

**Title: Proceedings of the international conference on internal combustion engines and powertrain systems for future transport / Assessing the low load challenge for jet ignition engine operation**

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## **Abstract**

Lean combustion in spark ignition engines is an advanced engine operating mode that has been proven to produce significant increases in efficiency, a requirement for future internal combustion engines in the transportation sector. This operation necessitates the use of advanced ignition or ignition controls concepts in order to achieve acceptable levels of combustion stability.

This study utilizes a Jet Ignition concept that has been under development for several years. MAHLE Jet Ignition® is a pre-chamber-based concept that produces high energy jets of partially combusted species that induce ignition and enable rapid, stable combustion at lambda values in excess of 2. In light duty engines this has resulted in minimum brake specific fuel consumption (BSFC) values of approximately 200 g/kWh with reductions in engine-out nitrogen oxides (NO<sub>x</sub>) emissions of 95% compared to conventional gasoline engines.

Historically pre-chamber-based combustion concepts have had limited success achieving acceptable combustion stability under low load operation including idle and catalyst light-off. These conditions require a high degree of spark retard capability, a capability that is typically lacking with jet ignition concepts. The purpose of this study is to evaluate the challenges associated with idle and catalyst light-off jet ignition operation, examine the underlying causes, and explore potential solutions with a goal of achieving similar performance to a conventional spark ignited engine under these conditions. Test results from a dedicated 1.5L 3-cylinder jet ignition engine are provided with comparisons to a conventional spark ignition variant of the same engine. Potential solutions to achieving comparable performance metrics to a conventional spark ignited engine are proposed and evaluated on the testbed. The influence of in-cylinder charge motion is assessed relative to low load performance. The applicability of these results to other jet ignition engine applications is discussed.