

A Study on Change in NO_x Conversion Performance of Urea SCR Catalysts Due to Urea Pulse Injection

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KEY WORDS: Heat engine, Selective catalytic reduction NO_x removal, Measurement, Urea-SCR, Pulse injection [A1]

Starting in November 2026, the European Union (EU) will begin enforcing Euro 7, its new emissions regulation. As the regulations become stricter, diesel exhaust aftertreatment technologies will need to become even more advanced. The NO_x reduction reaction varies in reaction rate and pathway depending on the composition and temperature of the exhaust gas. Therefore, it is believed that the optimal method for supplying urea solution to achieve the highest NO_x reduction efficiency varies depending on the engine operating conditions. In this study, we conducted a conventional urea SCR system under operating conditions of catalyst temperature 300°C, SV = 9.7×10^4 l/h, and 400°C, SV = 7.9×10^4 l/h, using steady injection in which injection is performed every 1 Hz and pulse injection in which the presence or absence of injection is controlled at an arbitrary duty ratio, and investigated the influence of the injection duty ratio on the NO_x conversion rate.

In tests conducted using a test bench equipped with an actual inline 4-cylinder, 4-stroke engine, under operating conditions of a catalyst temperature of 300°C, SV = 9.7×10^4 l/h and 400°C, SV = 7.9×10^4 l/h. The pulse injection cycle for the urea solution was fixed at 20 s, and measurements were taken while varying the duty ratio at 15%, 25%, 35%, 50%, 75%, and 85%. The results confirmed that the NO_x conversion rate fluctuated in synchronization with the urea solution pulse injection cycle. A comparison of the results at catalyst temperatures of 300°C and 400°C reveals that the NO_x emission spike is higher at 400°C. This is attributed to the fact that the maximum NH₃ adsorption capacity decreases at higher catalyst temperatures, resulting in less NH₃ being consumed by surface reactions when urea solution is not being injected. Fig. 1 shows the relationship between the duty ratio and the NO_x conversion rate under various conditions. As shown in Fig. 1 (a), under conditions where the catalyst temperature was 300°C, a 3.2 pt% improvement in the conversion rate was observed at a pulse duty ratio of 50% compared to steady-state injection. Furthermore, as shown in Fig. 1 (b), under a catalyst temperature of 400°C, a 2.0 percentage point improvement in the NO_x removal efficiency was observed at a pulse duty ratio of 85% compared to steady-state injection. As shown in Fig. 1, changes in the NO_x removal efficiency at each duty ratio, as indicated by the dashed lines, were confirmed under both catalyst temperatures of 300°C and 400°C. Under both catalyst temperatures of 300°C and 400°C, when the pulse injection duty ratio was reduced from 100% (steady-state), the NO_x conversion rate initially improved but then showed a tendency to decline.

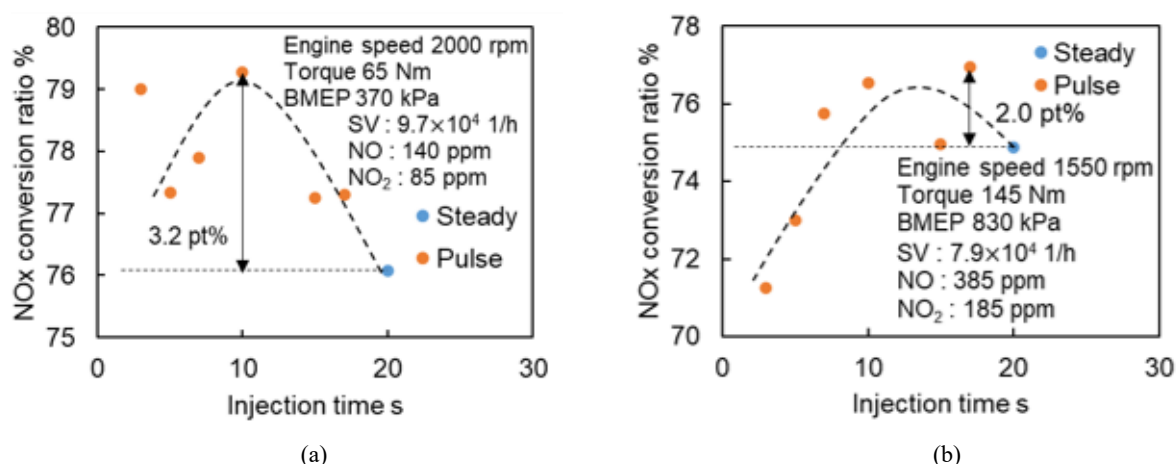


Fig. 1 Relationship between injection time and NO_x conversion rate at catalyst temperature of (a) 300°C, (b) 400°C.