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Comparison Study of Certification Emission Test and Real-time Road Driving Emission Test for Various Emission Level Vehicles

Myungdo Eom, Junhong Park

Transportation Pollution Research Center,
National Institute of Environmental Research, Korea.

Doo-Sung Baik*

Computer-aided Mechanical Design Engineering,
Daejin University, Pocheon 487-711, Korea
**(Corresponding Author) E-mail: dsbaik@ daejin.ac.kr*

Abstract

Vehicle driving test has been conducted on a chassis dynamometer with NEDC mode for diesel vehicles and CVS-75 for gasoline vehicles. And also excessive driving test has been done with US06 for rapid acceleration and high speed driving and SC03 for maximum load operation condition for air-conditioning. The test has been carried out on 22 vehicles having different emission levels from EURO-4 to SULEV in order to understand emission characteristics clearly. This research aims to investigate characteristics of NOx and PM emissions in driving conditions as emission standard has been strengthened and furthermore to provide political plans for the improvement of air-pollution in near future.

Keywords: Air-pollutant, NOx, PM, NEDC, PEMS

1 Introduction

In order to minimize air pollution due to automobile, Korean environmental regulation for automobile has been strengthen continuously 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.[1] The emissions certification of domestic air pollutant has been applied differently according to fuel and applied reduction technology.

European emission regulation has been introduced for allowable emission standard and testing method for Korean diesel vehicles. Certification test method and real-time driving emission control system will be introduced since there are some limitations for reflecting actual road driving conditions in NEDC (New European Driving Cycle).[2] Europe plans to implement WLTP (Worldwide harmonized light-duty vehicle test procedure) and develop RDE-LDV (Real Driving Emission-Light-Duty Vehicles).[3]

According to reports in Korea and Europe, light-duty diesel vehicle have emitted more NOx emission on other conditions than certifications test mode conditions.[4][5] Domestic diesel vehicles have emitted NOx emission excessively under the condition of air-conditioning and sudden acceleration. According to the data 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 NOx emission from diesel vehicle exceeds certification standard.[6][7] This excessive NOx emission from real-time driving of diesel vehicles has been reported in Europe as well. European Commission-Joint Research Centre (EC-JRC) conducted real-time driving emission test for 12 vehicles from year 2007 to year 2010 by using PEMS and NOx emission for diesel vehicles was emitted 4~7 times of certification emission standard. Competitive Automotive Regulatory System (CARS21) has pointed out air-pollutants in large cities has been exceeded air-pollutant standard, and in particular it suggested to prepare measures on the reduction of real driving NOx emission from diesel vehicles in order to decrease NOx concentration.[8] 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 technology was used. As driving certification modes, CVS-75 mode for gasoline vehicle and NEDC mode for diesel vehicle were used for a chassis dynamometer.

2 Experimental Approach

Table 1 represents specification of test vehicles and consists of fuel type, vehicle type, engine volume and emission levels. Euro-5(1) vehicles represent vehicles before NOx improvement, and Euro-5(2) vehicles represent vehicles when NOx

improvement is made. Euro-6 vehicles are applied by LNT or SCR. A hybrid vehicle is selected from SULEV vehicles.

Table 1: Main specification of test vehicle on 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

3 Results and Discussion

Fig. 1 represents NOx emission from gasoline and diesel vehicles according to 5 emission standards (Euro-4, 5, ULEV, SULEV). NEDC and CVS-75 modes are applied to diesel and gasoline vehicles respectively. NOx emission in diesel vehicles have decreased certainly since emission standard has been strengthened and NOx emissions in diesel vehicles of Euro-6 and in gasoline vehicles are emitted in a similar level. PM emission is reduced to a very lower level from Euro-4 vehicles because DPF reduction technology is applied. (See Fig. 2) Fig. 3 represents NOx emission when air-conditioning or hot-starting is operational. NOx from Euro-4 and Euro-5(1)

vehicles emitted maximum 10 times more than certification emission standard. But NOx emission from Euro-6 vehicles is satisfied to certification emission standard of NEDC mode even when air-conditioning or hot-starting is operational.

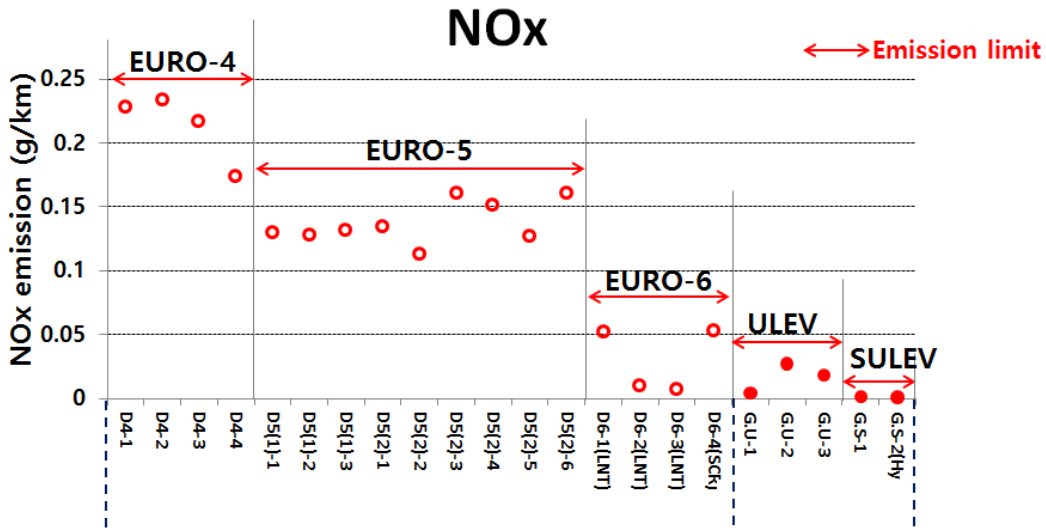


Fig 1. NOx Emission

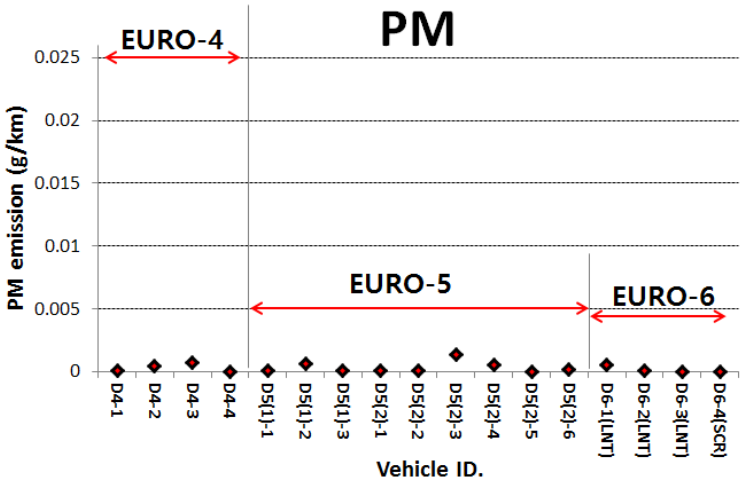
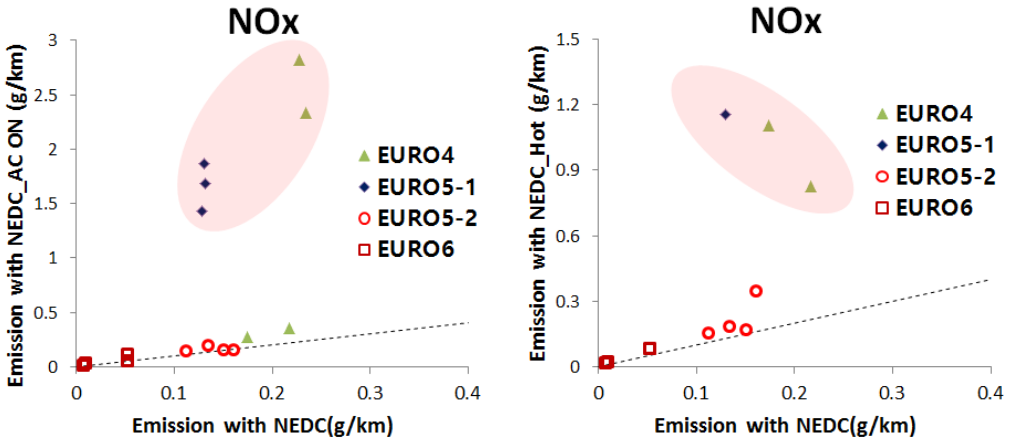


Fig 2. PM emission

In Fig. 4, NOx emission from gasoline and diesel vehicles on WLTC mode is compared with NOx emission on certification test mode (NEDC or CVS-75). NOx emission from gasoline vehicles of ULEV or SULEV is similar both on CVS-75 mode and WLTC mode. NOx emission of Euro-5(2) in diesel vehicles is significantly

different in NEDC and WLTP driving mode, but in Euro-6 vehicles this difference of NOx emission is not noticeable. Fig. 5 represents NOx emission from gasoline and diesel vehicle in two excessive driving modes (US06, SC03). NOx emission in Euro-6 diesel vehicles is in a different trend in accordance with applicable technology. NOx emission in SC03 mode and US06 mode occurs much more than in NEDC mode despite LNT is applied to vehicles, however, there is not significant differences in NOx emission between in SC03/US06 mode and NEDC mode as long as SCR technology is applied to the vehicles. Therefore, there is possibility can be a similar level to emission standard level of NEDC mode by applying SCR technology to the vehicles even in an excessive driving condition. Fig. 6 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 meets emission standard in NEDC mode.



(a) Operation of air-conditioner **(b) hot-engine starting**

Fig 3. NOx Emission in operation of air conditioner or hot engine starting with NEDC mode

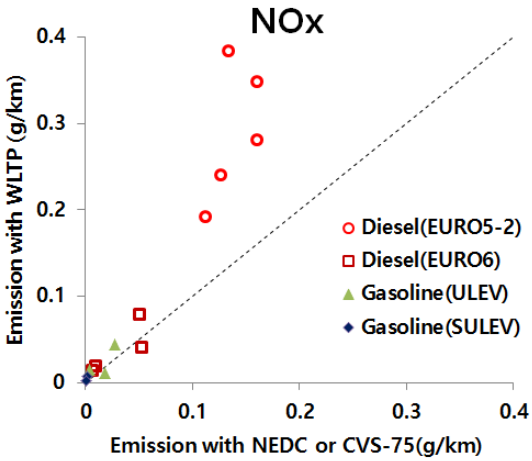


Fig 4. Comparison of NOx emission on driving WLTP and certification test mode

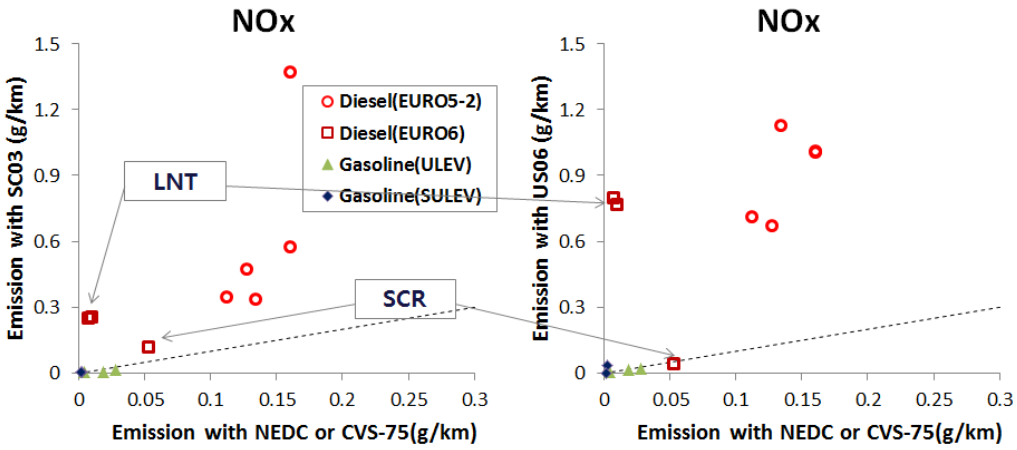


Fig 5. Comparison of NOx Emission (US06, SC03, NEDC, CVS-75)

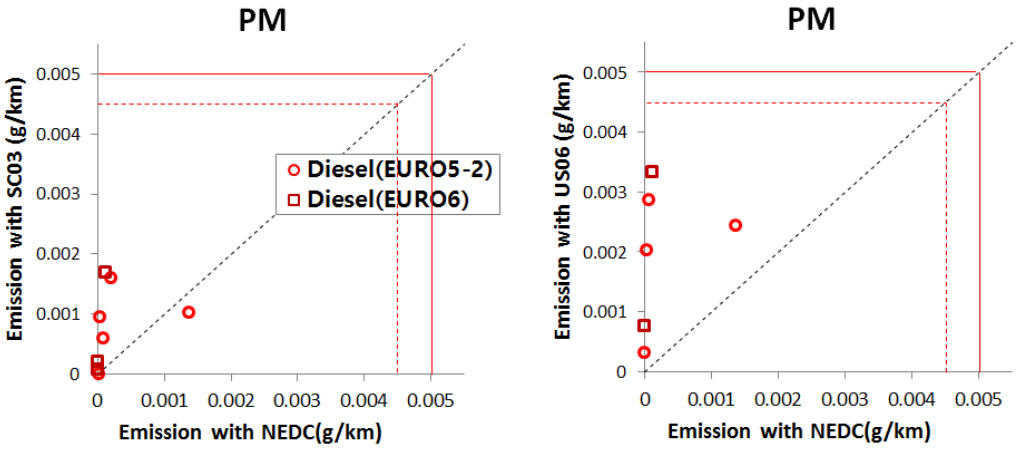


Fig 6. Comparison of PM emission (US06, SC03, NEDC, CVS-75)

4 Conclusion

With the tightened emission standard 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 NOx and PM emissions was made in two excessive conditions of SC03 and US06 modes and NEDC mode. In particular, it was investigated whether their emission standard could be satisfied or not when LNT or SCR was applied to Euro-6 diesel vehicles. PEMS test plan to adopt by RDE-LDV is developed by European emission regulation. After analyzing the results after applying evaluation method of RDE-LDV, discrepancy between emissions of air-pollutants on certification mode test and real-time road driving can be eliminated or reduced significantly and finally

expected to raise the efficiency of the strengthening acceptance of exhaust emission policies.

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