

## Characteristics of Air-pollutant From Automobile

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**Abstract.** General vehicle driving test has been conducted on a chassis dynamometer with NEDC mode for diesel vehicles and CVS-75 for gasoline vehicles. And excessive driving test has been done with US06 for rapid acceleration and high speed driving and SC03 for maxim load operation condition for air-conditioning. The test has been conducted on 22 vehicles having different emission levels from EURO-4 to SULEV in order to understand emission characteristics clearly. This study aims to investigate characteristics of NO<sub>x</sub> and PM emissions in driving condition as emission standard has been strengthen and provide political plans for improvement.

**Keywords:** Air-pollutant, NO<sub>x</sub>, PM, NEDC

### 1 Introduction

In order to minimize air pollution due to automobile, Korean environmental regulation for automobile has been strengthened continuously. Regulation for Ultra Low Emission Vehicle (ULEV) has been imposed since year 2006. And Euro-5 standard has been imposed to Korea since year 2009 in which Euro-5 standard has been imposed to Europe as well. However, concentration of nitrogen oxides was not decreased noticeably in Seoul Metropolitan area. The emission certification of domestic air pollutant has been applied differently according to fuel and applied techniques.

According to reports in Korea and Europe, light-duty diesel vehicles have emitted more NO<sub>x</sub> on conditions other than those of certification testing mode. Domestic diesel vehicles have emitted NO<sub>x</sub> emission excessively on the condition of air-conditioning and sudden acceleration. According to the date of real-time driving emission by using Portable Emission Measurement System (PEMS), air pollutant materials from gasoline or LPG vehicles are within the certification standard but NO<sub>x</sub> emission from diesel vehicles exceed certification standard. This excessive NO<sub>x</sub> emission from real-time driving of diesel vehicle has been reported in Europe as well. European Commission-Joint Research Center (EC-JRC) conducted real-time driving emission test for 12 vehicles from year 2007 to year 2010 by using PEM and NO<sub>x</sub> emission for diesel vehicles was emitted 4~7 times of certification standard. Competitive Automotive Regulatory System (CARS21) has pointed out air-pollutants

in big cities has been exceeded air-pollutant standard, and in particular it suggested to prepare measures on the reduction of real driving NO<sub>x</sub> emission from diesel vehicles in order to decrease NO<sub>2</sub> concentration. Based on this, EC began to develop Real Driving Emission Light-duty Vehicle (RDE-LDV) and implementation of corresponding regulation has been underway since Sept. 2017.

Accordingly in this research the characteristics of air-pollutants reduction were evaluated when fuel type and applied technologies is used. As driving certification modes, CVS-75 mode for gasoline vehicle and NEDC mode for diesel vehicle were used for chassis dynamometer.

## 2 Experiment

Table 1 represents specification of test vehicles and consists of fuel type, vehicle type, engine size and emission levels. Fig. 1 represents NO<sub>x</sub> emission from gasoline and diesel vehicles according to 5 emission standards (EURO-4, 5, 6, ULEV, SULEV). NEDC and CVS-75 modes are applied to diesel and gasoline vehicles respectively. NO<sub>x</sub> emission in diesel vehicles have decreased certainly since emission standard has been strengthened and NO<sub>x</sub> emissions in diesel vehicles of EURO-6 and in gasoline vehicles were emitted in a similar level. PM emission is reduced to a very lower level from EURO-4 vehicles because DPF technique is applied (Fig. 2).

Fig. 3 represents NO<sub>x</sub> emission from gasoline and diesel vehicle in two excessive driving modes (US06, SC03). NO<sub>x</sub> emission from EURO-5 diesel vehicle increases rapidly in US06 and SC03 modes, however NO<sub>x</sub> emission in EURO-6 diesel vehicles is in a different trend in accordance with applicable techniques. NO<sub>x</sub> emission in SC03 mode and US06 mode occurs much more than in NEDC mode despite LNT is applied to vehicles, however there is no significant differences in NO<sub>x</sub> emission between in SC03/US06 mode and NEDC mode as long as SCR technique is applied to the vehicles. Therefore, there is possibility can be a similar level to emission standard level of NEDC mode by applying SCR technique to the vehicles even in an excessive driving condition. Fig. 4 represents comparison of PM emission characteristics of diesel vehicles in excessive driving modes and NEDC mode. PM emission increases slightly in SC03 mode and US06 mode but meet emission standard in NEDC mode.

**Table 1.** Main specification of test vehicle with chassis dynamometer

Vehicle ID	Fuel	Type	Engine Volume(L)	Emission Level
CD1	Diesel	SUV	2.0	EURO-4
CD2	Diesel	SUV	2.0	EURO-4
CD3	Diesel	SUV	2.0	EURO-4
CD4	Diesel	SUV	2.0	EURO-4
CD5	Diesel	SUV	2.0	EURO-5
CD6	Diesel	SUV	2.0	EURO-5
CD7	Diesel	SUV	2.0	EURO-5

CD8	Diesel	SUV	2.0	EURO-5
CD9	Diesel	SUV	2.0	EURO-5
CD10	Diesel	SUV	2.0	EURO-5
CD11	Diesel	SUV	1.6	EURO-5
CD12	Diesel	Sedan	2.0	EURO-5
CD13	Diesel	Sedan	2.2	EURO-5
CD14(LNT)	Diesel	Sedan	2.2	EURO-6
CD15(LNT)	Diesel	Sedan	2.0	EURO-6
CD16(LNT)	Diesel	Sedan	2.0	EURO-6
CD17(SCR)	Diesel	Sedan	2.2	EURO-6
CG1	Gasoline	Sedan	1.0	ULEV
CG2	Gasoline	Sedan	2.0	ULEV
CG3	Gasoline	Sedan	1.6	ULEV
CG4	Gasoline	Sedan	1.8	SULEV
CG5(Hybrid)	Gasoline	Sedan	2.0	SULEV

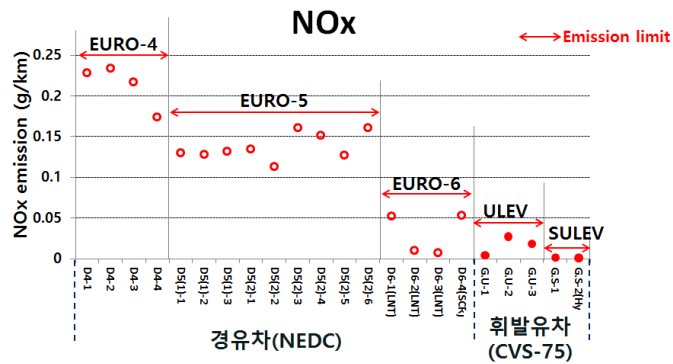


Fig. 1. NO<sub>x</sub> emission

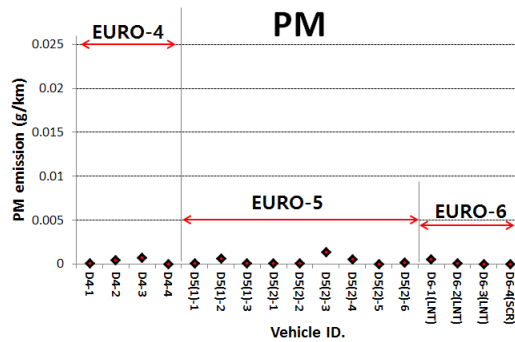


Fig. 2. PM emission

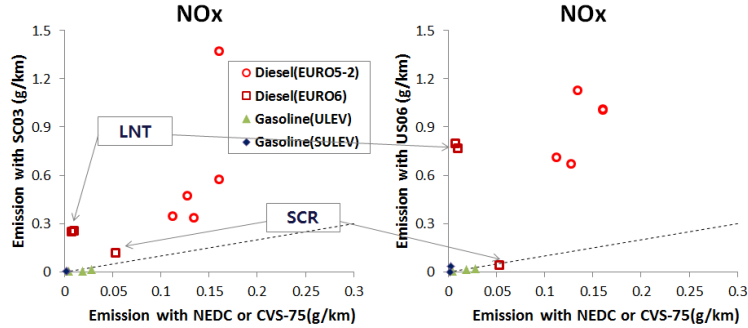


Fig. 3. Comparison of NO<sub>x</sub> emission (US06, SC03, NEDC, CVS-75)

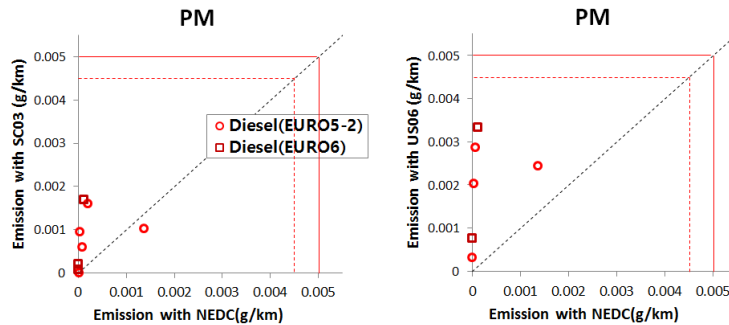


Fig. 4. Comparison of PM emission (US06, SC03, NEDC, CVS-75)

### 3 Conclusions

With the tighten emission standards regulation air-pollutant were measured on a chassis dynamometer by applying NEDC mode for diesel vehicles and CVS-75 mode for gasoline vehicles and their characteristics were analyzed. Comparative study on NO<sub>x</sub> and PM emissions was made in two excessive conditions of SC03 and US06 modes and a NEDC mode. In particular, it is investigated whether their emission standard can be satisfied or not when LNT or SCR is applied to EURO-6 diesel vehicles.

### References

1. Weiss, M, Bonnel, P., Hummel, R., (2011). Analyzing on-road emission of light-duty vehicles with Portable Emission Measurement Systems (PEMS), EUR 24697 EN ISBN 978-92-79-19072-8.