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A New Active DPF System for “Stop-&-Go” Duty Cycle Vehicles

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Presentation Outline

- Introduction
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- Description of the Active DPF System
 -
- Refuse Trucks Retrofit Applications
 -
- Improvement in association with Fuel-Borne Catalyst
 -
- Conclusions
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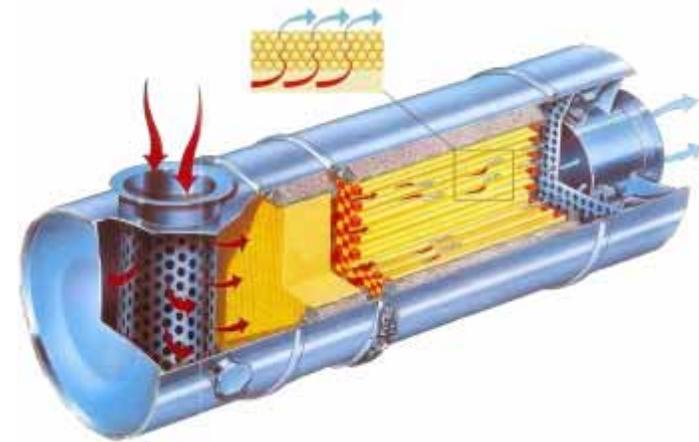
Real Need of DPF System for "Stop-&-Go" Cycles

Passive Catalyzed-DPF Systems were tested on refuse trucks from May 2001 to March 2003:

- AIRMEEX
- EMINOX (CRT®)
- ENGELHARD (DPX®)

a "Stop-&-Go" urban cycle:

- too low temperature for regeneration
- really dependant on the engine
- damage on the catalysts and filters



Rapid DPF damage with losing PM reduction efficiency

Source: Workshop on "Ecologic Refuse Trucks" 10/2003

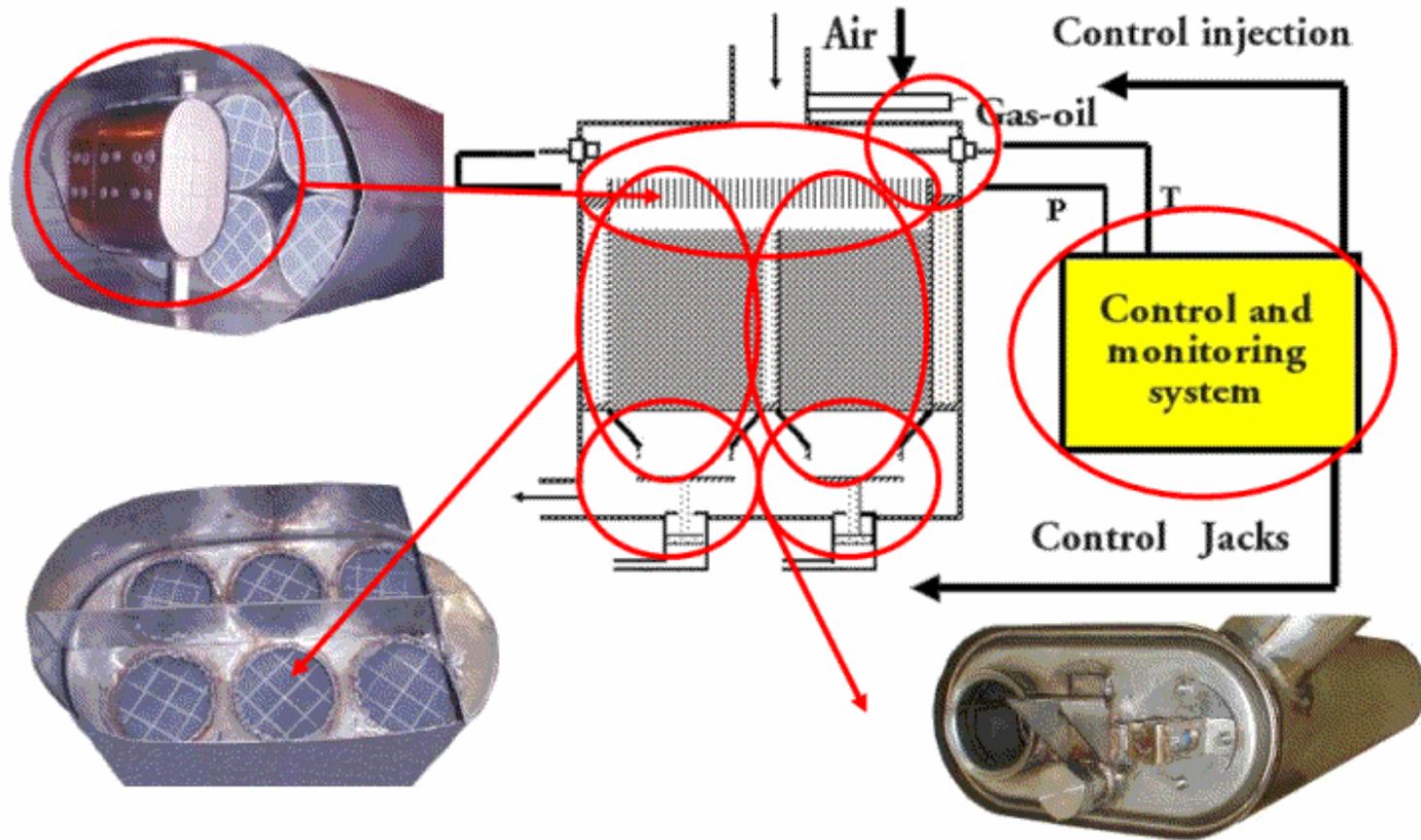


The Strategy of the DPF System

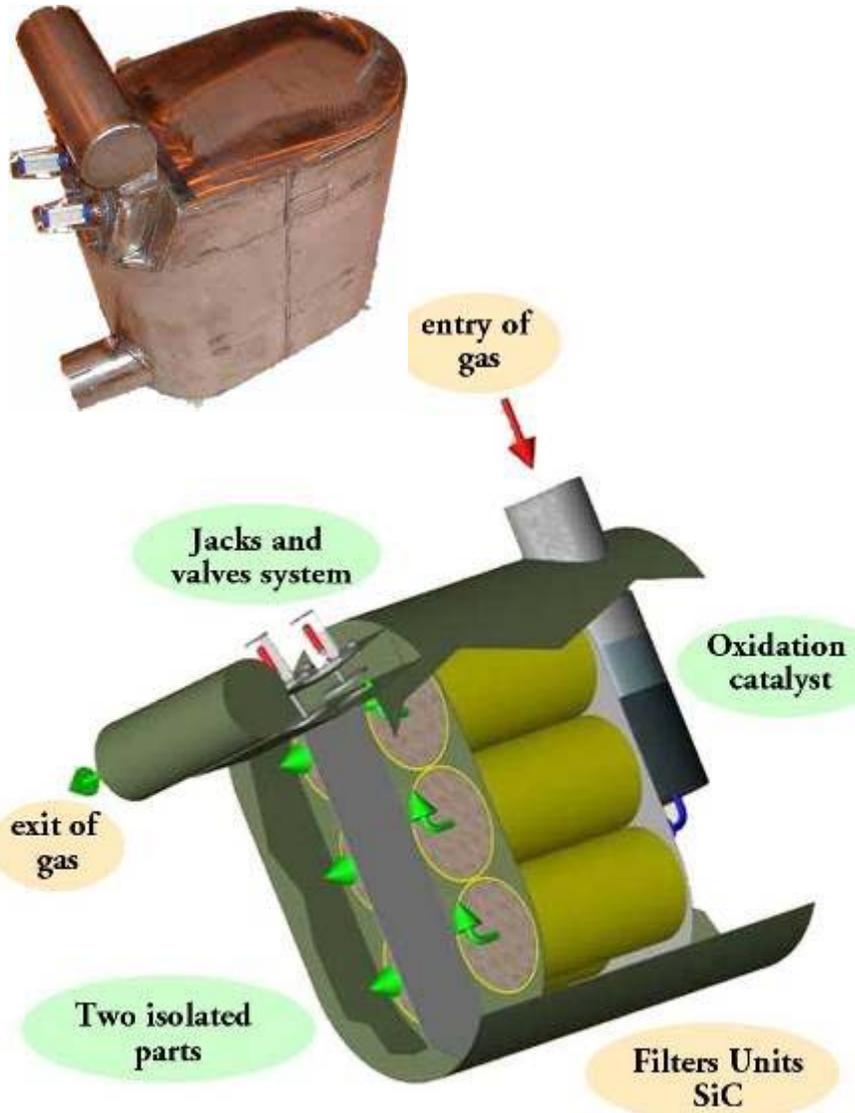
- To fit the “Stop-&-Go” Duty Cycle Requirements, a new Active DPF System was developed, to prevent risk of clogging and uncontrolled filter regenerations
- The Active DPF System is based on two main principles:
 - a variable volume of filtration;
 - a global thermal management:
 - *a thermal insulation*
 - *a catalytic combustion of hydrocarbons*
- The DPF System is applicable to Smoke nbr. $<2 \text{ m}^{-1}$:
EURO 1-3 vehicles and some EURO 0
- with high flexibility regarding the sulfur content in the fuels



Description of the Active DPF System



Management of Volume of Filtration

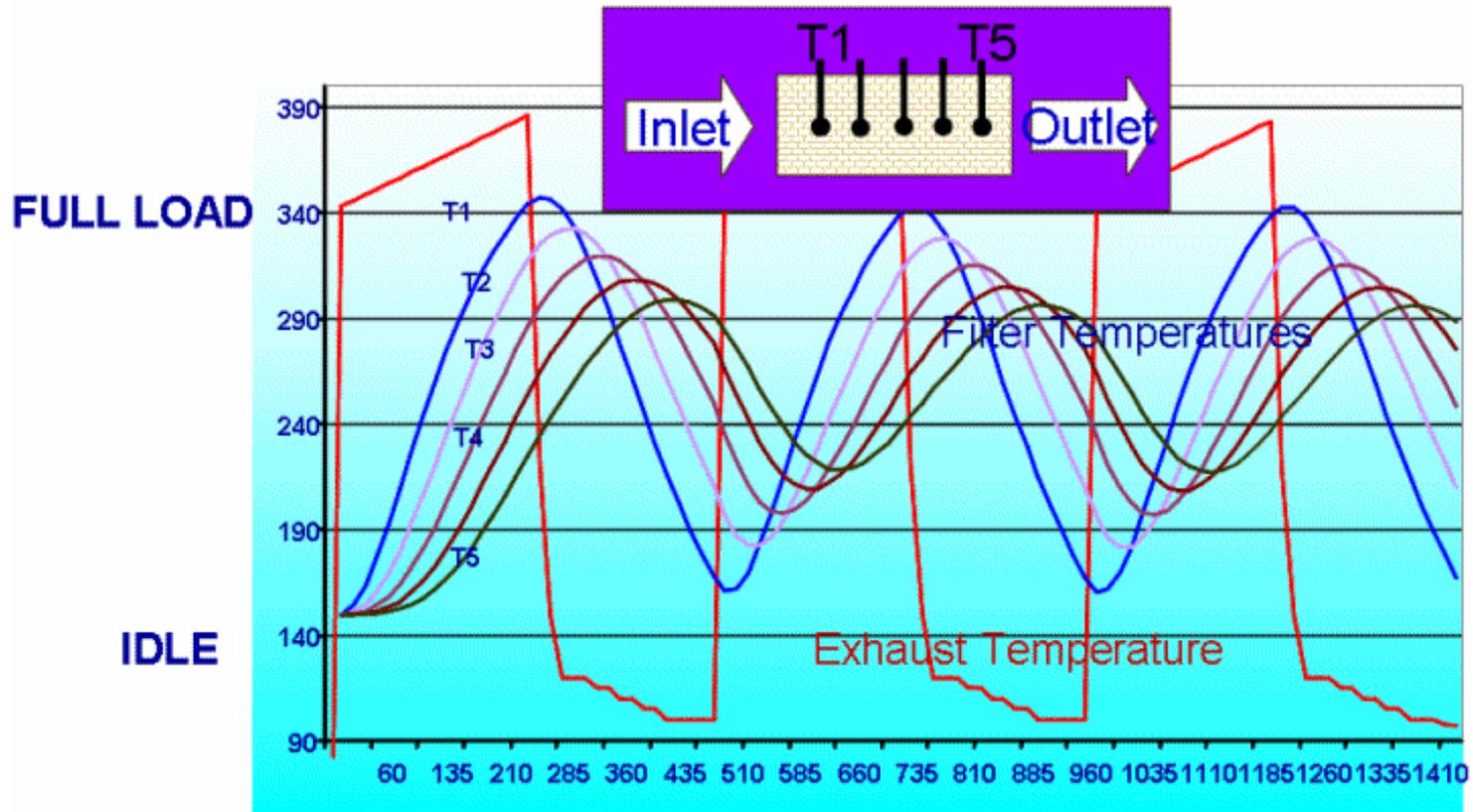


- Valves and actuators in order to isolate part of the volume of filtration (at idle or low load)
- 1/2 to 2/3 of filtration area is kept under higher temperature than 320°C
- slow but continuous soot combustion w/ Oxygen

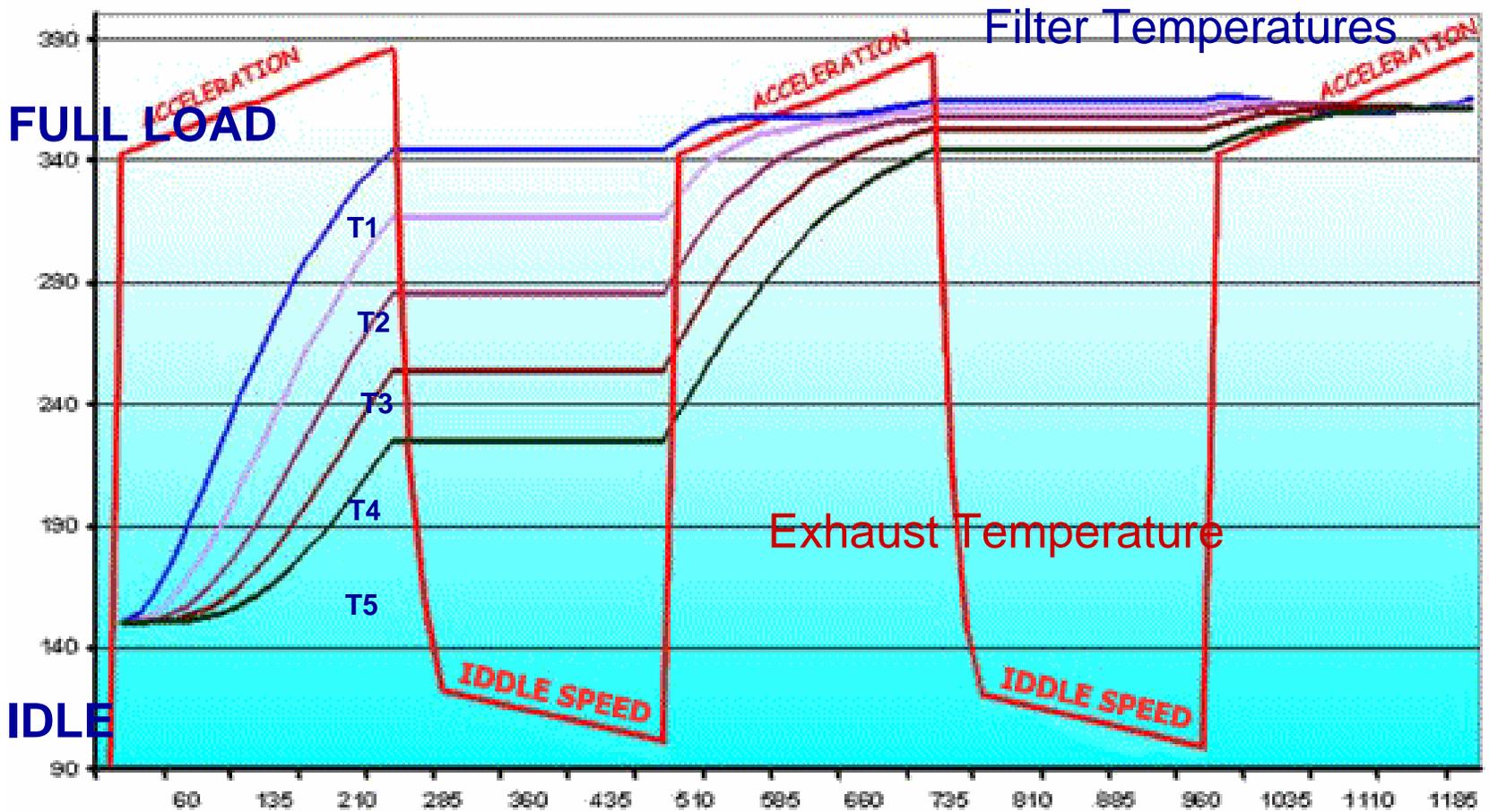


Typical Thermal Profile with Simple Trap

Cycle Simulating Refuse Truck Driving and Collection Phases



Valve Effect on Filter Thermal Profile



Performance and Field Tests

To demonstrate reliability, robustness, flexibility and durability, the Active DPF System was tested on different applications, such as urban buses and refuse trucks

Exhaust emission measurements were performed at the official UTAC facilities on :

- Refuse Trucks (w/ Veolia) under the national ADEME evaluation program (Retrofit applications)



Refuse Truck Retrofit Applications



- Renault Trucks Premium 62045 MIDS
- 20-tons Refuse Truck with EURO II calibration,
- fitted with 6 SiC filters units (20m² filtration area)
- placed in the existing muffler volume

Evaluation with Standard fuel (350ppm Sulfur) over a 12 months program

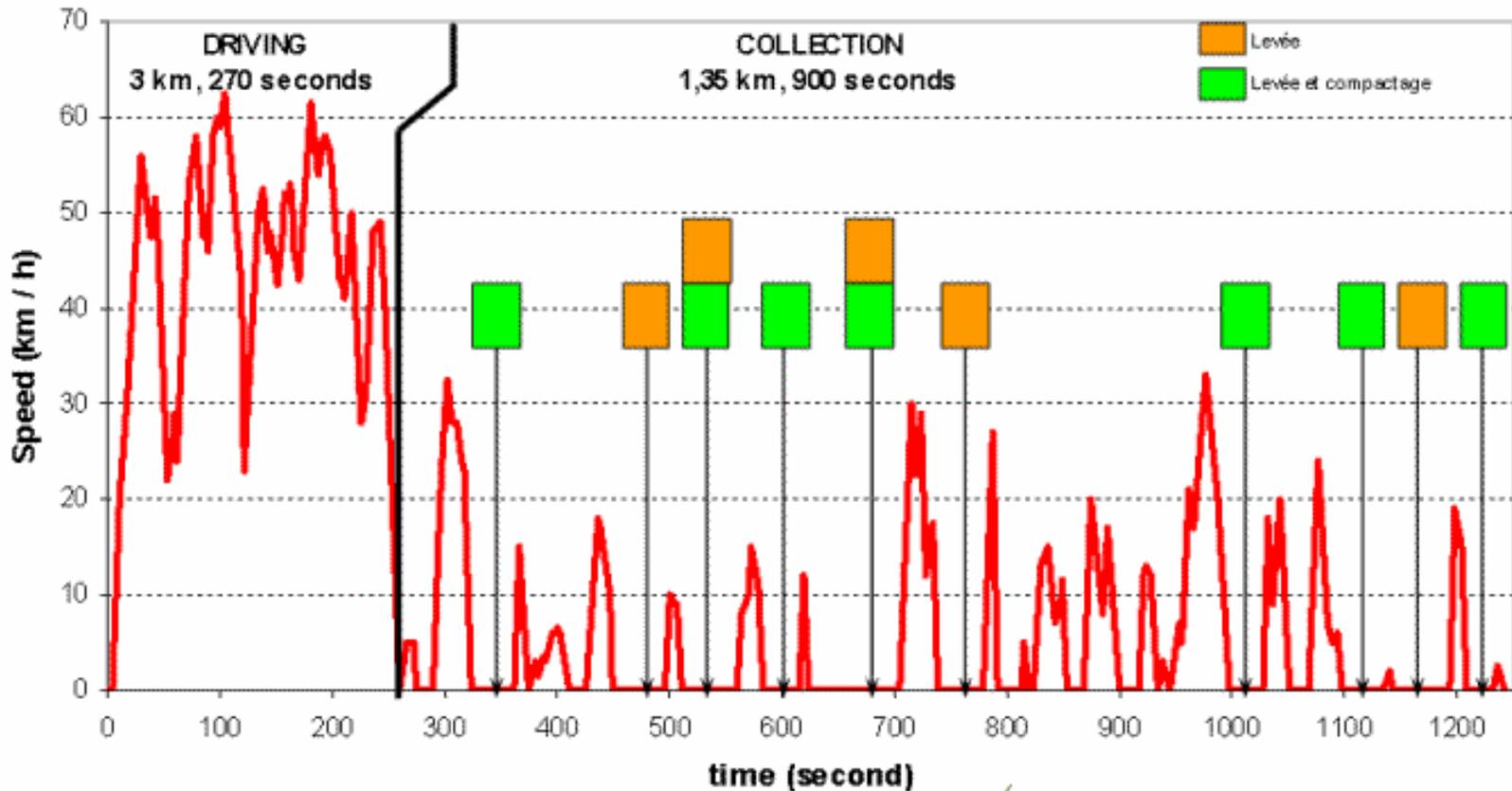


Source:

"The Ecologic Refuse Trucks: data and references" ADEME / 2003



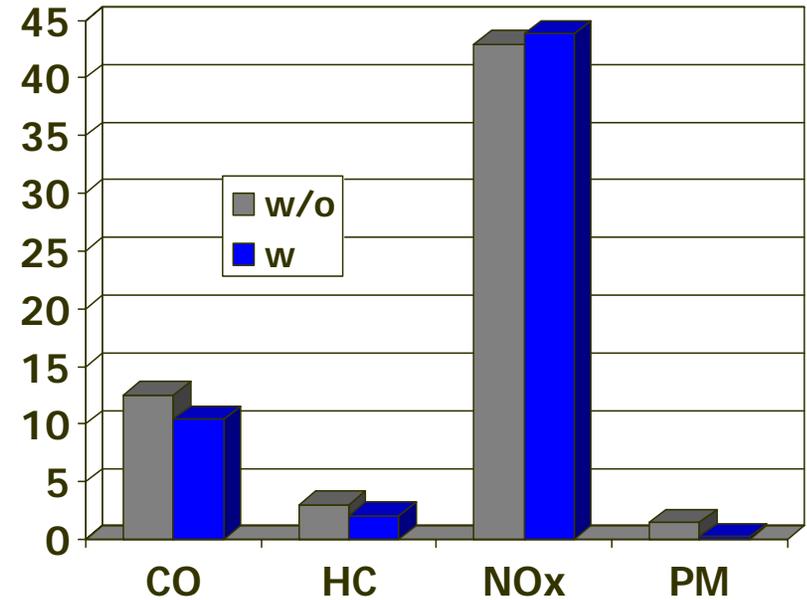
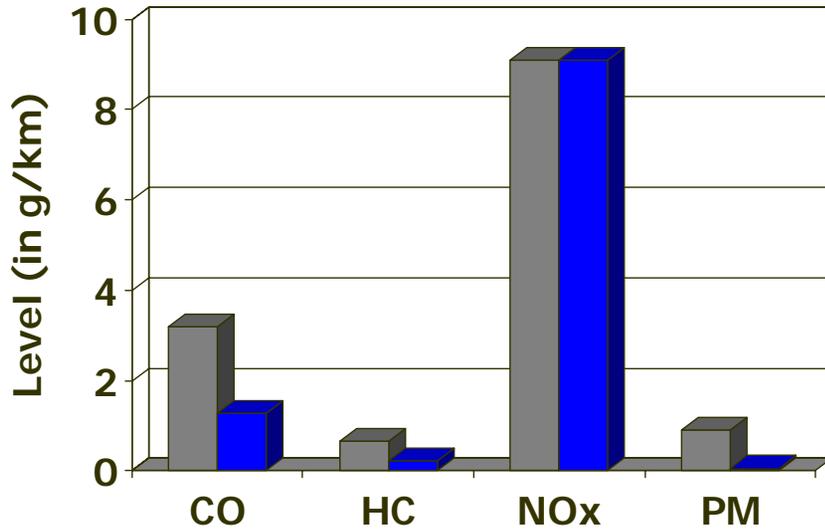
Representative "Refuse Truck" Duty Cycle



All the data will be given in g/km

Measurements based on 3 successive cycles

Efficiency of the DPF System



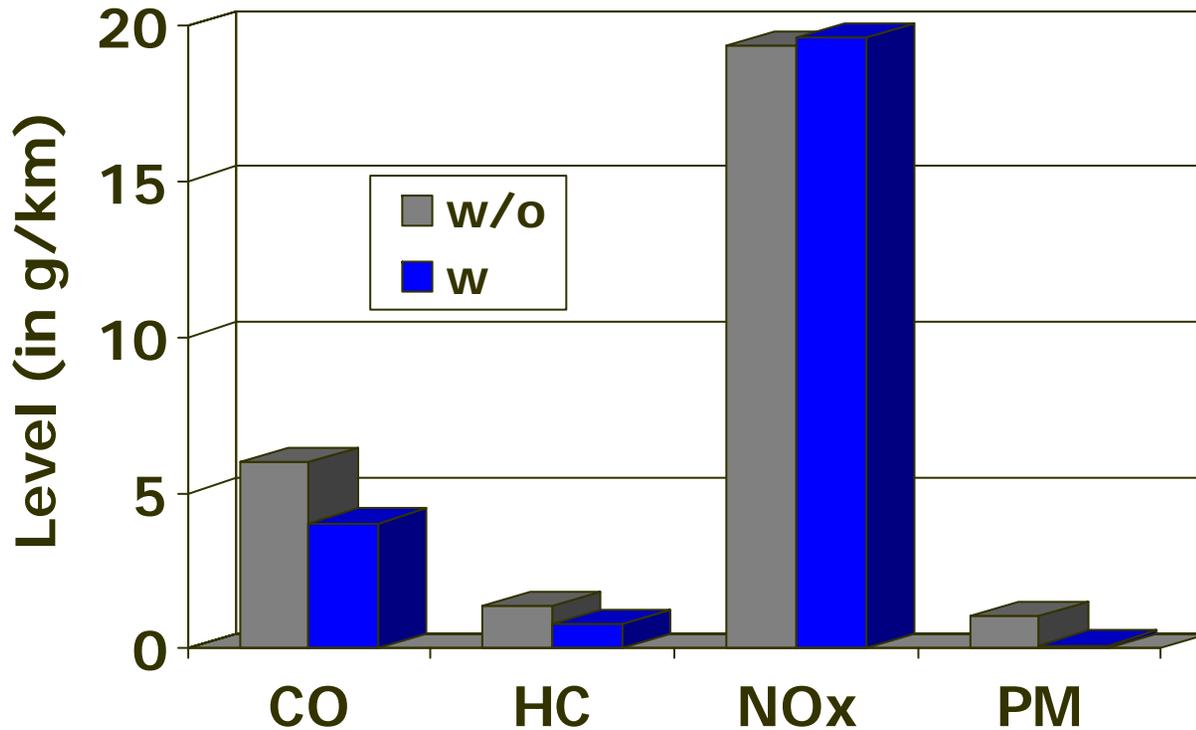
Higher efficiency over the Driving Part vs. Collection Part

CO: 60% vs. 17%

HC: 65% vs. 32%

PM : 93% vs. 82%

Average DPF System Efficiency over the Cycle



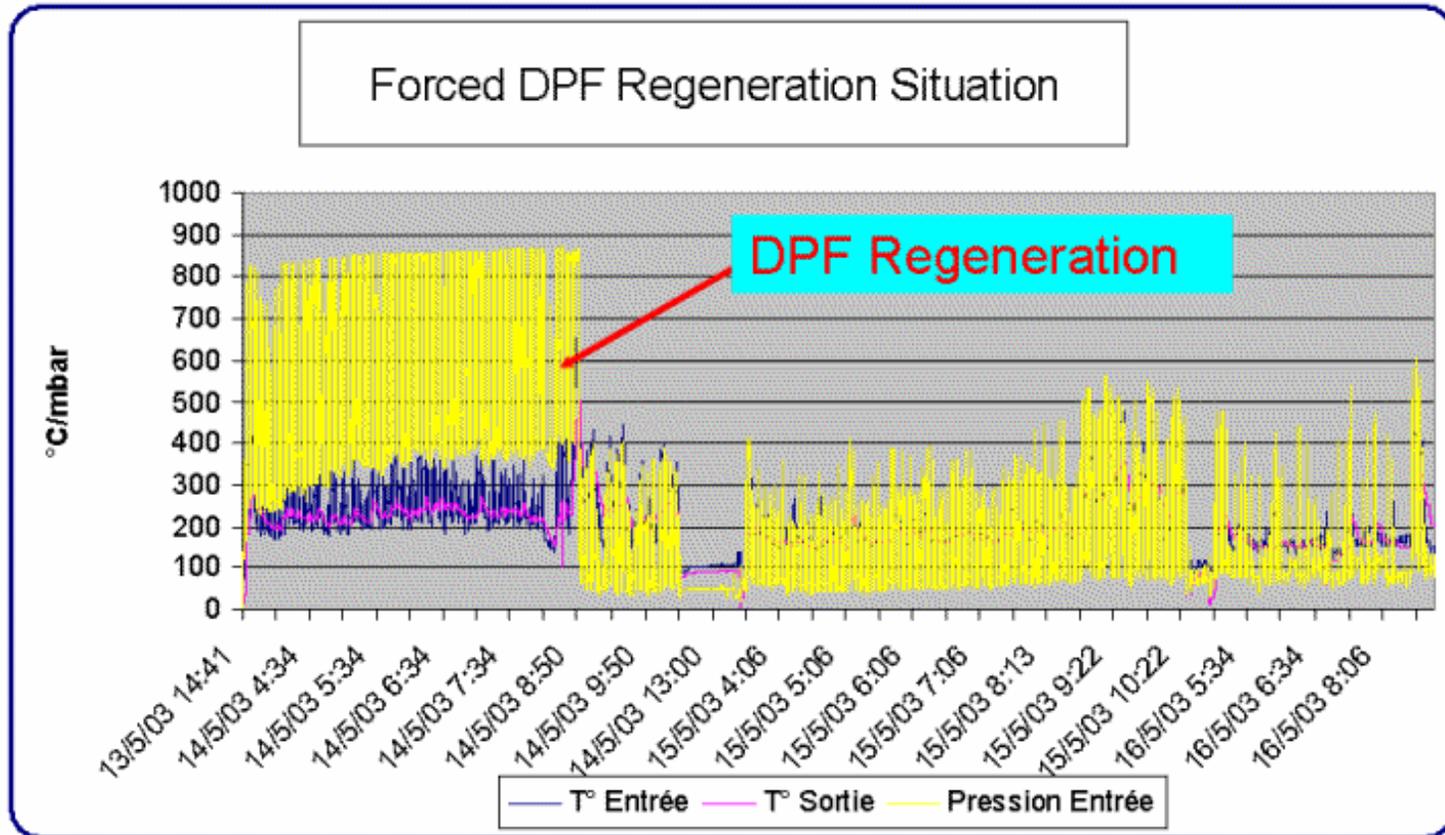
33% CO reduction

44% in HC reduction

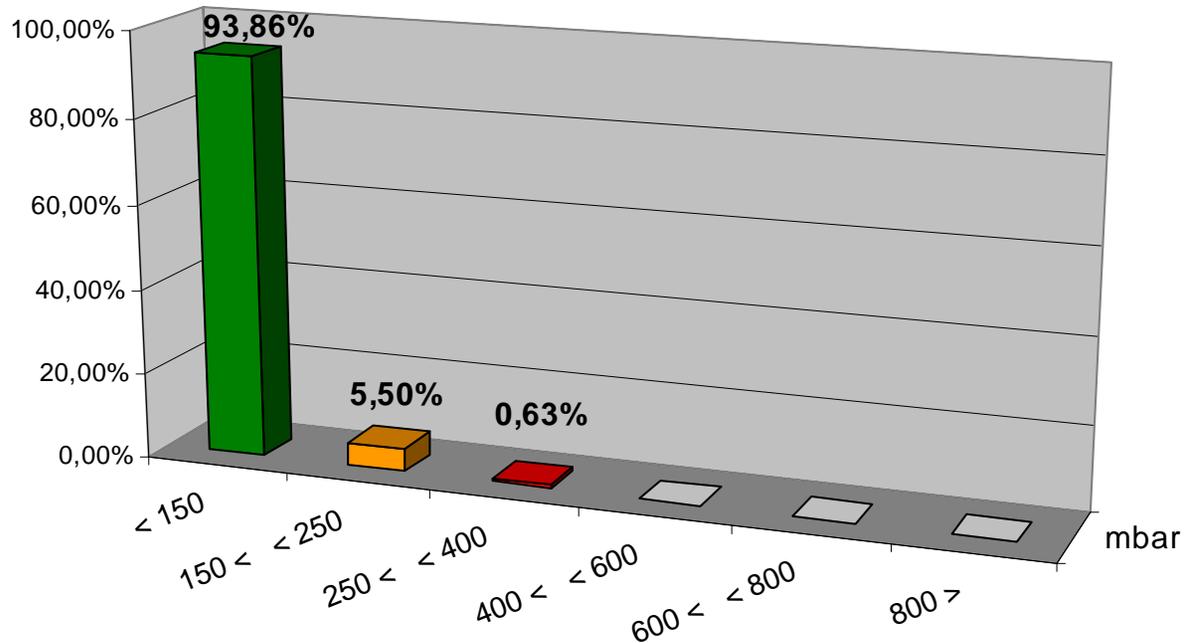
89% in PM reduction

Insignificant NOx effect

Reliability of the Active DPF System



Regular and Low Backpressure over Field Test



A backpressure kept lower than 150 mbar over 94% of the 12 months field test



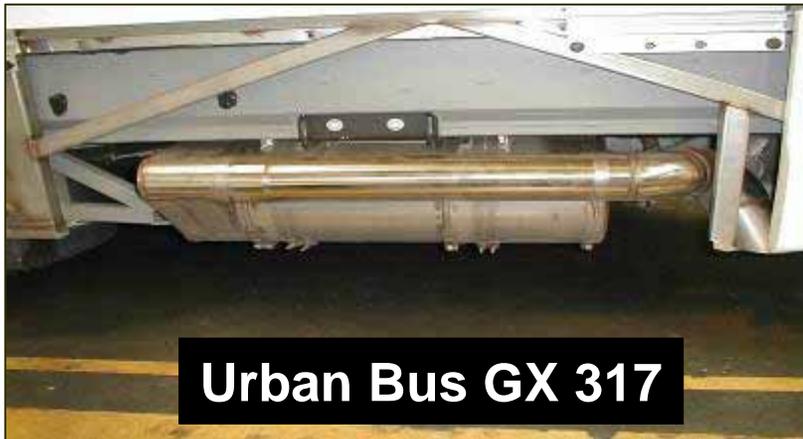
Urban Buses Retrofit Applications

Urban buses Applications (smoke nbr. $<2m^{-1}$)

- fitting the standard muffler volume
- and the engine performance

Example:

For a 9 l / 250 hp Diesel engine,
we need **4** SiC-DPF 5,66"x10" units



OEM Refuse Trucks Applications (as an Option)

For the EURO III calibration,
Premium DCI 11 320 engine :

- *11 l engine displacement*
- *max. power : 330 kW @ 1900rpm*
- *max. torque : 2130 Nm @ 1200rpm*
- *fitted with 6 SiC 5,66"x10" filters units*
- *placed in the standard muffler volume*



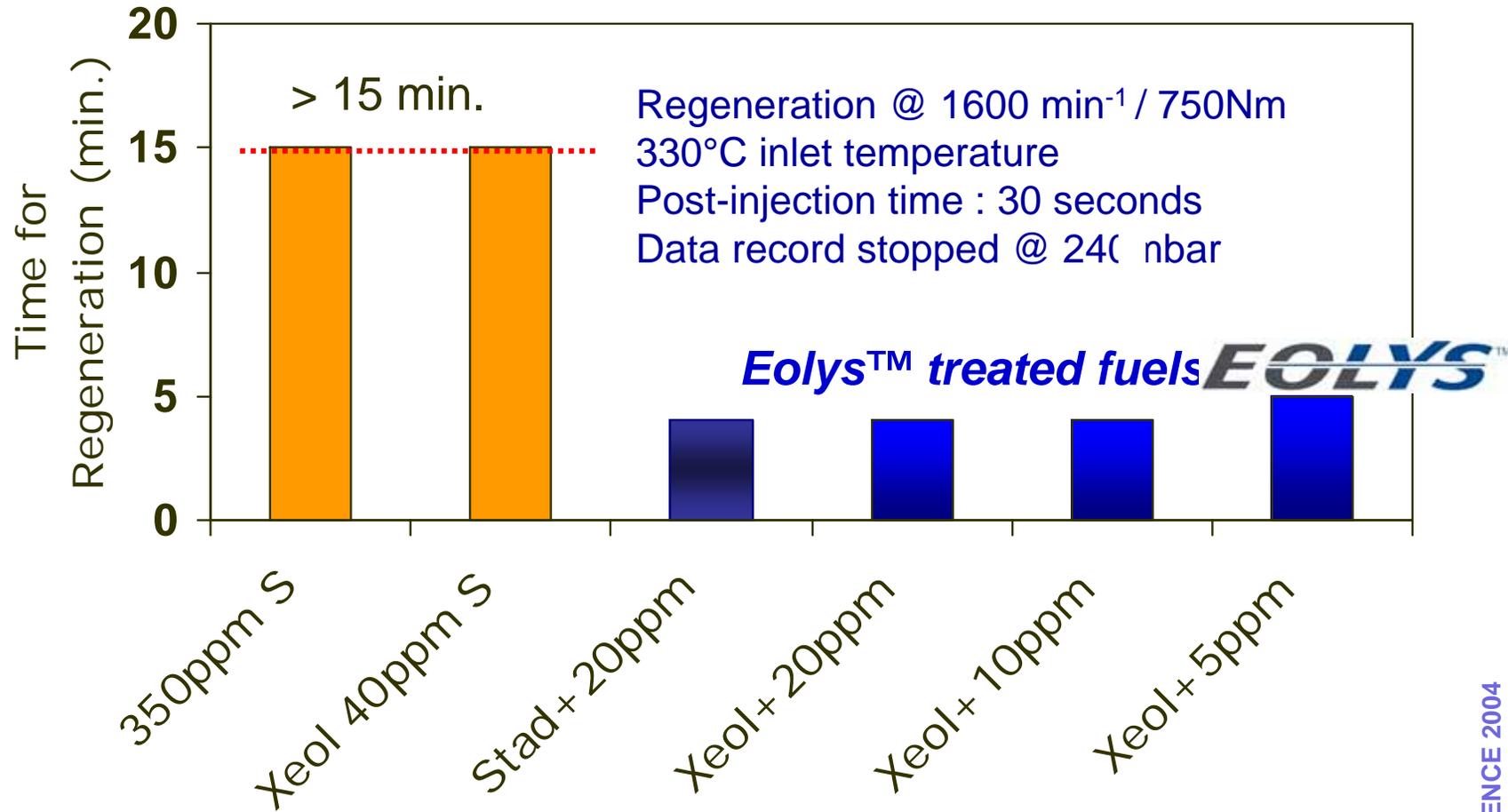
Global Improvement of the Active DPF System

To improve performance, extend the market segments, reduce global cost and limited the maintenance, a Global System Approach is under development:

- **Combination with Fuel-Borne Catalyst and Automatic On-Board Dosing System**
- New Filter Design and Materials
- Downsizing of the DPF System to target the LDV, SUV and Sedan vehicles
- Combination with NOx reduction approaches
 - ➔ *Water-based Fuel emulsion*
 - ➔ *SCR-based technologies*
 - ➔ *EGR technologies*

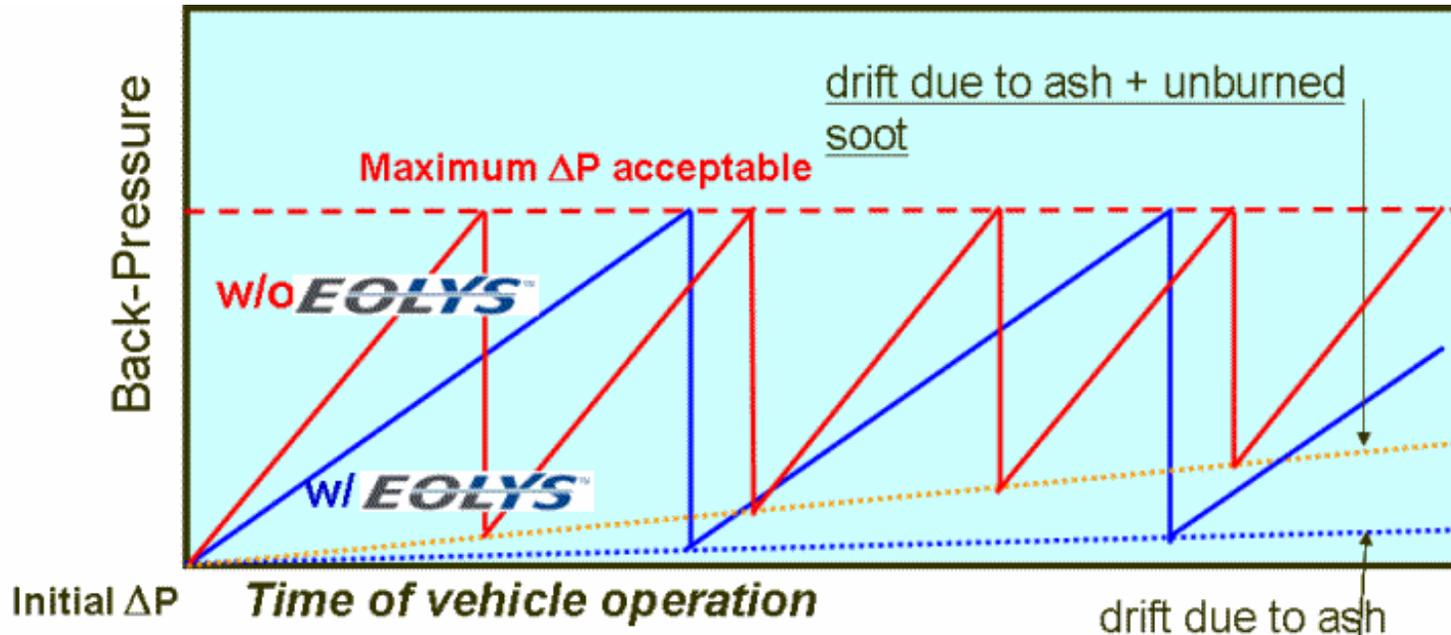


Eolys™: Fast and Complete DPF Regeneration



Synergy effect observed with Eolys™, with reduction of the recommended dosing rate for complete and fast DPF regeneration

Eolys™: Extension of the DPF Operation



- Extend the DPF operation length, before maintenance
 - Decrease the forced regeneration frequency:
 - extend the DPF loading time (synergy effect)
 - get a complete DPF regeneration
- with global fuel economy

Synergy Effect w/ Eolys™

The dosing rate of Eolys™ is reduced from 20-30ppm to 7-5ppm (for a EURO II engine)

With reduction of the soot loading time of filter (by factor 2)

With reduction of the filter maintenance:

	w/o EOLYS™	w/ EOLYS™
<i>Maintenance frequency (Euro II)</i>	70-140,000 km 12-18 months	> 150,000 km > 24 months

With flexibility with Sulfur fuel level: Standard (350ppm S), Xeol™ (40ppm S), GECAM™ (water emulsion, 30ppm S)

Start of Retrofit field tests in Mexico (500ppm S) and China (350-2000ppm S)



Conclusions

A new Active DPF System has been developed for the “Stop-&-Go” Duty Cycle Applications (Urban buses, Refuse and Delivery Trucks), based on:

- ➔ *Variation of Volume of Filtration (valves and actuators)*
- ➔ *Global Thermal Management, using Heat Injection in the Exhaust (Catalytic Combustion, Back-Pressure Management, Fuel-burner, etc...)*

Efficiency, reliability, flexibility and durability of the DPF System have been demonstrated in retrofit program and OEM certifications:

- ➔ *High efficiency on the Particulates*
- ➔ *Reliability of the Active DPF Regeneration Strategy*
- ➔ *Flexibility with the Sulfur content in the Fuels*

Conclusions (cont.)

This Active DPF System has shown a cumulative mileage of 3,500,000+ km since its market introduction, with more than 3 years experience

RENAULT Trucks proposes this Active DPF System as an option for the EURO 3 Premium DCI 11 320 Diesel engine (Refuse Trucks, Diesel-powered Cradles)

Synergy effects were found in the association with the Eolys™ Fuel-Borne Catalyst: limitation of the maintenance and flexibility; under the VERT Certification (till Nov. '04)

Next step: association with NOx control strategies to offer a complete NOx/PM/CO₂ solution for Retrofit and OEM applications (EURO 4 w/ SCR NOx Reduction)

Acknowledgment

The authors would like to thank :

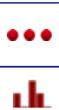
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RHODIA (Pierre MACAUDIERE)

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