels. The study unveils a significant influence of the global stretch factor during the initial phases of flame kernel evolution. However, as the post-ignition effects diminish, the dominant factor shifts towards the wrinkling of the flame front. Elevated values of turbulence intensity lead to increased flame convolution and small-scale wrinkling, while higher integral length values contribute to a smoother flame surface. Higher Karlovitz numbers correlate with intensified fuel consumption, driven by accelerated flame surface expansion from enhanced wrinkling and increased local consumption speed due to differential diffusion effects.

Relevance for Nek [100 words max]

Reactive flow with NEK.

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