

Influence of Hydrothermal Aging on DeNO_x Characteristics for Selective Catalytic Reduction of NO_x by Hydrogen

Kyungseok Lee · Cheolho Kim · Kyoungbok Lee · Gildong Kim · Kwangchul Oh*

Korea Automotive Technology Institute

Key words : Hydrogen-SCR; H₂-ICE aftertreatment, Hydrothermal aging, NO_x conversion, Pt/ZSM-5 catalyst

* Corresponding author, E-mail: kcoh@katech.re.kr

The sustainable energy and environmental concerns in transport are being addressed through decarbonization efforts and the potential use of carbon-free and zero-emission alternative fuels. Hydrogen fuel has attracted significant attention in recent years because due to its high potential for reducing carbon-containing emissions, such as CO, CO₂, and soot. An internal combustion engine using hydrogen fuel (H₂-ICE) can generate sufficient engine power while producing only H₂O from the combustion process. However, the fast flame propagation rate of H₂ promotes the formation of tailpipe NO_x emissions due to high heat generation in the confined in-cylinder environment during high-temperature and high-load operations. This is one of the primary challenges in the development of H₂-ICE technology. The formation of nitrogen oxides (NO_x) from H₂-ICE is regarded as a major cause of atmospheric pollution, which should be reduced by modification of engine-operation (high A/F, EGR, and optimal fuel injection strategy) and applying appropriate aftertreatment devices.

To successfully reduce NO_x emissions and inhibit undesirable side reactions, H₂-ICE deNO_x aftertreatment systems must be reliable and well-suited, with satisfactory catalytic performance. The present study aims to investigate the effect of hydrothermal aging on deNO_x performance over the H₂-SCR catalysts. In most H₂-SCR studies, the Pt/TiO₂ catalyst has demonstrated reasonable H₂-SCR activity at low reaction temperatures. However, the reaction characteristics of hydrothermal aged catalyst are not fully understood due to a lack of relevant studies. Thus, this study focuses on comparing the resistance to hydrothermal aging between Pt/TiO₂ and Pt/ZSM-5 catalysts. The catalytic performance was systematically evaluated using a laboratory aftertreatment bench-test rig. The effects of catalyst support, loading amount of Pt (0.1, 0.25 and 0.5 wt.%) and reaction conditions (NO_x/H₂ ratio and O₂ content) on NO_x conversion were tested on both fresh and hydrothermally aged catalysts. The experimental results show that the ZSM-5-supported H₂-SCR catalyst exhibits higher resistant to hydrothermal aging (600 °C for 12 h with 10 vol.% H₂O) compared to the TiO₂-supported catalyst.

[Acknowledgment]

This research was financially supported by “Technology Innovation Program (Development of Direct Injection Hydrogen Engine Source Technology base on Carbon-Free Hydrogen Fuel, 20018473)” funded by the Ministry of Trade, Industry and Energy and “Regional Innovation Cluster Development Program (R&D, P0025423)” supervised by the Korea Institute for Advancement of Technology (KIAT) funded by the Ministry of Trade, Industry and Energy, Republic of Korea.

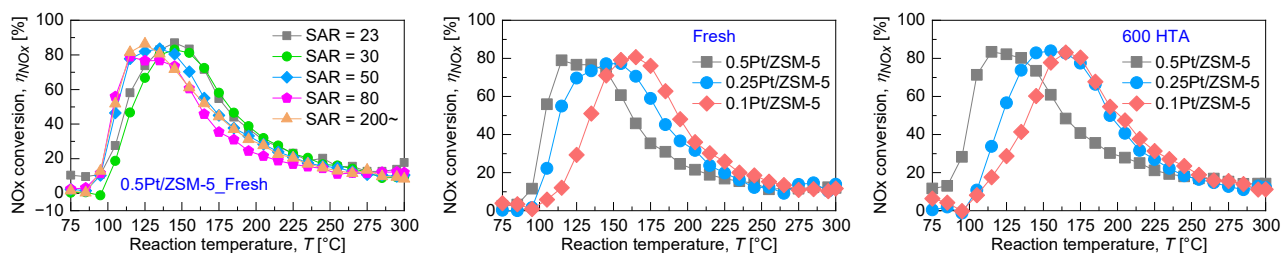


Fig. Comparison of NO_x conversion over the fresh and hydrothermally aged Pt/ZSM-5 based H₂-SCR catalysts