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A Study of Turbulent Flame Development with Ethanol Fuels in an Optical Spark Ignition Engine

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ABSTRACT

The work was concerned with experimental study of the turbulent flame development process of ethanol fuels in an optically accessed spark ignition research engine. The fuels were evaluated in a single cylinder engine equipped with full-bore overhead optical access and operated at typical stoichiometric part-load conditions. High-speed natural light (or chemiluminescence) imaging and simultaneous in-cylinder pressure data measurement and analysis were used to understand the fundamental influence of both low and high ethanol content on turbulent flame propagation and subsequent mass burning. Causes for the difference in cyclic variations were evaluated in detail, with comparisons made to existing burning velocity correlations where available.

Overall, it was concluded that the faster burning exhibited with pure ethanol fuel was the result of marginally higher initial laminar-like burning providing a “head start” to the turbulent flame development process, with the turbulent spectrum more quickly encroached leading to reduced bulk flame distortion and faster in-cylinder pressure development. While the chemical differences are often cited, such physical interactions have been widely overlooked within recent literature relating to ethanol use in modern SI engines.