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JCAP Studies on retrofit of CR-DPF and Diesel particle size measurements

JCAP Studies on Retrofit of CR-DPF and Diesel Particle Size Measurement

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Summary

In Japan, auto industry and oil industry have been carrying out auto/oil program that is named JCAP(Japan Clean Air Program) with the support of government since 1997.

In the second step of this program (FY 1999-2001), the studies of on retrofit of CR-DPF(Continuous Regeneration-Diesel Particulate Filter)and the diesel particle size measurement was carried out.

This presentation shows the outline of JCAP organization, the result of CR-DPF retrofit study and trial measurement of particle size distribution.

From the study of retrofit of CR-DPF, the following results were obtained.

- Low sulfur diesel fuel is required to enhance the CRT/CSF performance.
- Concerning applicability of CR-DPF to vehicles in use
  There are few opportunities of application in the typical drive condition in the Tokyo urban areas, because exhaust gas temperature does not reach the regenerating temperature.
  On the other hand, some opportunities can be found in the vehicles that run under the high exhaust temperature conditions.

From the trial measurement of the diesel particle size distribution, the following results were obtained.

- CR-DPF reduces PM number concentration during transient mode simulating Tokyo metropolitan
- It is not clear whether PM number concentration was measured accurately in the range of ultrafine particles. Further study is necessary.

JCAP Studies on Retrofit of CR-DPF and Diesel Particle Size Measurement

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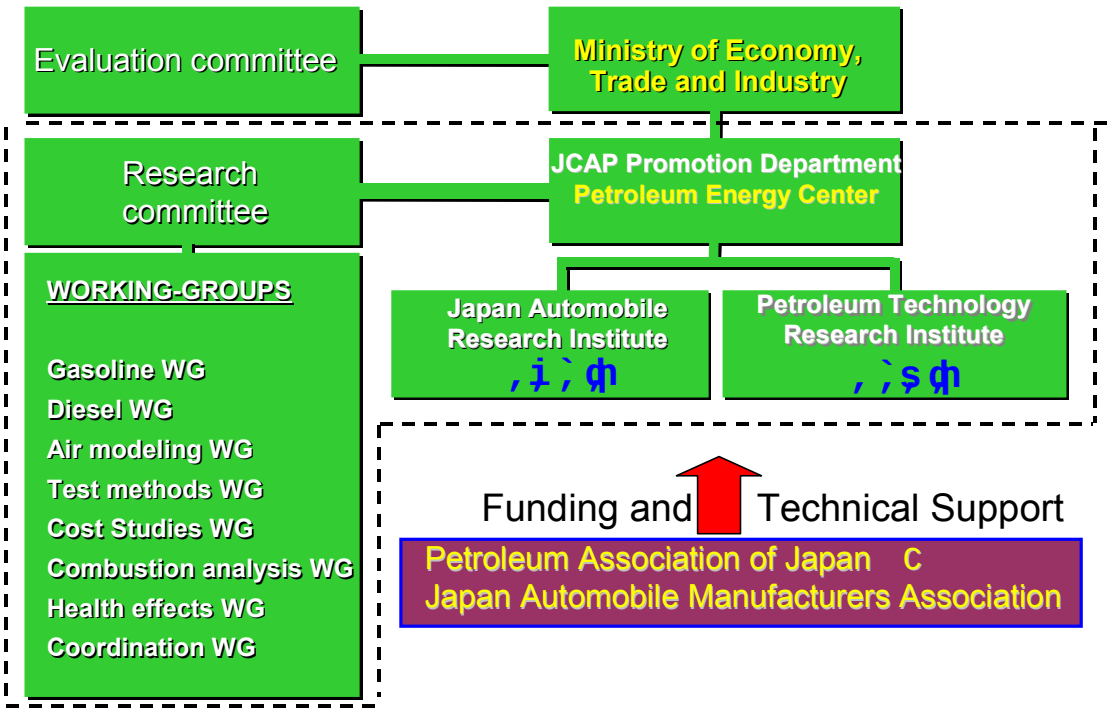
- **What's JCAP?**
- **Retrofit of CR-DPF**
- **PM Size Measurement**

What's JCAP

- Japan Clean Air Program
- Government/Oil Industry/Auto Industry collaborative Program
- 5 Years @50milion $ @
- Primary program finishes 2002/March

JCAP Organization



Retrofit DPF Study

Engine Used for Test

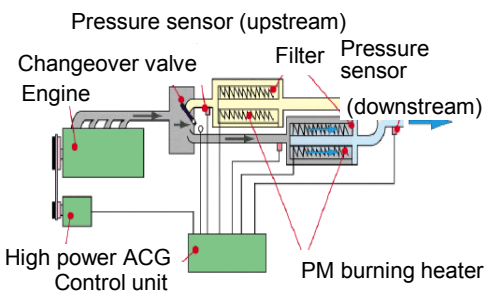
Regulation	Year 1989 reg.	Short term reg.	Long term reg.
Model/Year	1989	1994	1999
Displacement	,PPPSXƒƒ	,XQORƒƒ	,UXQTƒƒ
@Power @ @ @	,PUU ς v	,PUQ ς v	,PVT ς v
@Torque @ @	,VUS m	,TUX m	,UUV m
@Feature	w/o turbocharger	w/o turbocharger	@w/ inter-cooler turbocharger electronic control

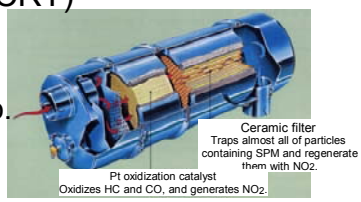
Diesel Fuel Used for Test

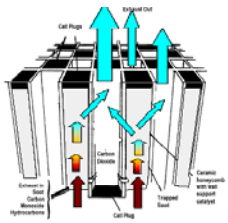
	Existing fuel	Low-sulfur fuel
Sulfur level	,SSR,,	,SU,,
Cetane number	,TV	,TX
90% distillation temperature	,RQT •	,RRS •
Density	,ODWRQ	,ODWRP

DPF Used for JCAP Test

Alternate regeneration Heat and burn by heater	Continuous regeneration
Alternate regeneration DPF made by Isuzu	CRT™ (CRT) made by Johnson Matthey Co.
	DPX™ (CSF) made by Engelhard Co.







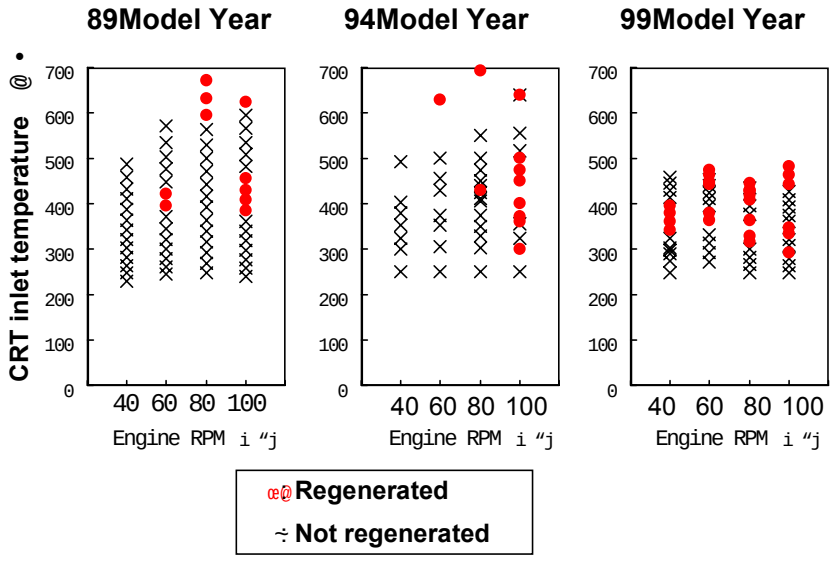
Collection efficiency

Sulfur in fuel (ppm)	DPF	Steady drive (D13 mode) Test engine 1989 &1994 model.	Steady drive (D13 mode) Test engine 1999 model	Urban drive (JARI transient test cycle) Test engine 1999 model
50	CRT	Over 95%	, ¥%	
	CSF		, X%	98%
500	CRT	40-70%	Increase	97%
	CSF			-
500	Alternate regeneration , ` , a	84%		97%

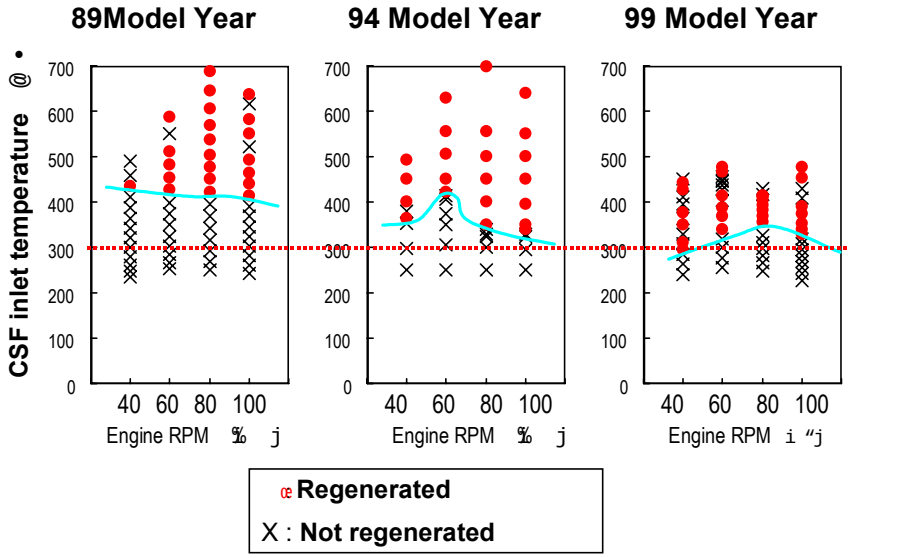
, `Cordierite honeycomb + heater (tested in JCAP STEP 1)
, aSiC fiber + heater

CRT Regeneration Temperature Range

(Sulfur level 50 ppm)

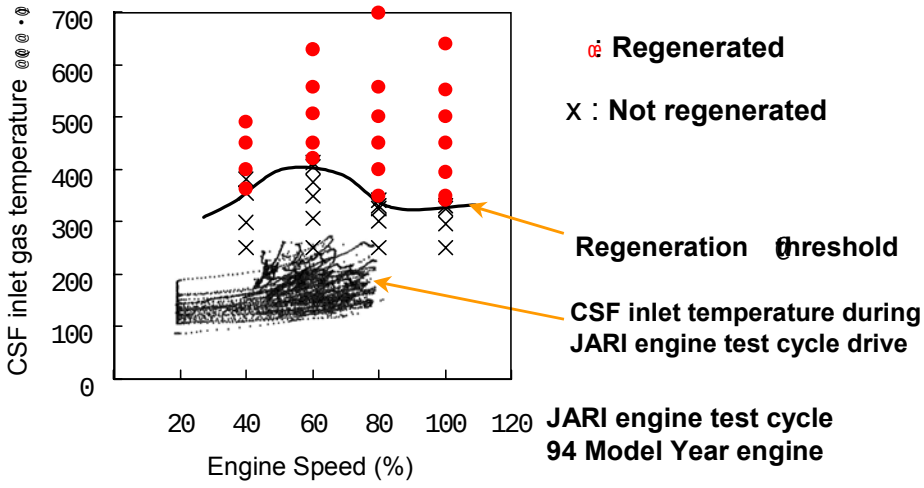


CSF Regeneration Temperature Range
(Sulfur level 50 ppm)



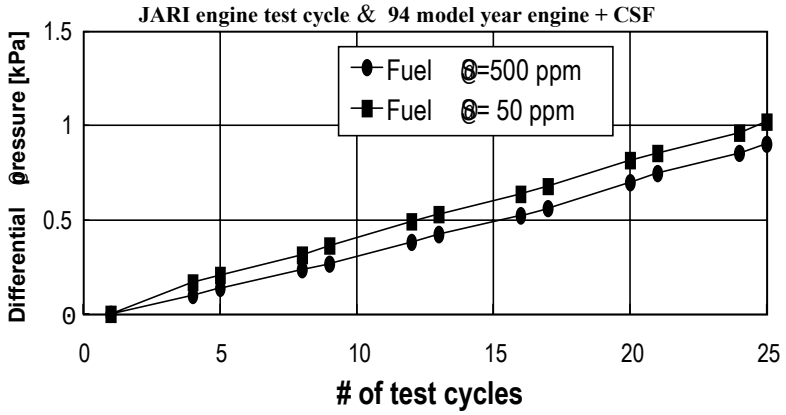
Does the Exhaust Temperature Reaches a Level That Causes CSF to Regenerate during a Drive in Urban Area?

In typical urban drives, the exhaust temperature does not reach the regeneration threshold.



When the Exhaust Temperature Does Not Reach the Regeneration Threshold, Does PM accumulate in CSF?

Result of engine test equivalent to 300 km drive
- **The differential pressure before and after CSF continuously increase**
- **(Indicates PM accumulation)**



Summary of Regeneration Performance

Mode	Engine	,þqs	,þre
Steady drive mode	89 M/Year engine	Regeneration observed in some of mid-to-high speed RPM ranges	Regeneration observed in all ranges at exhaust temperature of more than 400 C
	94 M/Year engine		Regeneration zone in high RPM expanded wider than 1989 reg. Engines
	99 M/Year engine	Regeneration zone wider than 1989 reg. and short-term reg.	Regeneration zone expanded further than short-term reg. engine
Urban drive mode	94M/Year engine	No regeneration occurred in JARI engine test cycles	

Summary of Retrofit Study

1 Fuel requirements

- Low sulfur diesel fuel is needed to enhance the CRT/CSF performances.

2 Applicability to vehicles in use

- There are few opportunities of application in the typical drive conditions in the Tokyo urban areas.
- Some opportunities can be found in the vehicles that run under the conditions where the exhaust temperature is high.

PM Size Measurement

Trial Measurement of Diesel PM Size

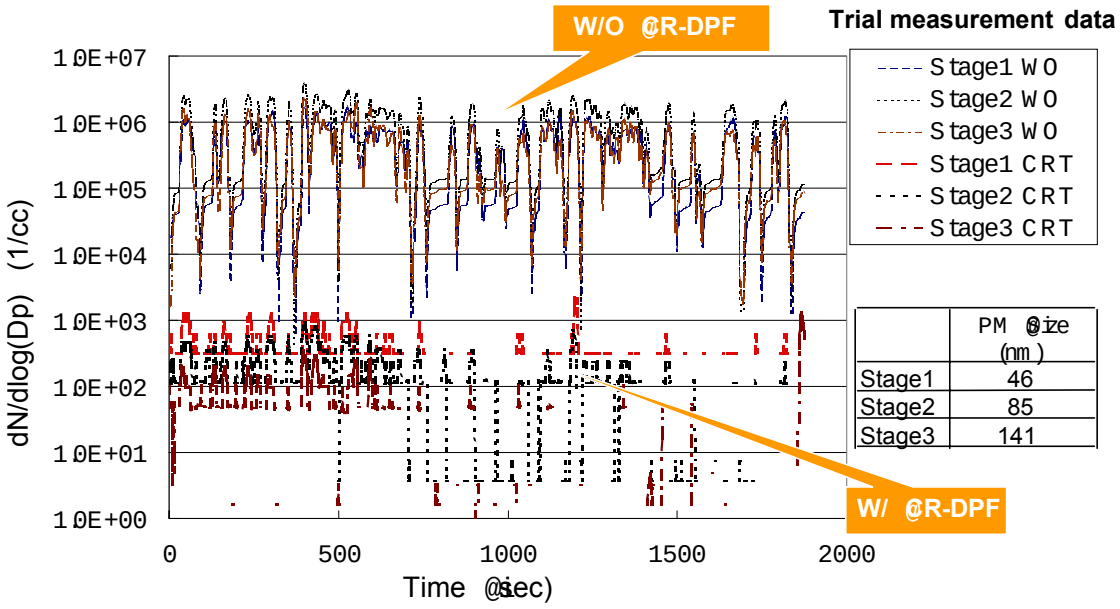
Using STEADY MODE and TRANSIENT MODE

ENGINE SPEC
- IN-LINE 4 CYLINDER DIESEL ENGINE
- DISPLACEMENT 6 9,k
- INTERCOOLER & TURBOCHARGER
- with and without CONTINUOUS
- REGENERATION-DPF

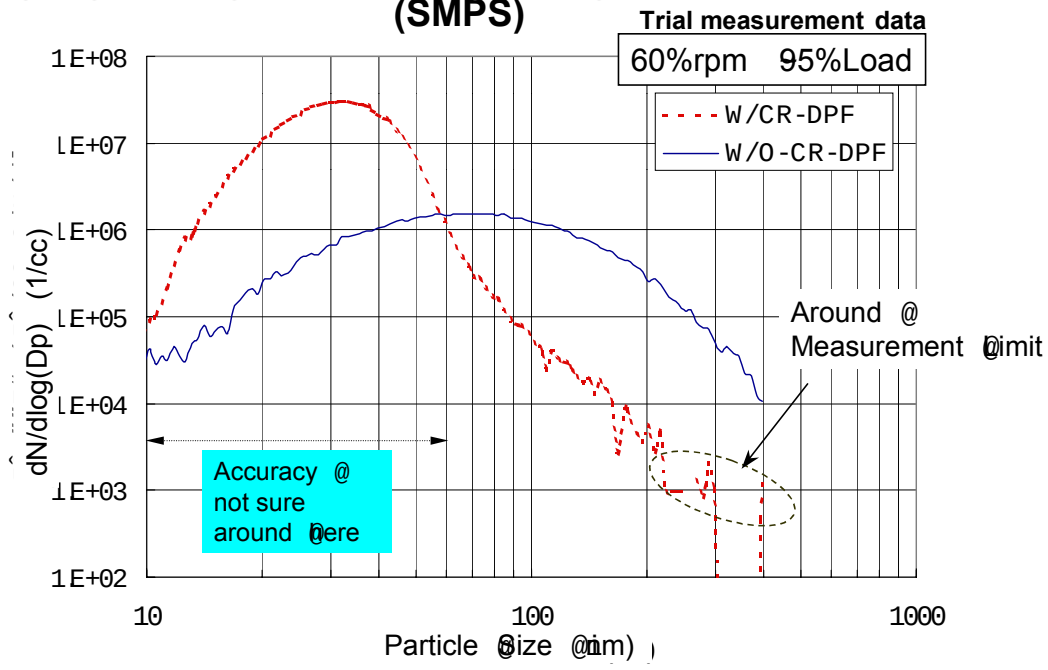
FUEL SPEC
- S 48 ppm

MEASUREMENT DEVICE
- SMPS
- ELPI

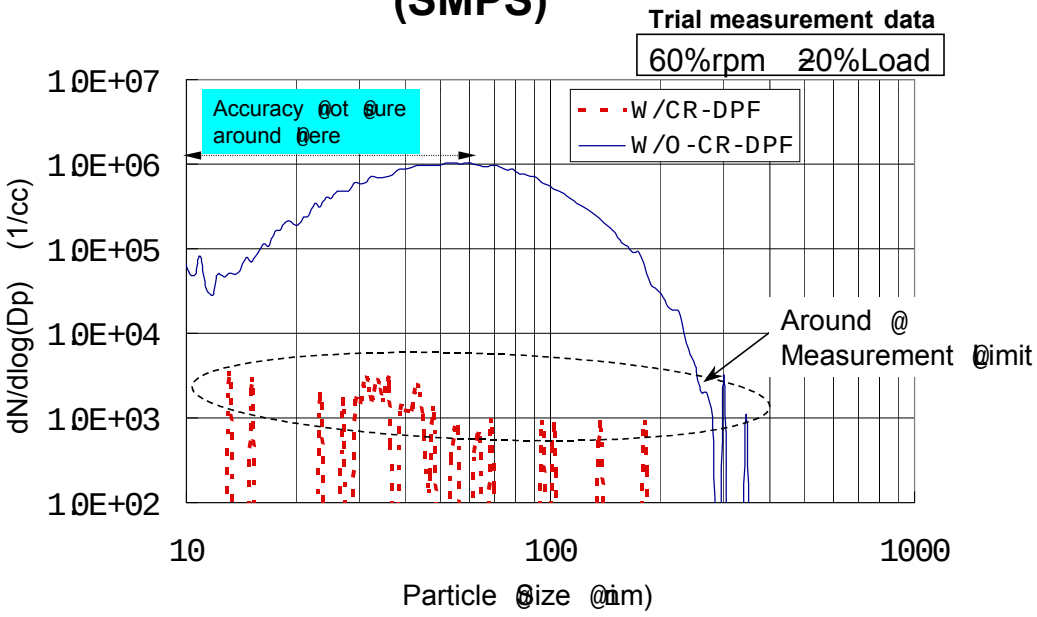
NUMBER of PM during TRANSIENT MODE @ ELPI j



PM SIZE DISTRIBUTION on STEADY MODE at HIGH EXHAUST GAS TEMPERATURE (SMPS)



PM SIZE DISTRIBUTION on STEADY MODE at LOW EXHAUST GAS TEMPERATURE (SMPS)



Summary of , ρ l Size Measurement

- CR-DPF educes PM umber oncentration during transient ode imulating okyo etropolitan D
- It s ot clear whether PM umber oncentration was measured accurately in the range of ultrafine particles.

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Next tudy

PM measurement is under discussion

- Accuracy of measurement n the ange of ultrafine particles
- The omposition of each PM ize

General Summary

1. Retrofit Study
   - Low sulfur diesel fuel is needed to enhance the CRT/CSF performances.
   - CRT/CSF hardly regenerate in the typical drive conditions in the Tokyo urban areas.
2. PM Size Measurement
   - The method is not established and needed to develop more.