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A Turbulent Jet Ignition Pre-Chamber Combustion System for Large Fuel Economy Improvements in a Modern Vehicle Powertrain

Neil Fraser
MAHLE Powertrain Ltd.

William P. Attard, Patrick Parsons
MAHLE Powertrain LLC

Elisa Toulson
Michigan State University

ABSTRACT

Turbulent Jet Ignition is an advanced pre-chamber initiated combustion system for an otherwise standard spark ignition engine found in current on-road vehicles. This next generation pre-chamber design overcomes previous packaging obstacles by simply replacing the spark plug in a modern four valve, pent roof spark ignition engine.

Turbulent Jet Ignition enables very fast burn rates due to the ignition system producing multiple, distributed ignition sites, which consume the main charge rapidly and with minimal combustion variability. The fast burn rates allow for increased levels of dilution (lean burn and/or EGR) when compared to conventional spark ignition combustion, with dilution levels being comparable to other low temperature combustion technologies (homogeneous charge compression ignition - HCCI) without the complex control drawbacks.

This paper focuses on preliminary performance, efficiency, emissions and combustion effects of a Turbulent Jet Ignition system operated with commercially available fuels at the world wide mapping point of 1500 rev/min, 3.3 bar IMEP_n (□2.62 bar BMEP). Single cylinder experimental results highlight that the pre-chamber combustion system is capable of tolerating up to 54% mass fraction diluent while still maintaining adequate combustion stability. The high diluent fraction has enabled the pre-chamber combustion system to record an 18% improvement in fuel consumption when compared to conventional stoichiometric spark ignition. The efficiency improvements are due to a combination of combustion improvements, the near elimination of dissociation due to the low combustion temperatures and reduced engine throttling. Additionally, the low temperature combustion has resulted in single digit ppm engine out NO_x emissions with controllable levels of HC and CO emissions.