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Benefits of Octane-On-Demand in an E10-Gasoline Engine Vehicle Using an On-Board Fuel Separator

Knock in gasoline engines at higher loads is a significant constraint on torque and efficiency. The anti-knock property of a fuel is closely related to its research octane number (RON). Ethanol has superior RON compared to gasoline and thus has been commonly used to blend with gasoline in commercial gasolines. However, as the RON of a fuel is constant, it has not been used as needed in a vehicle. To wisely use the RON, an On-Board Separation (OBS) unit that separates commercial gasoline with ethanol content into high-octane fuel with high ethanol fraction and a lower octane remainder has been developed. Then an onboard Octane-on-demand (OOD) concept uses both fuels in varying proportion to provide to the engine a fuel blend with just enough RON to meet the ever changing octane requirement that depends on driving pattern.

In this work, the authors assessed the OOD concept on a state-of-art high-efficiency SI engine in three tasks: (1) Comparison of performance characteristics of an up-to-date reference engine coupled with cylinder deactivation (CDA) system, with a similar OOD engine. (2) Study of the OOD engine performance at vehicle level. This involves interaction between the time-dependent onboard fuel separation process and fuel consumption under different driving cycles, such as FTP75 and US06. (3) Potential of the OOD concept for engine downsizing with the needed boosting to maintain maximum torque.

It was found that overall mid-to-high load engine efficiency is improved significantly with the OOD engine. However, the improvement in the CDA operating region is small due to the higher combined pumping and friction losses at higher load region where knock occurs. At the vehicle level, the performance of OOD engine is dependent on the control strategy. With appropriate spark control strategy, the efficiency improvement with OOD engine is between 1% and 1.5%, depending on the aggressiveness of the driving pattern. The OOD concept is an attractive approach to increase efficiency of downsized engine. However, this requires the ethanol content in the pump fuel be significantly higher than currently typical 10% levels.