

A Fundamental Study on the Impact of Light (Ethanol) and Heavy Components on Gasoline Deposits under Heating–Cooling Cycles

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In recent years, the introduction of bioethanol has been actively debated in many countries. Generally, deposit formation is known to be influenced by gasoline fuel properties. Nakayama et al. (2025) reported that repeated heating–cooling cycles can accelerate deposit hardening in regular gasoline in Japan. This report examines the effects of light fuel components (ethanol) and heavy fuel components (aromatics) on deposit formation under repeated heating–cooling cycles.

Simulated deposits were produced by applying heat to the fuel in an autoclave (a heated pressure vessel, Fig.1). Fuel was poured into sample dishes, which were placed inside the autoclave. Under controlled pressure and a NO_x atmosphere, the samples were subjected to prescribed heating–cooling conditions, and the remaining residue was collected as the simulated deposit.

First, simulated deposits were produced from 100% regular gasoline (E0) and gasoline blended with 10% ethanol (E10). Visual observation after seven cycles showed that E0-derived deposits retained adequate fluidity, whereas E10-derived deposits exhibited reduced fluidity (Fig.2). Measured deposit-generation ratios were lower for E10 than for E0—consistent with the volatility of ethanol reducing residual mass. Comparison of average molecular weight at cycle counts of 0, 6, and 12 showed no observable effect attributable to E10.

From these results, under the 100°C environment studied, the chemical reactions that increase molecular weight via formation of covalent bonds proceeded similarly for E0 and E10; ethanol did not change the rate or extent of molecular-weight growth. The effect of ethanol under heating–cooling cycles was to accelerate the onset of reduced deposit fluidity. The authors infer this results from more abundant formation of hydrogen-bonding sites within the deposit when ethanol is present, promoting structures that reduce flow.

Second, the influence of heavy components was evaluated by adding aromatic compounds into the fuel. After 12 cycles, fuels containing aromatics produced approximately three times the amount of residual deposit compared with fuels lacking these aromatics. This tendency is consistent with earlier results obtained from simple heating treatments, suggesting that the contribution of aromatic compounds to increased deposit formation is independent of cycle conditions.

Overall, these results suggest that, at the tested 100°C conditions, the heating–cooling cycle does not fundamentally alter the chemical reactions that form higher-molecular-weight deposit material. Instead, the cycle dynamics—specifically, the intermittent flow of the sample between cycles—increase surface exposure to NO_x, accelerating surface reaction rates and thereby promoting deposit formation or hardening.

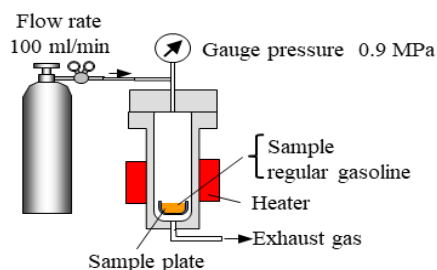


Fig.1 Schematic image of deposit generation equipment

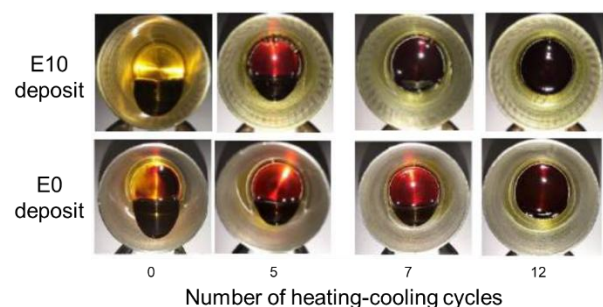


Fig.2 Visual observation of the deposit's fluidity