Event: Small Engine Technology Conference & Exposition

# Title: Design and Development of a High-Efficiency Single Cylinder Natural Gas-Fuelled Jet Ignition Engine

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## Abstract

The current energy climate has created a push toward reducing consumption of fossil fuels and lowering emissions output in power generation applications. Combined with the desire for a more distributed energy grid, there is currently a need for small displacement, high efficiency engines for use in stationary power generation. An enabling technology for achieving high efficiencies with spark ignited engines for such applications is the use of jet ignition which enables ultra-lean ($\lambda$ > ~1.6) combustion via air dilution.

This paper provides a comprehensive review of the development of a 390cc, high efficiency single cylinder natural gas-fueled jet ignition engine operating ultra-lean. The engine was developed as part of the Department of Energy's Advanced Research Projects Agency–Energy (DOE ARPA-E) GENSETS program. Design choices for minimizing friction are highlighted as well as test results showing further friction reduction through downspeeding. Extensive hardware optimization of the combustion system has been performed and results are presented for air-flow path optimization and the jet igniter. The efficiency benefits related to enleanment and downspeeding are analyzed using an efficiency loss breakdown based on the First Law of Thermodynamics. Through optimization efforts a peak brake thermal efficiency in excess of 34% was achieved, representing an increase of greater than 20% over the current state-of-the-industry for comparably sized CNG engines.