

Introduction of Diesel Emission After-treatment System

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Topics

Outline of After-treatment Products

- 1. Oxidation Catalyst**
- 2. NO_x Reduction System**
- 3. NO_x – PM Reduction Components**
- 4. Continuously Regenerating DPF**
- 5. Active regenerating DPF**
- 6. R&D Facility**
- 7. R&D Network**

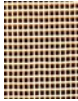


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After-treatment Components Outline

	Components	Description	Reduction Ratio	Sales
PM	DPF	Continuously Regenerating SiC Fiber Filter with Heating System	90%	10K Unit
	Oxidation Catalyst (1)	Metal Honeycomb Catalyst	60 ~40%	60K Unit
	Low Cost Oxidation Catalyst (2)	Precious Metal Less Honeycomb Catalyst	60 ~40%	Under Development
	Continuously Regenerating DPF	Continuously Regenerating By Special Catalyst	90 ~60%	On-road Vehicle Un-road Vehicle
NOx	Reduction Catalyst	Using supplemental fuel injection	40%	On-road Vehicle Un-road Vehicle
		NOx Adsorbent + Lean-Rich Components	50~40%	On-road Vehicle Un-road Vehicle
		Using Urea injection	60~40%	On-road Vehicle Un-road Vehicle

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1-1 Oxidation Catalyst

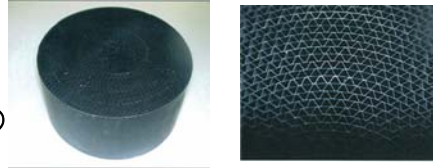
Material of catalyst	CH	MH	MH
			
Cell density(CPSI)	300	300	500
Surface(m ² /L)	2.4	3.3	4.1
Wall Thickness (mm)	0.2	0.03	0.03
Wash-coat Thickness(mm) Apparent	0.02	0.02	0.02
Density(g/cm ³)	0.6	0.44	0.56
Opening Area rate (%)	70	84	81
Pressure Loss (mmH ₂ O) *1	2.8	1.8	3.0
Heat Capacity (J/L · °C)	525	184	211

*1: SV: 60,000 h⁻¹ · Air: 125.3L/min (at *2: 1J/L=4.1865 Cal.=1055.056 BTU 273K) LV: 0.85m/sec

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1-2 Metal Honeycomb Standard Spec.

- Catalyst Substrate - Metal Honeycomb
- Substrate Material - Fe-Cr-Al Alloy
- Substrate Thickness - 30µm
- Cell Density - 500 CPSI (200~900CPSI)
- Catalyst - Pt,Pd, Others
- PM Reduction - More Than 40%



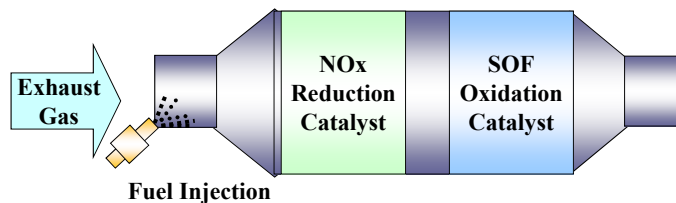
Type	A Outer Pipe OD(mm)	B Length Length(mm)	C Catalyst Size Dia.(mm)	D Length (mm)	E Catalyst Volume Litter/pc
M15	124.8	140	121.8	120	1.40
M20	143.6	140	140.6	120	1.86
M25	160.2	140	157.2	120	2.33
M30	175.2	140	172.2	120	2.79
M35	189.0	140	186.0	120	3.26
M40	201.8	140	198.8	120	3.72
M50	225.2	140	222.2	120	4.65
M60	246.5	140	243.5	120	5.59
M70	266.0	140	263.0	120	6.52
M80	284.2	140	281.2	120	7.45



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2.1 NO_x Reduction System (Selective Reduction)

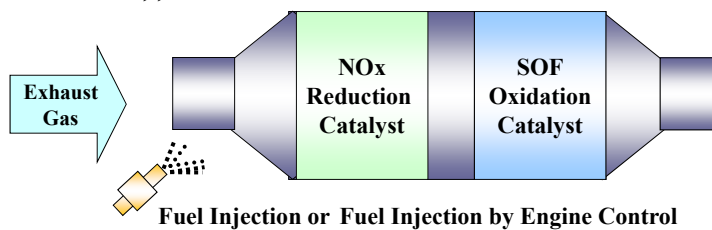
- Selective NO_x Reduction Catalyst by using reduction agent
- NO_x Reduction about 40%
(D13 , JE05 Japan Urban Transient Cycle)



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2-2 NO_x Reduction Catalyst (Adsorbent)

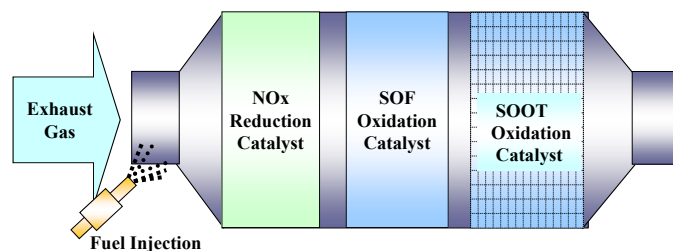
- O₂ in the exhaust gas is periodically reduced in rich air and N₂ is emitted.
- NO_x reduction more than 40% (D13, JE05(Tokyo Urban Driving Schedule))



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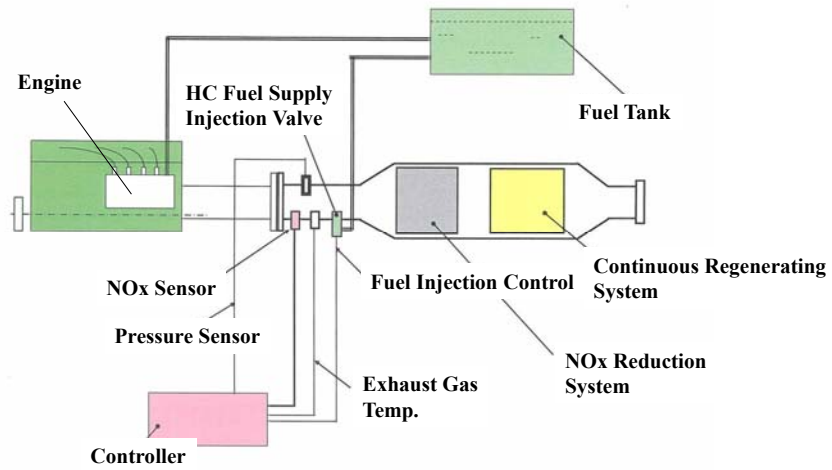
3-1 NO_x – PM Reduction Components (For Retrofit)

- Selective NO_x Reduction Catalyst by using fuel injection and Continuous regeneration DPF is combined.
- NO_x reduction more than 40%, PM reduction more than 70%(D13 Mode)



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3-2 NO_x-PM Reduction System



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3-3 NO_x PM Reduction System (Photo.)



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4.1 Continuously Regenerating DPF (Target)

- 1. Simple Structure**
- 2. Less Plugging**
- 3. Least Control Possible**
- 4. Easy to install**
- 5. Competitive Cost**

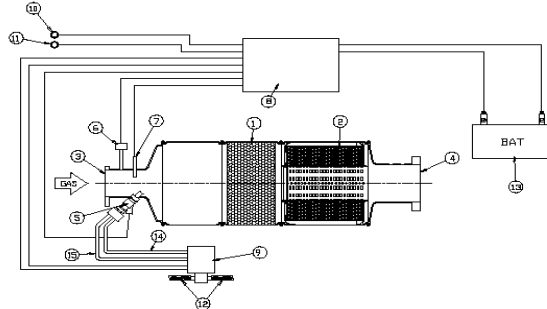
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4.2 Continuously Regenerating DPF (Feature)

- 1. Purifying SOF by Oxidation Catalyst**
- 2. Trapping and combusting soot by catalytic filter**
- 3. Coating catalyst on metal wire mesh filter**
- 4. No plugging by continuously low speed driving**
- 5. Increase Temperature in case of plugging**

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4.3 Continuously Regenerating DPF(Structure)



No.	Name	Function	Notice
1	SOF Oxidation Catalyst	Oxidize SOF	
2	PM Trapping/Combustion Catalyst	Trap PM and Continuously combust	Multi Plate Filters
3	Inlet Pipe	Inlet of Exhaust Gas, Install various sensors	
4	Outlet Pipe	Outlet of Exhaust Gas, Install various sensors	
5	Fuel Injection Nozzle	Spray diesel fuel as NOx reduction agent	
6	Pressure Sensor	Measure Pressure of Exhaust Gas at Inlet Pipe	
7	Temperature Sensor 1	Measure temperature of Exhaust Gas at inlet pipe	
8	Electronic Control Unit	Control system	
9	Fuel Supply Device	Separate fuel to supply to reduction system	
10	LED 1 in Room	Indicate Operating status of system to a driver	
11	LED 2 in Room	Indicate Operating status of system to a driver	
12	Fuel Supply Hose	Hose for Fuel Supply to vehicle	
13	Vehicle Battery	Standard Vattery of Vehicle	
14	Supplemental Fuel Supply Pipe(Inlet)	Supply fuel to Fuel Injection Device	
15	Supplemental Fuel Supply Pipe(Outlet)	Fuel return from Fuel Injection Device	

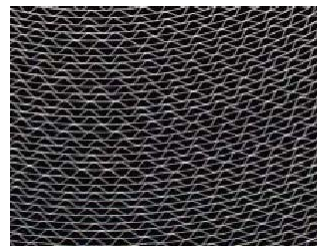
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4.4 Continuously Regenerating DPF

-Photo. of DOC -

Metal honeycomb based on high heat resistant stainless steel

High performance and compact using 500 cpsi



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4.4 Continuously Regenerating DPF -Photo. of Filter -

High heat resistant metal wire
Special catalyst coating on wire-mesh surface



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4.5 Continuously Regenerating DPF

	1 Series	2 Series	3 Series	4 Series
Applicable Displacement (L)	20 - 11	15 - 7	11 - 4	5 - 2
Applicable Loading Weight & Vehicle	Over 10 t Truck	10t Truck	Over 4t Truck	2,3t Truck
Weight Increase (kg)	Equivalent to silencer	←	←	←
Electric Power (W)	50	50	50	50

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4.6 Continuously Regenerating DPF

PM reduction 60% to 90% upon application

**Adjust volume and density of wire mesh filter
Adjust volume and catalyst loading of
oxidation cat.**

No plugging by continuously driving under 300 °C

Increase temperature by fuel injection to combust soot

Low pressure loss

Equivalent to silencer

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5.1 Active regenerating DPF(Feature)

Wide range of application

Applicable to high sulfur fuel

**Usable in any driving condition such as
heavy traffic**

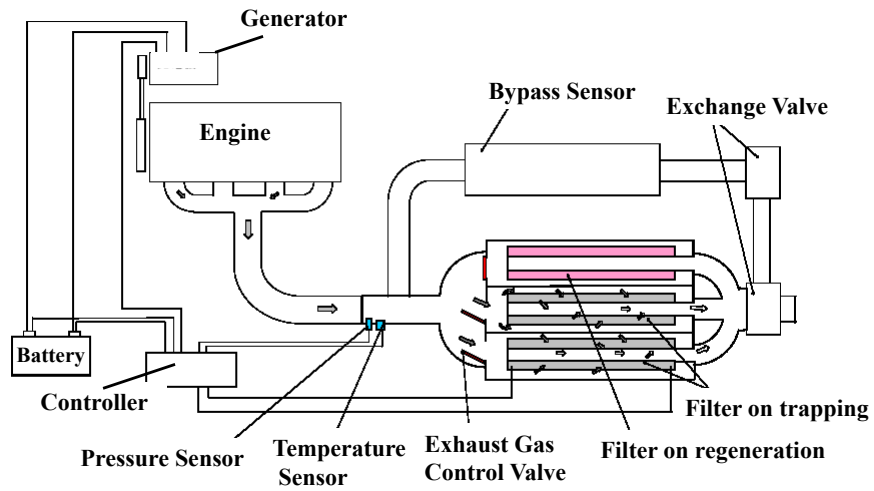
Light weight and compact

Most of all vehicle type can be applied

Compatible to the silencer

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5.2 Active regenerating DPF(Operation)



Bypass combined unit is also available

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5.3 Active regenerating DPF(Photo.)

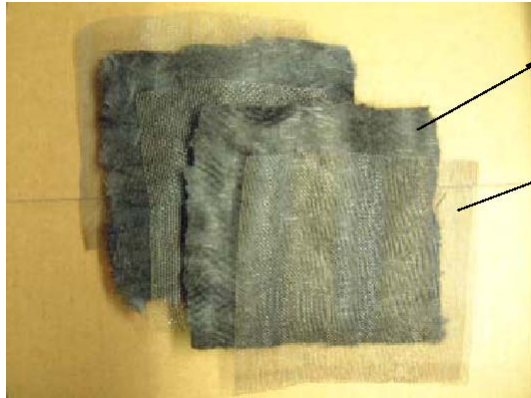


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5.4 Active regenerating DPF(Photo.)

**Filter with special metal mesh and SIC fiber
in 5 layers**

**Electricity is turned on the metal mesh
in the center layer**

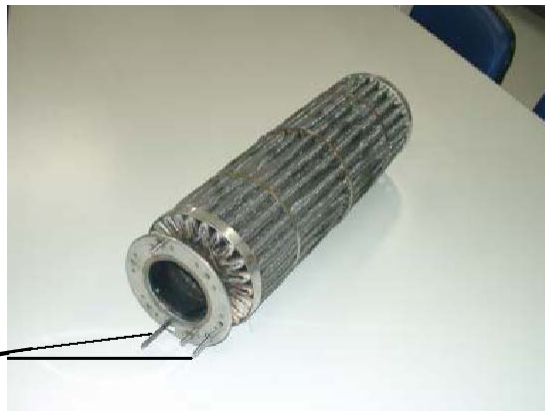


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5.5 Active regenerating DPF(Filter Photo.)

**5 layers of filter is formed like bellows
and packed in cylindrical shape.**

Gas goes in from outside to inside

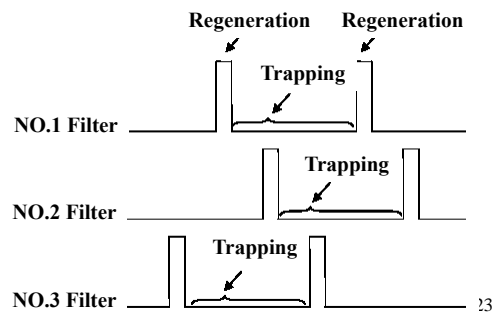


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5.6 Active Regenerating DPF (Filter structure and operation)

3 small filters put in parallel and packed in 1 cylindrical case so that bypass pipe is not necessary to be compact.

All filters keeps on trapping soot while taking frequent rest for regeneration so that filter can work effectively.



5.7 Active regenerating DPF(Series)

	1 Series	2 Series	3 Series	4 Series
Applicable Displacement (L)	20 - 11	15 - 7	11 - 4	5 - 2
Applicable Loading Weight & Vehicle	Over 10 t Truck	10t Truck	Over 4t Truck	2,3t Truck
Weight Increase (kg)	50	47	36	30
Electric Power (W)	1300	950	800	650

5.8 Active regeneration DPF (Installation on a city bus)

Installed on the position of silencer



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5.9 Active Regenerating DPF (Installation on a truck)

Installed on a 10t loading weight of truck



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5.10 Active Regenerating DPF (Vertical Installation)

Installed on a 2t loading weight of truck



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5.10 Active Regenerating DPF (Summary)

High PM reduction (more than 85%)

Fuel sulfur contents does not affect

**Trapping soot and regeneration
in any driving condition**

Urban area, Heavy Traffic, Highway etc.

Compact

Most of all vehicle type can be applied

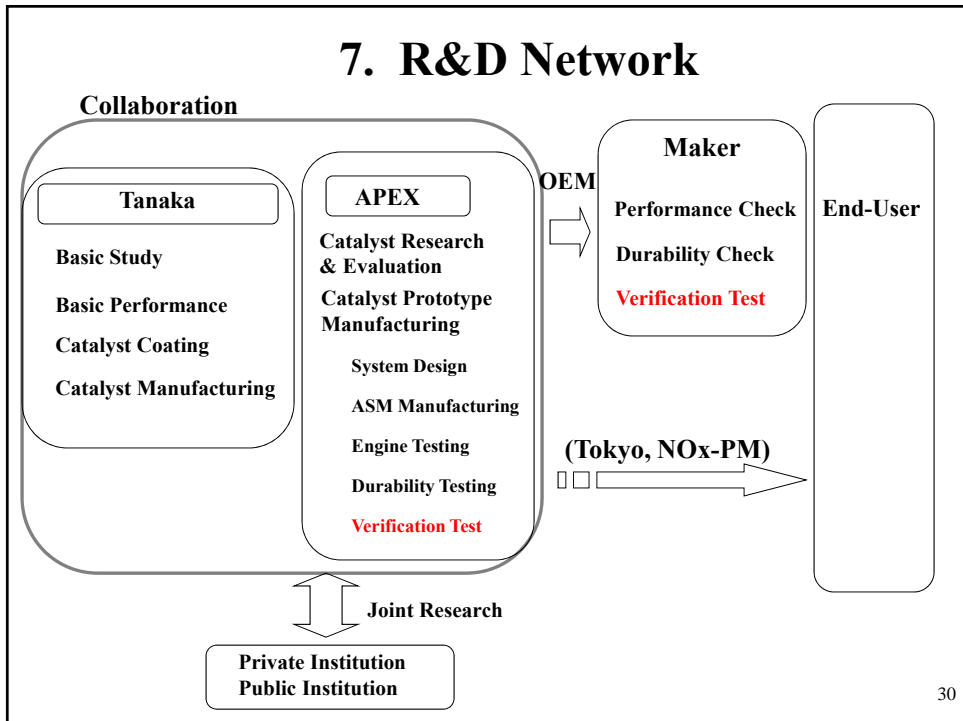
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6. R&D Facility

List of Equipment	Q'ty	Description
Components Performance Evaluation Equipment		
Engine Bench	5	~1000ps } Used for Verification By Japanese Gov't
Exhaust Gas Analyzer	5	
Micro Tunnel	4	
PM Continuous Measurement Equipment	1	SOF & SOOT Continuous Measurement
PM Analysis	1	SOF & SOOT Separation Measurement
Material Evaluation Equipment		
SEM(Scanning Electron Microscope)	1	Composition analysis on the micro area of surface
EPMA(Electron Probe Micro Analyzer)	1	Analysis of μm level of element distribution
TG/DTA	1	Check phenomena at different temperature (Separation, oxidation etc.)
ICP(Inductively Coupled Plasma Emission Spectrometer)	1	ppb~ppm Level of Trace Quantitative Analysis
X-Ray Diffraction Analyzer	1	Qualitative & Quantitative Crystal Compound (Organic & Inorganic)
Evaluation Equipment		
Universal Tester	1	Max. Load 200kN
Fatigue Tester	1	Max. Load 200kN, Max. Frequency 60Hz
Vibration Tester	1	Thermal Shock Addition(900°C RT Water Injection)
Noise Measurement Equipment	1	Noise Measurement For Silencer (Anechoic Chamber)

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7. R&D Network



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