Dual-Alcohol Blending Effects on Gasoline Properties

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Biofuels can contribute to reducing greenhouse gas emissions from the transportation sector. While the use of a neat alcohol as a fuel for spark-ignition engines would displace large amounts of petroleum, neat alcohols cannot provide the distillation temperature range required for smooth driveability and often exhibit high enthalpies of vaporization and low vapor pressures, which create cold-start problems. Even gasoline blends containing high concentrations of single alcohols have shortfalls. Blends of lower alcohols (methanol and ethanol) exhibit azeotropic behavior, lower calorific value, and low stability, while the low volatility of higher alcohols significantly limits the maximum fraction at which they can be blended. One way to circumvent these issues is to use a dual-alcohol approach, mixing a lower and a higher alcohol with gasoline to obtain a blend with properties close to that of the neat gasoline. In this study, the fuel potentials of ten dual-alcohol blends at a wide range of blending ratios (10 to 80 vol %) and corresponding single alcohol-gasoline blends were evaluated based on their vapor-liquid equilibrium properties, physiochemical properties, and mixing/sooting potential compared to the neat gasoline. The higher alcohols used in these tests were iso-butanol and 3-methyl-3-pentanol, which were identified as promising alcohols for blending with gasoline in our previous study. This was the first effort to investigate the fuel potential of 3-methyl-3-pentanol blends. In addition, the azeotropic volatility behavior and volatility/mixing limited soot formation of dual-alcohol blends were examined by monitoring the distillate composition during the distillation and coupling this with droplet evaporation and direct-injection engine models. The results of this study showed that it is advantageous to use dual-alcohol blends as they offer better properties than single alcohol blends and have characteristics necessary for good performance in existing spark-ignition engines, regardless of total alcohol concentration.