Solid ammonium SCR system has been investigated to reduce NOx emission from diesel engine. Solid ammoniums such as ammonium carbamate and ammonium carbonate have 2-3 times higher ammonia storage density than 32.5% urea solution. The solid ammoniums are decomposed into ammonia gas before injection. The ammonia gas injection is helpful to mixing and NOx reduction at low temperature. The solid ammonium SCR system is developed to control generation and dosing rates of ammonia gas. The solid SCR system consists of reactor, heater, dosing module and controller. Compact dosing module is developed including sensors, a regulator and an injector. Heating time and energy are reduced by the compact dosing module. Ammonium carbamate is used as an ammonia carrier. 6 bar of reactor pressure and over 100°C of dosing module temperature are required to inject ammonia and prevent solidification. At cold start, the reactor pressure and the dosing module temperature are reached within 180s. Decomposition rate of ammonium carbamate is measured depending on electrical power input. The solid SCR system is tested using a 2.5L engine at European stationary cycle (ESC). NOx conversions of the solid ammonium SCR system and urea SCR system are compared. The solid ammonium SCR system is also tested when SCR catalyst temperature is under 200°C. Urea injection is unavailable under 200°C because of solid deposit formation. The low temperature operation of SCR system could reduce NOx emission during urban driving.

Advantages of solid ammonium SCR system

- Ammonia gas injection improves NOx reduction rate under 200°C.
- Mixer can be minimized by ammonia gas injection.
- Solid ammonium has 2-3 times higher ammonia storage density than DEF.

Urea SCR system

- Urea SCR system is widely used to meet EURO-6 standard. However, DEF injection is limited under 200°C because of solid deposit formation.
- Ammonia gas injection, burner, Heated DEF dosing, etc. are promising technologies to reduce NOx emission under 200°C.

Introduction

Comparison of solid ammonium SCR system and urea SCR system of Korea Institute of Machinery & Materials, 2) University of Science and Technology

Solid ammonium SCR system

- Solid ammonium SCR system consists of dosing module, reactor, exhaust gas recirculation blower and controller.
- In the previous research, tier-4 emission standard was meet with 3.4L diesel engine and reactor type 2 at NRTC HOT mode.

Experiments

- Engine specification of engine used in this study
- Compression ratio: 17
- Max. power (ps/rpm): 155/2500
- Emissions standard: EURO-6
- Fuel injection system: Common rail

Results and Discussion

Dosing module and dosing valve
- Compact dosing module was developed to reduce start-up time and energy consumption.
- Accuracy and precision of ammonia dosing rate were improved by the modification of dosing valve.

Advantages of solid ammonium SCR system

- 3 times higher ammonia generation rate is required for WHTC of the 3.9L diesel engine.
- The reactor type 3 will be tested in WHTC of 3.9L diesel engine.
- Coil heater is introduced to increase ammonia generation rate.
- Sub-reactor is designed for ammonia generation during the cold start.
- The reactor type 3 will be tested in WHTC of 3.9L diesel engine.

Conclusion

1. Compact dosing module and dosing valve of solid ammonium SCR system were developed for accurate and precise ammonia dosing.
2. 94%~97% of NOx reduction rate was observed at mode No. 3~5, 7, 9 and 11~13 of ESC.
3. However, the required amount of ammonia was higher than ammonia generation rate at mode No. 2, 6, 8 and 10.
4. 3 times higher ammonia generation rate is required for WHTC of the 3.9L diesel engine.