



Contribution ID: 56

Type: **not specified**

A Numerical Study of the effects of Fuel Injection timing on Engine Performance and Emission characteristics of Spark Ignition Direct Injection Engine

Tuesday 28 May 2024 11:30 (10 minutes)

Key words: Compressed Natural Gas (CNG), Spark Ignition Direct Injection (SIDI) Engine, Fuel Injection Timing, Engine Performance, Emission Characteristics, Gasoline

Abstract: This study numerically investigated the effects of early and late injection timings on the combustion of compressed natural gas (CNG) in SIDI engines; that is spark ignition engines where the gas is directly injected at high pressures (50 bar). The pressure and emission characteristics of early and late CNG injection were compared with a 200-bar gasoline direct injection base study at wide open throttle. This was done to further understand the comparative performance of CNG against gasoline under different injection regimes and be able to predict the effect of injection timing on optimal performance.

The results showed the late injection of CNG increased in-cylinder pressures and flame propagation compared to the early injection due to the presence of a stratified charge and turbulence induced by the injection. This resulted in improved performance but at the cost of increased emissions caused by lack of adequate time to achieve a homogeneous mix in the engine combustion chamber. Compared to gasoline combustion, the late injection of CNG reduced CO₂ emissions by 36% even though the power output was the same in both cases. The study concluded that CNG provides reduced emissions compared to gasoline under both early and late injection conditions. Furthermore, late injection of CNG occasioned increased NO_x emission and soot formation. Further investigation is required to maximize the performance and reduce the emissions from late injection.

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Session Classification: Technical session 2

Track Classification: Engineering: Mechanical Engineering