

Analyzing the Dynamics of Swirl Flames Using a Novel Lean Premixed Dual-Swirl Burner

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The combination of hydrogen and ammonia balances the energy of hydrogen, increases the low flammability of ammonia, and is derived from renewable sources. However, ammonia yields NO_x emissions. By enhancing the flame's stability, NO_x emissions decrease and the combustion efficiency increases. This project aims to discover conditions that promote stable hydrogen-ammonia flames in a novel burner, using a well-tested fuel at first to ensure its viability. An axisymmetric dual-swirl burner supplied with a lean premixed methane fuel-air mixture was assembled at a fixed swirl angle and separation-tube height. The burner was adjusted to different bulk velocities (v) to analyze the flame dynamics. Also, to create a stability map that indicates bulk velocities for stable flames for 5 fixed equivalence ratios. Due to experimental limitations, the thermal power was kept under 8kW. The tests were repeated 3 times to ensure reproducibility and the variability difference was within $\pm 4\%$. The data showed that; the bulk velocity and the flame's height are directly proportional; If $v <$ flame propagation velocity, the flame flashes back; Different flame topologies develop, starting with the lowest bulk velocity: a V-shaped, an M-shaped, a lifted flame, then, the flame blows out; The stability range increases as the mixture becomes leaner. These results showed the viability of using this novel burner to test eco-friendly fuels. Therefore, hydrogen-ammonia fuel was tested at different separation-tube heights. Some results showed stability. The main nearest goal is to discover more conditions that stabilize hydrogen-ammonia fuel to use in engines and other practical heating devices.

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