

Synthetic Gasoline Production by the MTG (Methanol-to-Gasoline) Process and Quality Adaptation

Consideration of Gasoline Production through Comparison with FT Synthesis

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To achieve carbon neutrality in the transportation sector, synthetic fuels (e-fuels) produced from CO₂ and renewable-energy-derived hydrogen are attracting increasing attention. Among synthetic gasoline production technologies, the MTG (Methanol-to-Gasoline) process can directly convert methanol into gasoline-range hydrocarbons. In this study, MTG synthesis experiments were conducted using an HZSM-5 catalyst, and the quality characteristics of the resulting MTG crude oil were investigated. In addition, gasoline production efficiencies of the MTG and FT (Fischer-Tropsch) synthesis processes were compared to discuss future directions for synthetic gasoline production technologies.

The hydrocarbon composition of the MTG crude oil was analyzed and compared with literature data reported for the Mobil MTG process. As shown in Fig. 1, the aromatic hydrocarbon content decreased with reaction time, while olefins and isoparaffins increased. After 214 h of operation, the hydrocarbon composition became comparable to the reported C5+ product composition of the Mobil MTG process. Furthermore, higher reaction pressure and lower reaction temperature reduced aromatic formation, indicating that aromatization control is an important factor for MTG gasoline quality.

Analysis of individual aromatic compounds showed decreases in benzene, toluene, and xylenes, whereas durene increased with reaction time. Since durene has relatively high melting and boiling points, suppression of durene formation was identified as an important requirement for MTG gasoline quality control. These results indicate that both catalyst properties and operating conditions play important roles in achieving the desired gasoline quality while minimizing the formation of heavy aromatic compounds.

The aromatic content of the MTG crude oil was approximately 54 vol%, which was higher than that of European commercial MTG gasoline (approximately 31 vol%). Significant amounts of xylenes and C10+ aromatic compounds were observed, indicating the necessity of quality upgrading processes such as distillation before automotive application. Such upgrading is expected to reduce heavy aromatic compounds and improve fuel properties for automotive gasoline applications.

Feed-derived components and by-products were also analyzed. Methanol, dimethyl ether (DME), and dienes were not detected, while low-molecular-weight organic acids were observed only at trace levels, suggesting minimal impact on vehicle performance.

Fig. 2 compares the estimated gasoline production efficiencies of the MTG and FT synthesis processes based on the Concawe report. The MTG process achieved gasoline production efficiencies of 30.9–41.2%, depending on C5+ selectivity, whereas current FT-based pathways showed lower efficiencies. However, an assumed future FT case with improved wax selectivity and gasoline yield approached the MTG level. These results indicate that the MTG process is advantageous for direct gasoline production, while the FT process remains attractive for producing middle distillates such as diesel fuel and sustainable aviation fuel (SAF). It should be noted that this comparison focuses on gasoline production efficiency and does not represent an overall assessment of the value of each production pathway.

Therefore, future synthetic fuel production should not rely on a single technology; instead, the optimum production pathway should be selected according to fuel quality requirements, target fuel type, and end-use applications. Continued development of both MTG and FT technologies is expected to contribute to the efficient production and early commercialization of carbon-neutral liquid fuels.

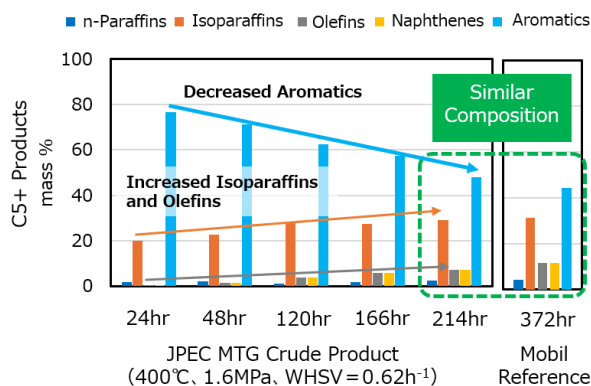


Fig.1 Hydrocarbon Composition of MTG crude oil

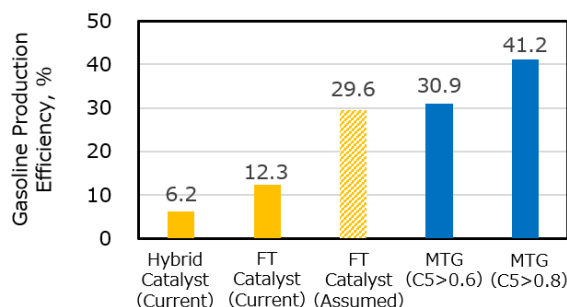


Fig.2 Comparison of Gasoline Production Efficiency of MTG and FT Processes