SCR & DPF RETROFITS FOR MOBILE DIESEL ENGINES

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Diesel Emission Control Strategies Verification

This page updated January 20, 2004.

For information on how to submit an application for verification of a diesel emission control technology, please see the regulation at Go there

What's New...

- **1/20/05:** The ARB has verified the Extengine Transport Systems Advanced Diesel Emission Control (ADEC) system for 1991 to 1995 model year off-road Cummins 5.9-liter diesel engines from 150 to 200 horsepower, which are used in excavators, dozers, and loaders, all with rubber tires, and utility tractor rigs operating on standard CARB or ultra low sulfur diesel fuel. The ADEC system employs a diesel oxidation catalyst, selective catalytic reduction catalyst, and ammonia slip catalyst to achieve a 25 percent reduction in particulate matter emissions, qualifying it for a Level 1 verification. The system also achieves an 80 percent reduction in NOx emissions. Specific conditions for which the ADEC system has been approved may be found in the Executive Order which will be posted within 10 days.

Program Links

Background
Contact Information
Formal Regulatory Documents
Level 1 - Verified Technologies
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Verification Procedures
Alternative Diesel Fuels

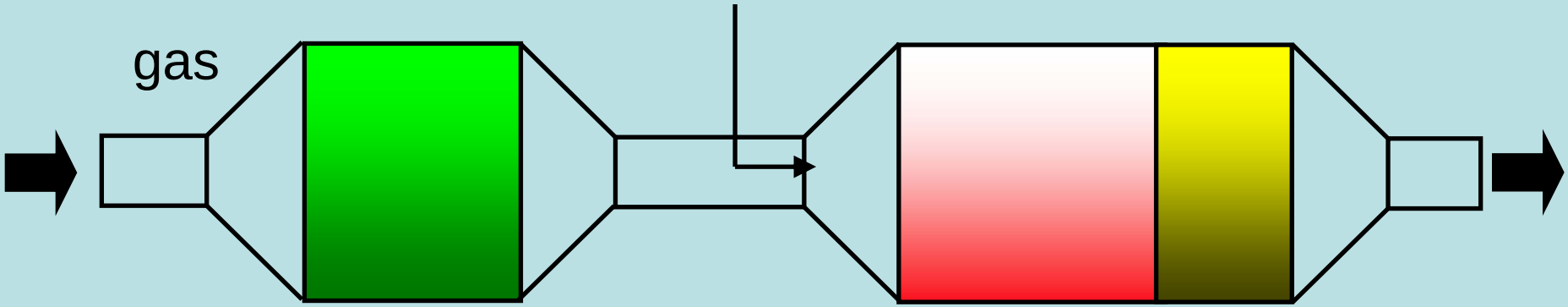
Principles of urea-SCR catalysts

Slip catalyst

$NH_3 + O_2 \rightarrow N_2$ & NO_x

Exhaust gas

Urea $(NH_2)_2CO$



$2NO + O_2 \rightarrow 2NO_2$

$4NH_3 + 4NO + O_2 \rightarrow 4N_2 + 6H_2O$

$2NH_3 + NO + NO_2 \rightarrow 2N_2 + 3H_2O$

$8NH_3 + 6NO_2 \rightarrow 7N_2 + 12H_2O$

Optimum: $NO/NO_2 = 1$

Engine out: $NO/NO_2 \approx 10$

Test results

Engine Certification Data (engine family)						
Emissions (g/bhp.hr)	**NMHC+NOx**	**PM**	**CO**	**NOx**	**NO2**	**CO2**
Diesel (3DDXH08.5FJB)	2.13	0.012	0.35	-----	-----	-----
CNG (3DDXH08.5FJG)	0.94	0.008	0.03	-----	-----	-----

Baseline Emission Tests (Engine is equipped with DPF)						
Emissions (g/bhp.hr)	**NMHC+NOx**	**PM**	**CO**	**NOx**	**NO2**	**CO2**
Hot start 1	2.95	0.01	0.26	2.95	0.69	755
Hot start 2	3.01	0.01	0.15	2.97	0.79	765
Hot start 3	2.81	0.01	0.17	2.77	0.73	743
Average Hot	2.92	0.01	0.19	2.90	0.74	754
Cold start	3.56	0.01	0.27	3.56	0.90	795
Composite Baseline	3.01	0.01	0.20	2.99	0.76	760

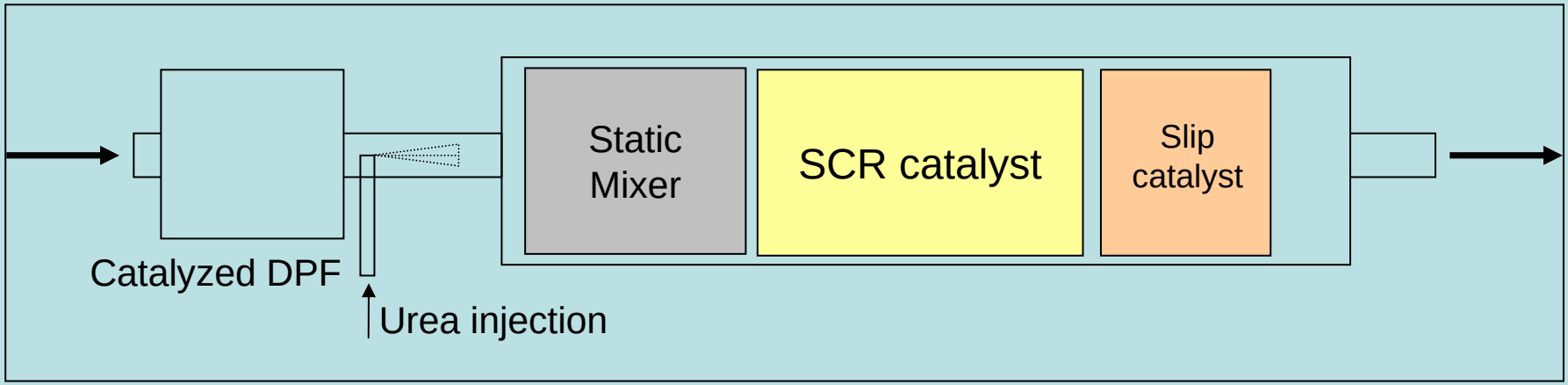
DPF with Urea SCR						
Emissions (g/bhp.hr)	**NMHC+NOx**	**PM**	**CO**	**NOx**	**NO2**	**CO2**
Hot start 1	1.06	0.01	0.43	1.06	0.25	746
Hot start 2	0.96	0.01	0.24	0.95	0.16	738
Hot start 3	0.99	0.01	0.27	0.99	0.24	740
Average Hot	1.00	0.01	0.31	1.00	0.22	741
Cold start	1.96	0.01	0.17	1.96	0.34	799
Composite Baseline	1.14	0.01	0.29	1.14	0.24	749
Conversion	62%	NC	-43%	62%	69%	1%

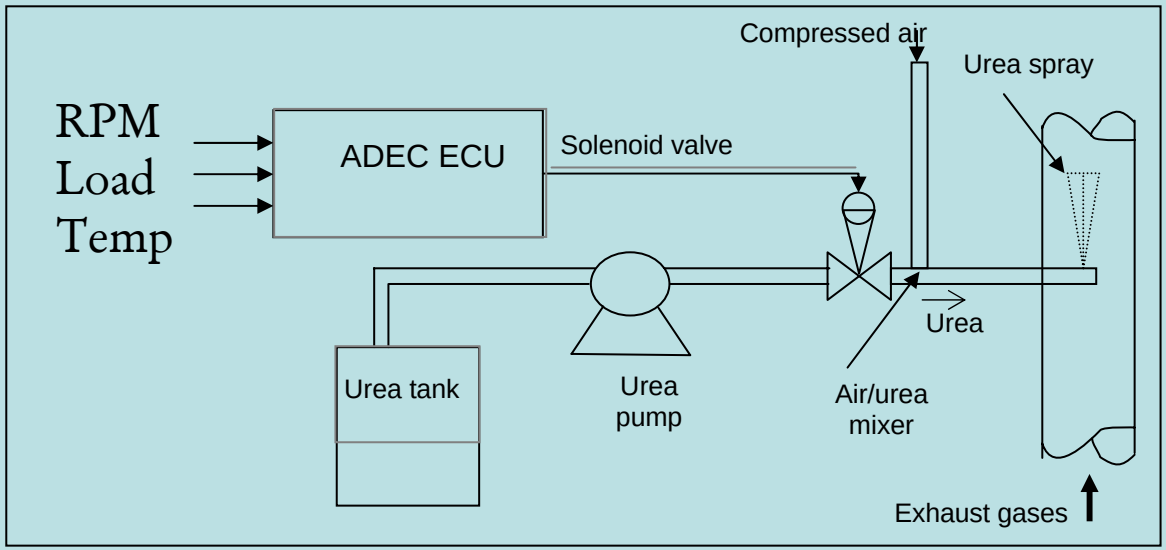
Test engine & catalyst data

- 2003 Detroit Diesel 50 – 8.5 L displacement
- Direct injection
- Engine certified @ PM = 0.01 g/bhp.hr (equipped with catalyzed diesel particulate filter)
- Turbocharged, charge air cooling, water-cooled EGR
- Rated 275 HP @ 2100 RPM

- Diesel particulate filter
  - Cordierite DPF catalyzed by Engelhard
  - Supplied by Detroit Diesel as certified system
- SCR catalyst
  - Metallic substrate catalyzed by Umicore
  - V based SCR catalyst
  - Diam 11.25” x 10”
- Slip catalyst
  - Metallic substrate catalyzed by Umicore
  - Diam 11.25” x 3”
- SCR & slip catalysts have been aged by 1000 hours
- Complete systems has run 25 hours prior to emission measurements

ADEC Generation II



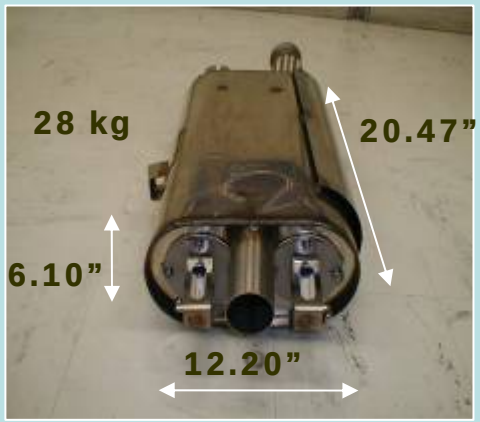


Urea dosing system supplied by Hilite International

Applications

MaxTRAP™ Active Diesel Particulate Filter

Mercedes-Benz Sprinter Active DPF



Dimension and weight of ExoClean™ design for Mercedes-Benz Sprinter application.

Temperature (°C)	Time %	Pressure (mbar)	Time %
< 200	97.25	< 100	95.76
200 - 250	1,64	100 - 148	3.56
250 - 340	0.90	148 - 300	0.68
340 – 400	0.17	300 - 400	0.00
400 - 450	0.04	400 - 500	0.00
> 450	0.01	> 500	0.00

Data from ExoClean™ field application on Mercedes-Benz Sprinter with commercial standard fuel (350ppm of Sulfur) for 1900 to 2000 hour field operation (fleet) with average speed 9.2 km/h.