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Ignition of Fuel-Rich H₂/O₂ Mixtures in Pure O₂ Near the 2nd Explosion Limit

Matthew G. Sandberg and Eric L. Petersen

J. Mike Walker '66 Department of Mechanical Engineering, Texas A&M University, College Station, TX, USA

**Corresponding Author Email: msandberg@tamu.edu*

Abstract: Ignition delay time measurements of fuel-rich H₂/O₂ mixtures were obtained in a high-pressure shock tube. Due to the anticipated possibility of remote or premature ignition, efforts were made to limit the overall reactivity by reducing the oxygen available in the mixture. The resulting equivalence ratios ranged from 2.00 to 8.00, which correspond to initial H₂ fuel loadings of 80–94%, by volume. Experiments were performed at both atmospheric and intermediate pressure to target the known 2nd explosion limit of H₂. Because of the limited temperatures over which ignition was possible, reflected-shock temperatures of 900 to 1100 K are reported. Ignition events were monitored at the side- and endwall using both pressure and excited species emission (OH* near 307 nm). Empirical correlations based on measurements from this study demonstrate a strong dependence on the initial reactant concentration at atmospheric pressure, but this dependence decreases for pressures near the second explosion limit. Our results are in good agreement with model results from the GRI-Mech 3.0 kinetics mechanism. The challenges in performing shock-tube experiments in pure O₂ environments with high H₂ fuel loading are also discussed herein. These results address the current lack of ignition data in pure O₂ and supplement previous literature data for hydrogen ignition in both highly diluted and fuel-air environments.

Keywords: *H₂/O₂, Second Explosion Limit, Undiluted, Exothermicity, Ignition Delay Time*