GRPE/WHDC/FE22

Effect of FAME on Exhaust Emissions of Engines with NOx After-Treatment Devices

(Interim report of Japan Auto-oil Program (JATOP))

Prepared for Oct. 15 2008
GRPE-WHDC-WG Beijing

JASIC

Background

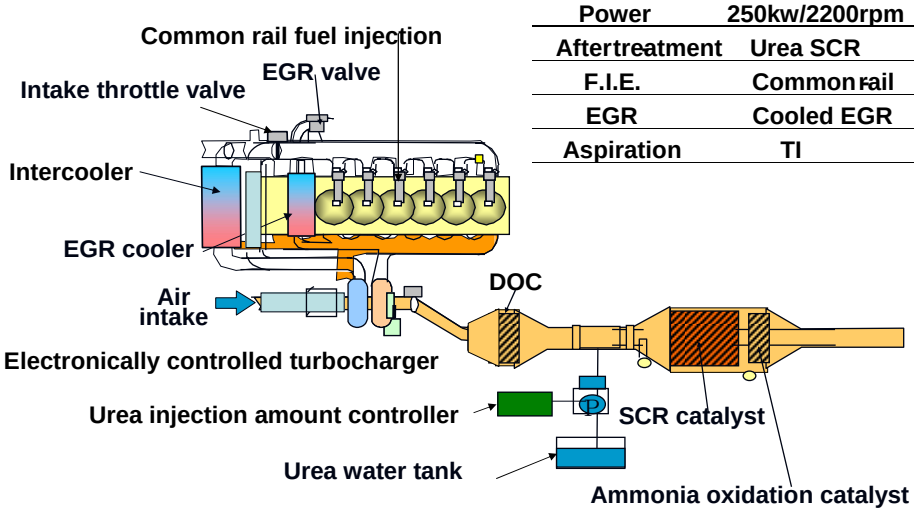
- From year 2007 a new auto-oil program named JATOP started in Japan, promoted by Japan Petroleum Energy Center (JPEC).
- In this program, effects of bio-fuel on the performance of diesel engines and vehicles equipped with two types of diesel NOx emission after-treatment devices, a Urea-SCR system and a NOx storage reduction (NSR) catalyst system, will be examined.
- 3 kinds of FAME (Soy bean, Rape seed, Palm) with 3 blending ratio (5,10,20%)matrix are used for test fuel.
- The program adopt statistical approach as EPEFE to assure data quality.

Data Quality

- Each of the fuels would normally be tested four times in each vehicle, to be conducted as two pairs of "back-to-back" tests. Each such pair would be regarded as one "true repeat", giving us two true repeats for each fuel in each vehicle.
- In each experiment, the true repeats were arranged into two blocks of size with each fuel appearing once within each block. The fuels were tested in different random orders within each block and different randomizations were used for each vehicle.
- Additional tests were conducted using a standard "quality control" fuel which did not form part of the main test matrices. This fuel was tested to ensure that the test procedure was working correctly, and subsequently to help monitor the data for systematic effects and correct it where necessary.

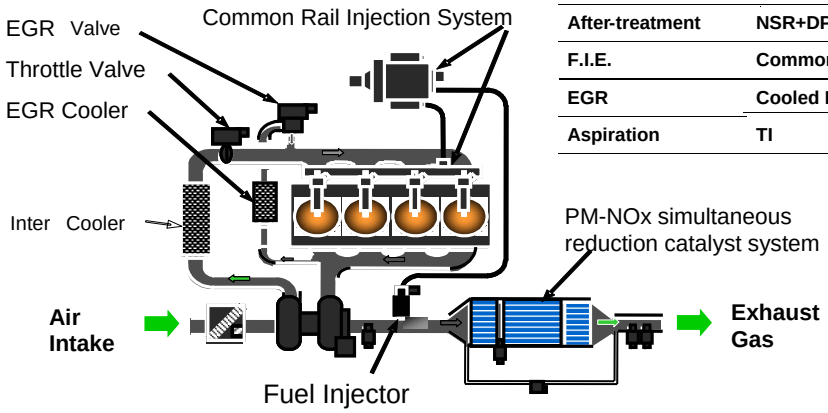
Urea-SCR System Configuration (w/o DPF)

Type of Engine	In- line 6
Displacement	9.2L
Power	250kw/2200rpm
Aftertreatment	Urea SCR
F.I.E.	Common rail
EGR	Cooled EGR
Aspiration	TI



DPF+NSR System Configuration

Type of Engine	**In-line 4**
Displacement	**4.0L**
Power	**110kw/3000rpm**
After-treatment	**NSR+DPF**
F.I.E.	**Common-rail**
EGR	**Cooled EGR**
Aspiration	**TI**



FAME Test Fuel Properties

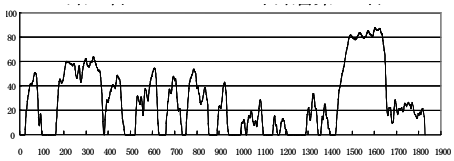
		Base	SME	RME	PME
Density	**gr/cm3**	**0.826**	**0.885**	**0.884**	**0.875**
Distillation ℃	**10%**	**207**			
	50%	**286**			
	90%	**341**	**357**	**363**	**351**
Aromatics cont.	**vol%**	**17.6**			
Sulfur cont.	**mass ppm**	**6**	**<3**	**<3**	**<3**
Cetane Number		**57.5**	**52.8**	**54**	**64**
Cetane index		**59.7**			

Base; Japanese JIS No.2 Diesel Fuel
SME; Soy bean Methyl Ester
RME; Rape seed Methyl Ester
PME; Palm Methyl Ester

Test Condition

- **Japan JE05 test cycle (transient)**

Vehicle Speed (km/Hr)



Time (sec)

Average speed; 27.6km/h

Vehicle speed are transformed to engine speed and load.

- **Steady-State test cycle**

  60% of maximum speed

  Exh. Temp. 400,300,250,180 deg.C

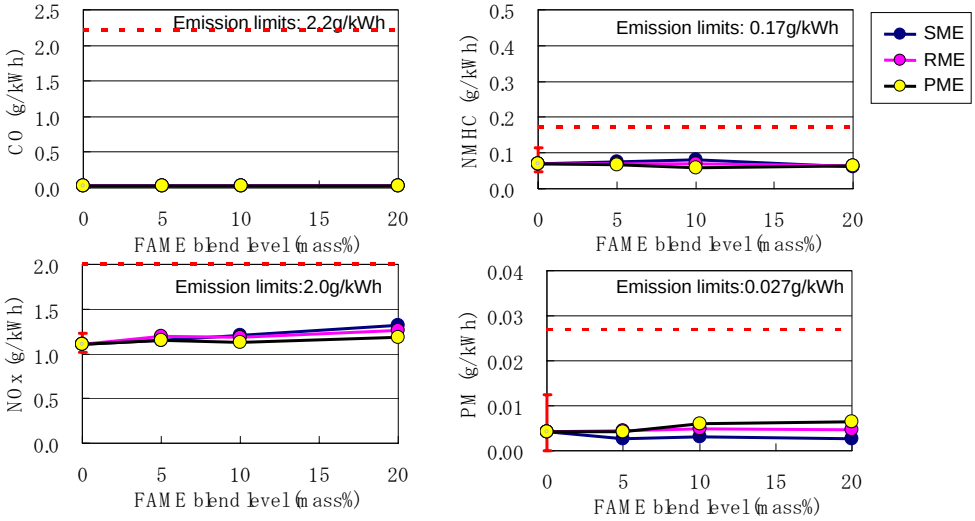
- **Measurement**

  NOx, PM (JE05 only), THC, CO, for both engine-out and post after-treatment (tail-pipe)

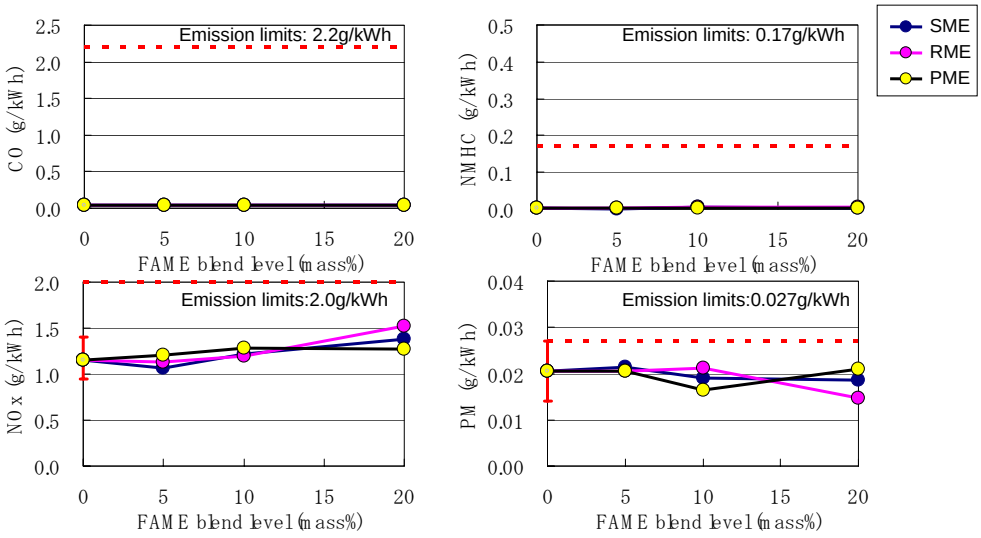
Interim Results

- The program is still under-way, and more detailed results with statistical data correction will be able to submit in Jan. 2009 GRPE meeting.

NSR+DPF Engine -JE05- (Tail-pipe data)

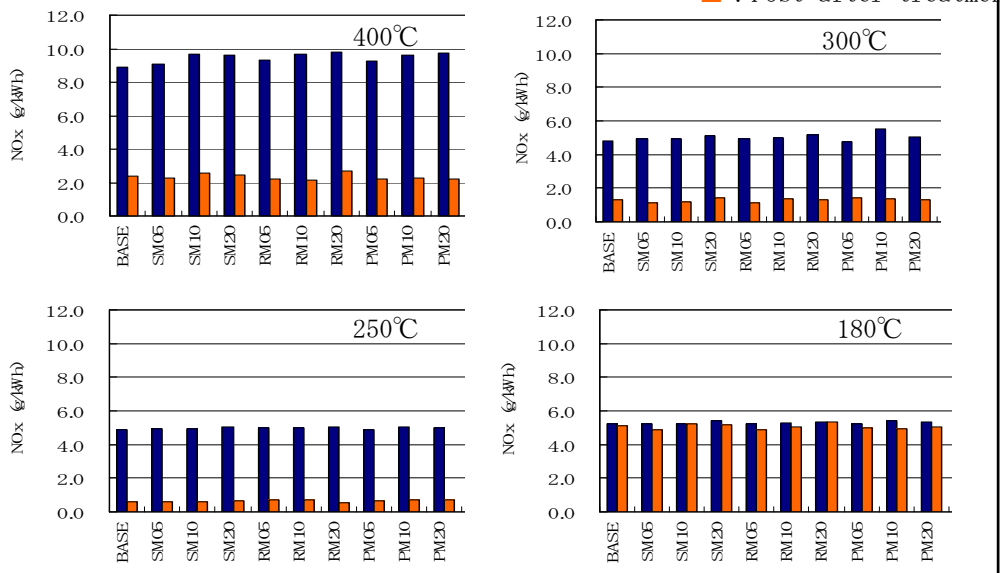


Urea SCR Engine -JE05- (Tail-pipe data)



Urea-SCR Engine -Steady State-NOx

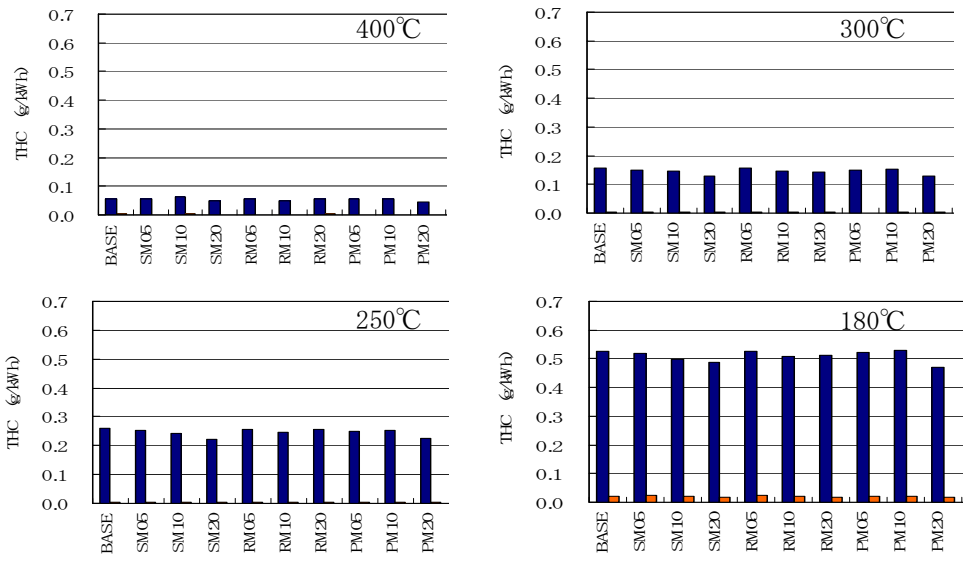
■ : Engine out
■ : Post after-treatmer



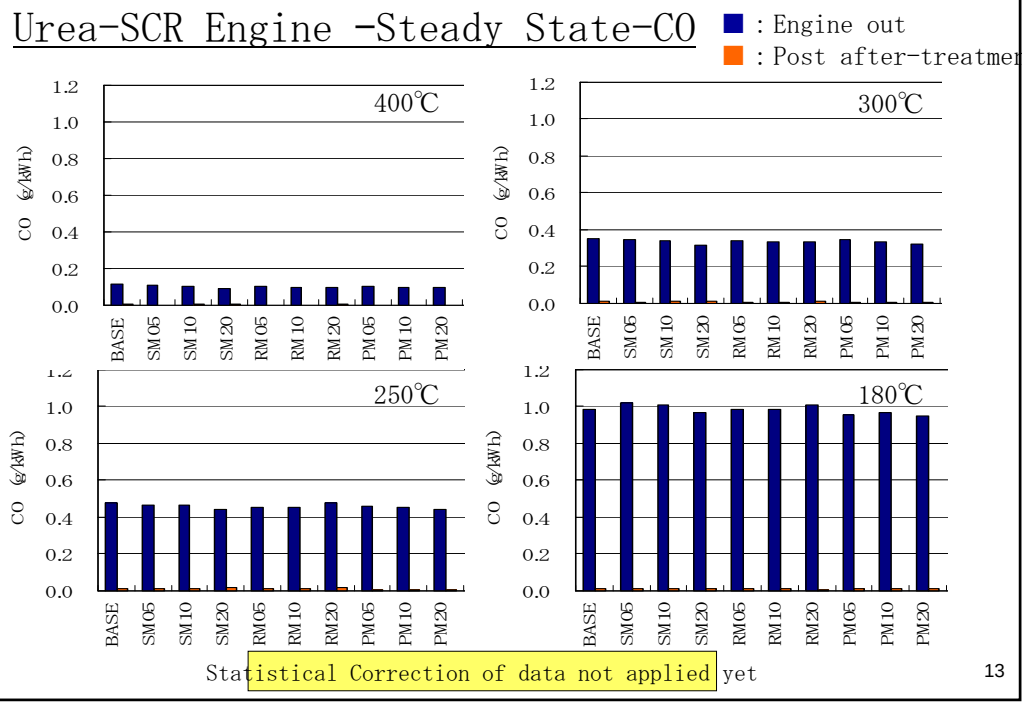
Statistical Correction of data not applied yet

Urea-SCR Engine -Steady State-THC

■ : Engine out
■ : Post after-treatmer



Statistical Correction of data not applied yet



Interim Results

- Concerning JE05 post-after-treatment (tail pipe) emissions, increasing FAME blending ratio increases NOx, and has small effects on THC, CO and PM for both NSR+DPF and Urea-SCR engine.
- NOx increase for 5% FAME blend is around 4~5% for both engines notwithstanding FAME materials.
- Concerning Urea-SCR engine steady-state gaseous emissions, increasing FAME blending ratio increases both engine out and post-after-treatment (tail pipe) NOx notwithstanding exhaust temperature. Increasing FAME blending ratio has small effects on THC and CO.
- In both JE05 and steady-state, there are small difference in exhaust emissions among the kind of FAME materials.