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Perspective

Control of Nitrogen Oxide Emission from Vehicular Engines: Brief Perspectives

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Introduction

Air pollution impacts are increasing and they are affecting the environment and public health. This has increased the strictness of pollutants (emission) concentration limits in the regulations and discharge limits of most of the countries. These limits are intended to decrease the emissions of Carbon Monoxide (CO), Nitrogen Oxides (NOx), and Particulate Matter (PM) from vehicular engines, specifically diesel engines. For example, in the European Union (EU), the limits for CO is 500 mg/km, NOx is 80 mg/km, and PM is 5 mg/km, respectively [1]. In recent years, the concentration of NOx from engines has significantly decreased due to the stringent regulations pertaining to NOx concentration throughout the whole world [2].

Catalytic Mechanism

NOx is usually produced from diesel exhausts, during the start-up of the engine. During start-up of the engine, the temperature is around 200°C and removing NOx at this low temperature is rather challenging. In this line of progressive engineering research, the Urea-Selective Catalytic Reduction (SCR) mechanism has been studied for more than 25 years and is a recognized technique for NOx removal from stationary diesel engines. In the urea-SCR, urea is hydrolysed to yield ammonia (Equation. 1):

$$H_2N\text{-}CO\text{-}NH_2 + H_2O \rightarrow CO_2 + 2NH_3 \quad (1)$$

Thereafter, the ammonia reacts with NO and NO_2. In diesel exhaust, more than 90% of the NOx emissions are NO. Thus, the main reaction that occurs in SCR is given by Equation. (2):

$$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O \quad (2)$$

The reaction of NO2 with ammonia is shown in Equation. (3):

$$3NO_2 + 4NH_3 \rightarrow 7N_2 + 6H_2O \quad (3)$$

This reaction is much slower than the reaction of NO with ammonia [3]. In the case of diesel engines, diesel oxidation catalyst, SCR, and diesel particulate filter have shown to be effective to decrease the concentration of CO, NOx, and PM after reaching their operating temperature. The SCR was proved to be very effective in decreasing the NOx concentrations in emissions. This process occurs by reducing the NOx to nitrogen with the help of reducing agents. Several reducing agents such as NH_3, CO, H_2 and HC have been used in the literatures, but NH_3 is the most commonly used and researched worldwide [4].

Perspectives and Applications

The urea-SCR catalytic system has been used in stationary diesel engines and it is a versatile technology. However, using the urea-SCR for automotive diesel engine is a challenge because the volume of catalyst used is large and it requires a proper control strategy for urea dosing [3]. Nevertheless, from a practical view-point, the SCR using urea is very effective in removing NOx under minimum operating temperatures, which is usually above 200°C [5].

In a recent study [6], Copper Zeolite (CuZSM5) catalyst showed 65% NOx removal when the temperature was 150°C. Thereafter, when the temperature was increased, the removal efficiency increased until it reached 98% at 200°C. Besides, CuZSM5 catalyst was able to maintain high NO conversion (> 95%) activity in a wide range of temperature (200°C to 400°C). The efficiency of CuZSM5 catalyst in removing NOx is highly dependent on the reactor operating conditions like space velocity and NH_3/NO feed ratio. Urea-SCR over CuZSM5 showed high NOx removal similar to NH_3-SCR, indicating that urea is a very effective reducing agent in the SCR reactor [6].

According to Baik et al. [6], the urea-SCR catalytic system with CuZSM5 catalyst is a very promising method for efficient NOx removal from diesel engine exhausts. This can be implemented in diesel engines in the future to help decrease the NOx emissions. In addition, copper zeolite can be used as a catalyst in other applications. One of these applications is the use of copper zeolite in upgrading the oil produced from the pyrolysis process, also known as bio-oil. The copper zeolite can also be used to accelerate the conversion of the oxygenated compounds in the bio-oil to hydrocarbons or less oxygenated compounds [7].

With the advent of modern computation technologies and sophisticated analytical instruments, more research should be done during the low temperature phase of engine start-up. Since the removal of NOx is highly dependent on the catalyst used, more novel catalysts should be studied for the NOx removal. For example, metal incorporated zeolite systems, wherein the metals can be cobalt, nickel, vanadium and titanium. Anew, the lifetime and hydrothermal stability of different catalysts should be studied and made known to be able to decide the applicability of this catalyst in engines.

References

1. European Union. Regulation (EC) No 715/2007 of the European Parliament and of the Council on Type Approval of Motor Vehicles with Respect to Emissions from Light Passenger and Commercial Vehicles (Euro 5 and Euro 6) and on Access to Vehicle Repair and Maintenance Information. Journal of the European Union. 2007; 171: 1-16.

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2. Lee J, Theis JR, Kyriakidou EA. Vehicle emissions trapping materials: Successes, challenges, and the path forward. Applied Catalysis B: Environmental. 2019; 243: 397-414.

3. Koebel M, Elsener M, Kleemann M. Urea-SCR: A promising technique to reduce nox emissions from automotive diesel engines. Catalysis Today. 2000; 59: 335-345.

4. Zeng Z, Lu P, Li C, Zeng G, Jiang X, Zhai Y, Fan X. Selective catalytic reduction of NO by urea loaded on activated carbon fibre and CeO_2/activated carbon fibre at 30°C: The selective catalytic reduction mechanism. Environmental Technology. 2012; 33: 1331-1337.

5. Theis JR, Lambert CK. An assessment of low temperature NOx adsorbers for cold-start NOx control on diesel engines. Catalysis Today. 2015; 258: 367-377.

6. Baik JH, Yim SD, Nam I, Mok YS, Lee J, Cho BK, et al., Control of NOx emissions from diesel engine by selective catalytic reduction with urea. Topics in Catalysis. 2004; 30: 37-41.

7. Kumar R, Strezov V, Lovell E, Kan T, Weldekidan H, He J, Dastjerdi B, et al., Bio-oil upgrading with catalytic pyrolysis of biomass using copper/zeolite-nickel/zeolite and copper-nickel/zeolite catalysts. Bioresource Technology. 2019; 279: 404-409.

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