FLAME LIFT-OFF IN DI DIESEL SPRAYS: IMPACT ON SOOT FORMATION

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The flame on DI diesel spray stabilizes at a location downstream of the fuel injector. This distance is referred to as the flame Alift-off@ height (or length). Air entrained into a diesel spray upstream of the flame lift-off length will mix with the injected fuel. The premixed fuel and air then react in a region immediately downstream of the flame lift-off. Recent measurements suggest that as much as 20% of the air required to burn the fuel being injected will be entrained upstream of the flame lift-off location. These results imply that combustion at the flame lift-off location plays a pivotal role in diesel combustion and emission formation processes. However, our current understanding of how various parameters affect flame lift-off, and the resulting fuel/air premixing, is extremely limited for diesel conditions.

This research is focusing on investigating the effects of various parameters (temperature and density of the ambient gas, Injection pressure, and orifice diameter) on the lift-off of a DI diesel spray flame, and the resulting impact on soot formation. The results indicate that there is strong link between soot formation and the fuel/air premixing that occurs upstream of the flame lift-off location. In addition, an important overall observation was made by considering the lift-off length data in conjunction with data from recent investigations of liquid-phase fuel penetration and spray development. The combined data suggest that a systematic evolution of the relationship and interaction between various processes in a DI diesel spray has been occurring over time, as parameters such as injection pressure, orifice diameter, turbocharging, intercooling, etc., have been changed as part of efforts to meet emissions regulations and improve engine performance. The new insight being gained will ultimately help explain the effects of these parameters on emissions formation processes in DI diesel sprays.