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 NOx emissions. By enhancing the flame's stability, NOx 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 ±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.