International Journal of Automotive Technology, Vol. 8, No. 6, pp. 667−674 (2007)

1229−9138/2007/037−01

REDUCTION CHARACTERISTICS OF NOx STORAGE CATALYST FOR LEAN-BURN NATURAL GAS VEHICLES

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(Received 15 February 2007; Revised 1 August 2007)

ABSTRACT−Various types of NOx storage catalysts for NGV's were designed, manufactured, and tested in this work on a model gas test bench. As in most of other studies on NOx storage catalyst, alkaline earth metal barium (Ba) was used as the NOx adsorbing substance. The barium-based experimental catalysts were designed to contain different amounts of Ba and precious metals at various ratios. Reaction tests were performed to investigate the NOx storage capacity and the NOx conversion efficiency of the experimental catalysts. From the results, it was found that when Ba loading of a catalyst was increased, the quantity of NOx stored in the catalyst increased in the high temperature range over 350. With more Ba deposition, the NOx conversion efficiency as well as its peak value increased in the high temperature range, but decreased in the low temperature range. The best of de-NOx catalyst tested in this study was catalyst B,which was loaded with 42.8 g/L of Ba in addition to Pt, Pd and Rh in the ratio of 7:7:1. In the low temperature range under 450ºC, the NOx conversion efficiencies of the catalysts were lower when CH_4, instead of either C_3H_6 or C_3H_8, was used as the reductant.

KEY WORDS : NOx storage catalyst, Natural gas, CH_4, Double layer washcoat, Adsorption, Desorption

1. INTRODUCTION

Improvement of fuel economy and reduction of harmful gas emissions are the top-ranked technological goals in the automobile manufacturing industry due to the public anxiety over another oil shock and environmental crisis. The increasing emissions of green-house gases have stimulated new strategies for fossil fuel combustion in transportation. The objective of these strategies is to decrease the amount of carbon dioxide (CO_2) emissions by increasing combustion efficiency through the use of lean-burn or low carbon number fuel as natural gas. One of effective methods for enhancing fuel consumption of spark-ignited automobiles is the combustion of lean air-fuel mixtures. Lean combustion, however, is not compatible with TWC (three way catalyst, simultaneous oxidation of CO (carbon monoxide), HC (hydrocarbons) and reduction of NOx (nitrogen oxides)), which is indispensable in meeting the ever-tightening emission regulations. TWC can effectively reduce gaseous pollutants only under stoichiometric air-fuel conditions. Excess oxygen in the lean-burn exhaust gas reduces NOx conversion (Miyoshi *et al*., 1995; Takahashi *et al*., 1996; Kaspar *et al*., 2003).

Current after-treatment technologies for NOx removal are unsuitable for lean NGVs. Automotive TWCs are ineffective outside of stoichiometric conditions, while ammonia SCR (selective reduction catalyst) is less attractive for the vehicle system due to cost and infrastructure concerns. Urea SCR has potential especially for mobile applications, but has the same limitations as ammonia SCR. An ideal after-treatment system would make use of the HCs present in the exhaust (or fuel) to reduce the NOx (Holmgreen *et al*., 2007).

A possible solution to the problem of NOx reduction during lean combustion is the NOx storage and reduction (NSR) (Takahashi *et al*., 1996). The materials in the NSR catalysts are the same as those in the TWC with the addition of a NOx trapping materials. The NSR concept is based on a periodic lean/rich engine operation. During the lean periods, NO_2 is stored on the adsorption materials. This NO_2 is released during short rich pulses (call rich spark), and subsequently, reduced by HCs, CO, and hydrogen over precious metals (PM) sites to form CO_2, N_2, and water. The NSR catalyst was developed for NOx reduction under lean air-fuel conditions, but it could not be applied to lean burn engines because of the insufficient durability of the catalyst due to its poisoning by sulfur in the fuel (Rohr *et al*., 2005). Recent advances in oil refining technology have reduced the sulfur concentration in gasoline, and catalytic additives have also been found to resist sulfur poisoning (Matsumoto,

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