Reformer-Assisted Lean NOx Catalysis for Emissions Control

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Introduction

Control of NOx from lean burn engines remains a significant challenge. One approach being examined is active lean NOx catalysis and so-called 'assisted' lean catalytic processes, where the reductant is treated in some fashion prior to reaction over the NOx catalyst. In this paper, we present a modified lean NOx catalytic approach where diesel or natural gas is treated in a fuel reformer to provide highly active oxygenated species for NOx reduction, and this reformed mixture is injected into the exhaust upstream of the lean NOx catalyst to promote reduction.

Experimental

The process employs a millisecond contact time reformer[1] to convert either diesel or natural gas to largely syngas components in addition to minimal amounts of carbon dioxide. The syngas is then pressurized to 200-300 psi and passed over a Cu/Zn catalyst at 240-280°C to form a mixture of dimethyl ether (DME), methanol (MeOH), hydrogen, carbon monoxide, carbon dioxide, and nitrogen[2]. This mixture is then fed into the exhaust upstream of a lean NOx catalyst to promote conversion of NOx to N_2.

Results and Discussion

Efforts to date have focused on optimization of the three stages of the system: syngas production, reductant synthesis, and lean NOx catalysis. Results have shown that DME and MeOH are highly selective for NOx reduction in simulated exhaust streams. With dimethyl ether as the reductant, NOx conversion at steady state and 400°C was above 70% at C_1:NOx ratio of 4 and 44000 GHSV over an undoped γ-alumina catalyst. Silver-doped catalysts have been explored, but DME combustion activity is too high on these catalysts to result in significant NOx reduction, even at extremely low silver loading.

Current efforts are examining the impact of residual syngas on lean NOx activity with DME-MeOH reductants. In addition, syngas production and reductant synthesis are being optimized and integrated. Progress on these activities will be presented in addition to developments in lean NOx catalysts for this system.

References

1. Krummenacher et al., *J. Catal*. **215** (2003) 332-343.
2. Ng et al. *Chem Eng Sci* **54** (1999) 3587-3592.