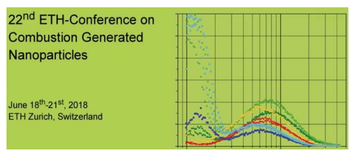

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A study on the characteristics of particle emissions from diesel and gasoline vehicles on real driving emission for ambient temperature

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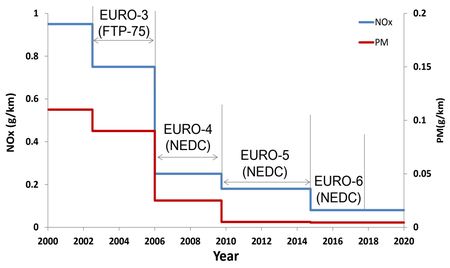
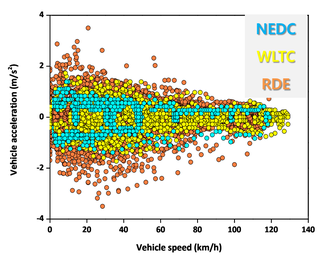
※ Introduction





√ To reduce nitrogen oxide(NOx) and particulate matter(PM) of light-duty vehicles has been strengthened emissions regulation in the Europe.

√ DISI engine system in gasoline vehicle is presently used to met emissions standard for gasoline vehicles. It is a trend due to high efficiency and downsizing technology.

√ Diesel vehicle use an after-treatment(LNT, SCR, DPF) to reduce nitrogen oxide(NOx) and particulate matter(PM) in order to cope with emissions standard strengthened.

√ Currently certification test mode does not reflect the driving conditions of real road, it is confirmed that there is distribution between RDE and chassis tests.

√ The RDE (Real-Driving Emissions) test for particulate numbers from diesel and gasoline vehicles and the new chassis test "WLTC(World Light-duty Test Cycle)" come into force on the September 2017 in Korea and Europe at the same time.

√ A need to study on the PN emissions from diesel and gasoline light-duty vehicles equipped with PEMS as of the introduction of WLTC and RDE test.

※ Test methods and results

√ The PEMS is consist of Exhaust Flow Meter(EFM), On-Board Diagnostics(OBD), Global Positioning System(GPS) and Gas analyzer.

√ The route is designed to be operated on cold-start conditions in RDE package 3 and it is consist of urban, rural and highway. Also, the tests were carried out under only cold-start condition.

√ In the gasoline vehicle, despite the NOx and PN emissions higher than diesel vehicle, an incomplete combustion due to wall-wetting in combustion chamber leads to an increase of PN emissions.

√ In the diesel vehicle, the NOx and PN emissions were measured at higher than NEDC in the new introduced WLTC. The WLTC has a relatively wide acceleration distribution and high load range.

※ Conclusions

√ To verify the reliability of PEMS data, we conducted correlation test with CVS and PEMS equipment.

- The correlation coefficient of NOx emissions measured by CVS and PEMS equipment was analyzed to be over 0.99, so the PEMS equipment had very high correlation with CVS.

√ The PEMS was installed in the gasoline and diesel vehicles for Real-Driving Emission(RDE) test and this study was performed at various ambient temperatures.

- NOx and PN emissions were high emitted under low temperatures in the diesel vehicle equipped with LNT system.
  In case of the DPF regeneration under RDE test, PN emissions were emitted more than Non-regeneration of RDE test.

- In the gasoline vehicle equipped with Three-Way Catalyst(TWC) had significantly lower NOx emissions than diesel vehicle.
  But, In case of PN emissions were high measured.
  The characteristics of the PN emissions under gasoline vehicle of DISI engine have not been clarified precisely.

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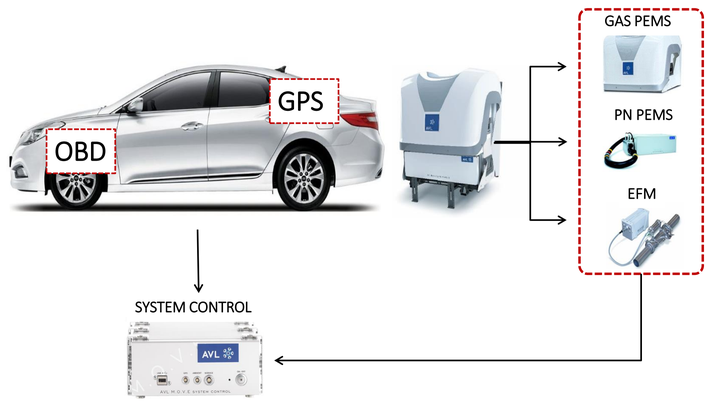
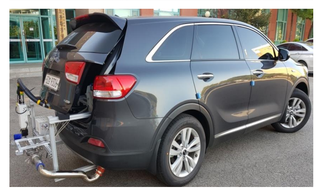
※ Schematics of PEMS for real-driving emission measurement



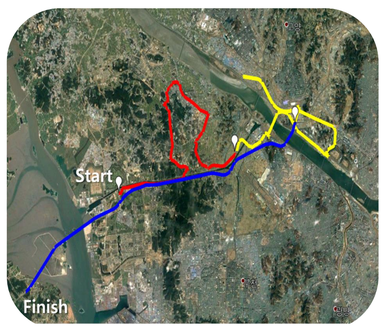
Item	Range	Principle
CO	0 ~ 5 vol.(%)	Heated NDIR (Non-dispersive infrared detection)
CO_2	0 ~ 20 vol.(%)	
NO	0 ~ 5,000 ppm	UV (Ultra-violet)
NO_2	0 ~ 2,500 ppm	
PN	Approx. O.5 L/min.	DC (Diffusion Charger)
Exhaust flow	23 ~ 610 kg/h	Pitot flow meter

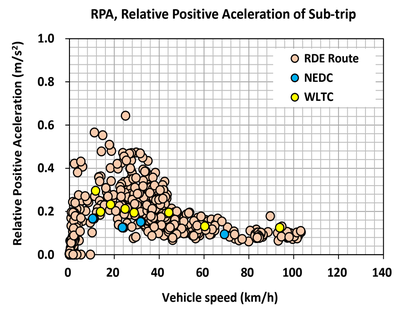
※ Test vehicles and route

[Gasoline vehicle]
Engine Type : I-4 DISI
Disp. (cc) : 2,400
After-treat : TWC



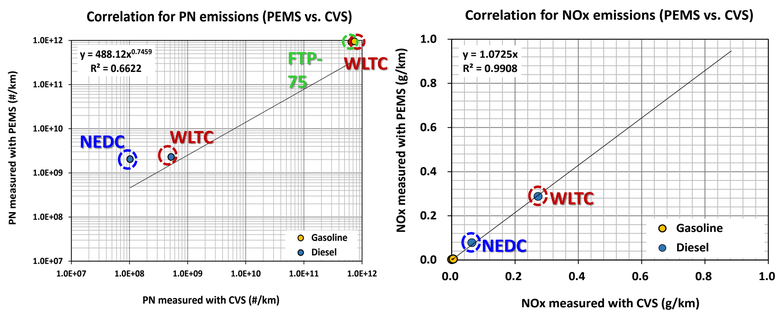
[Diesel vehicle]
Engine Type : I-4 CRDI
Disp. (cc) : 2,000
After-treat : LNT + DPF





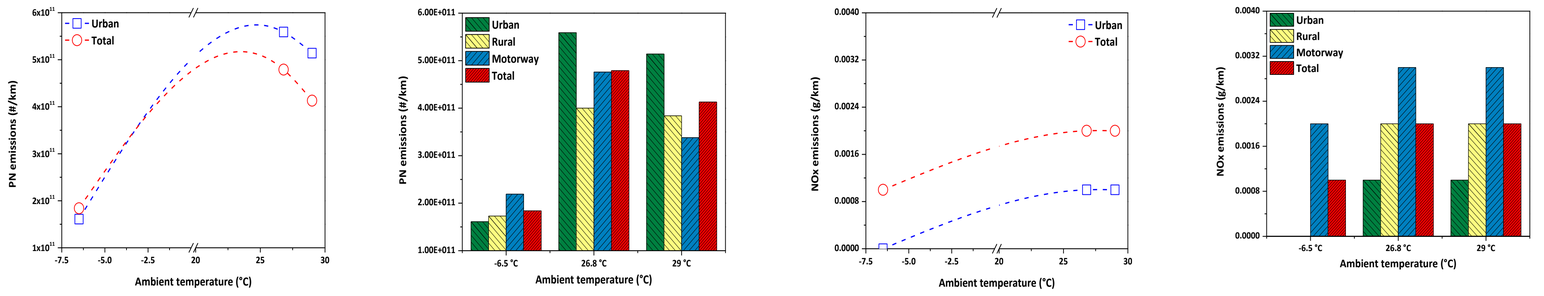
	Urban	Rural	Highway	Total
Trip distance (km)	32.7	29.0	28.9	90.9
Trip duration (min)	59.6	22.7	16.7	98.9
Avg. veh. Speed (km/h)	32.9	76.6	104.1	

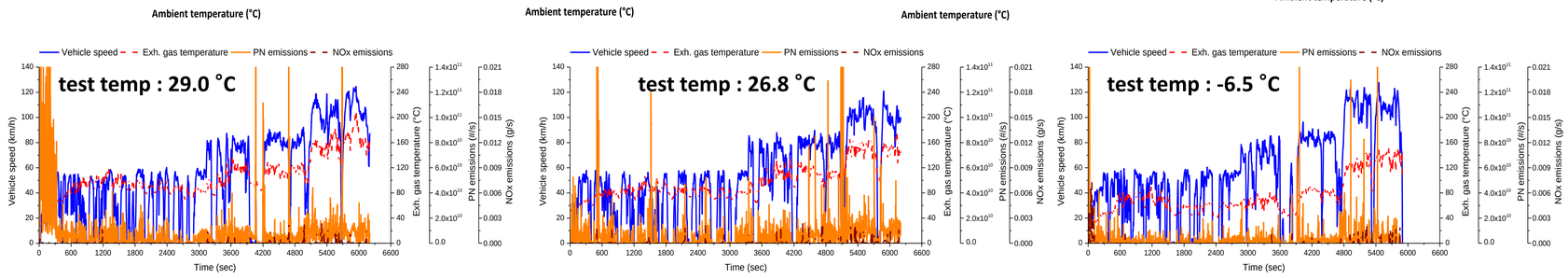
※ Correlation test from test vehicles



		CVS	PEMS	Diff (%)	Diff (abs)
Veh. 01	FTP - 75	6.51×10^{11}	9.20×10^{11}	29.2	2.69×10^{11}
	WLTC	5.62×10^{11}	6.92×10^{11}	18.8	1.30×10^{11}
Veh. 02	NEDC	1.02×10^{08}	2.05×10^{09}	95.0	1.95×10^{09}
	WLTC	5.61×10^{09}	8.05×10^{09}	30.3	2.44×10^{09}

※ Results of RDE test for gasoline vehicle





※ Results of RDE test for diesel vehicle