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Optimization of Combustion in Homogenous-Charge Compression Ignition Engines

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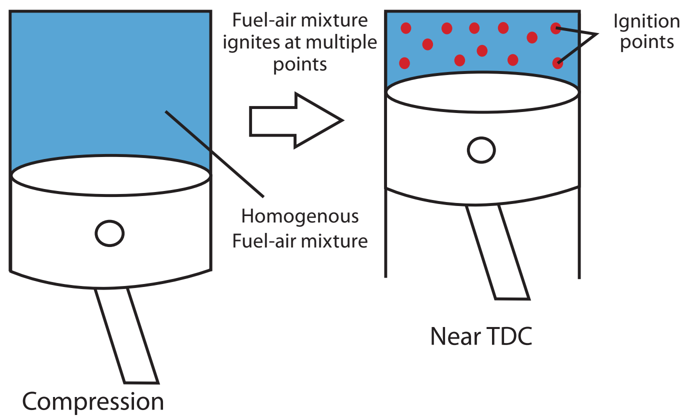
The purpose of this research is to optimize combustion in homogeneous-charge compression ignition (HCCI) engines. HCCI engines are advanced compression ignition engines that have the potential to provide high thermal efficiency with low emissions of toxic pollutants. However, the practical realization of the engine concept is challenging because of difficulties in controlling ignition over a wide range of operating conditions.

In this research, thermodynamic simulations have been carried out to assess the influence of fuel chemistry, intake pressure, intake temperature, exhaust gas recirculation, compression ratio, and wall heat loss on ignition time and heat release rates. Thermodynamic simulations are appropriate for these studies because the mixture is assumed to be homogeneous. As part of this project we also plan to assess the feasibility of employing varying fuel composition dynamically to adjust for engine heating and load variations.

Methane and n-heptane have been employed as fuel.As expected, the findings show high sensitivity to intake temperature and lower sensitivity to pressure. Using a combination of methane and n-heptane as the fuel and varying the composition is shown to be a potential avenue for ignition variability during transient operation.

The results also reveal that adding inert gases can reduce the harmful NO_x emissions produced from the cycle and that these gases can be used to control ignition timing. This provides the most practical use, recycling CO_2 back into the cylinder.

Research advisor John Abraham writes: "Challenges in controlling ignition in HCCI engines have limited its deployment in the automotive market, in spite of its potential. In this research, Joshua conducts numerical studies to understand factors that affect ignition with the objective of identifying variables that may be exploited to develop a combustion control strategy."



■ HCCI engine operation.

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