

2012-01-0823

Spark Ignition and Pre-Chamber Turbulent Jet Ignition Combustion Visualization

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ABSTRACT

Natural gas is a promising alternative fuel as it is affordable, available worldwide, has high knock resistance and low carbon content. This study focuses on the combustion visualization of spark ignition combustion in an optical single cylinder engine using natural gas at several air to fuel ratios and speed-load operating points. In addition, Turbulent Jet Ignition optical images are compared to the baseline spark ignition images at the world-wide mapping point (1500 rev/min, 3.3 bar IMEP_n) in order to provide insight into the relatively unknown phenomenon of Turbulent Jet Ignition combustion. Turbulent Jet Ignition is an advanced spark initiated pre-chamber combustion system for otherwise standard spark ignition engines found in current passenger vehicles. This next generation pre-chamber design simply replaces the spark plug in a conventional spark ignition engine. Turbulent Jet Ignition enables very fast burn rates due to the ignition system producing multiple, widely distributed ignition sites, which consume the main charge rapidly. This high energy ignition results from the partially combusted (reacting) pre-chamber products initiating combustion in the main chamber. The distributed ignition sites enable relatively small flame travel distances enabling short combustion durations and high burn rates. Multiple benefits include extending the knock limit and initiating combustion in very dilute mixtures (excess air and/or EGR), with dilution levels being comparable to other low temperature combustion technologies (HCCI), without the complex control drawbacks.