Single Fuel Policy

Compatibility with EURO 4 Diesel Engines

NATO RTO AVT ET-073 SPRING MEETING 2007

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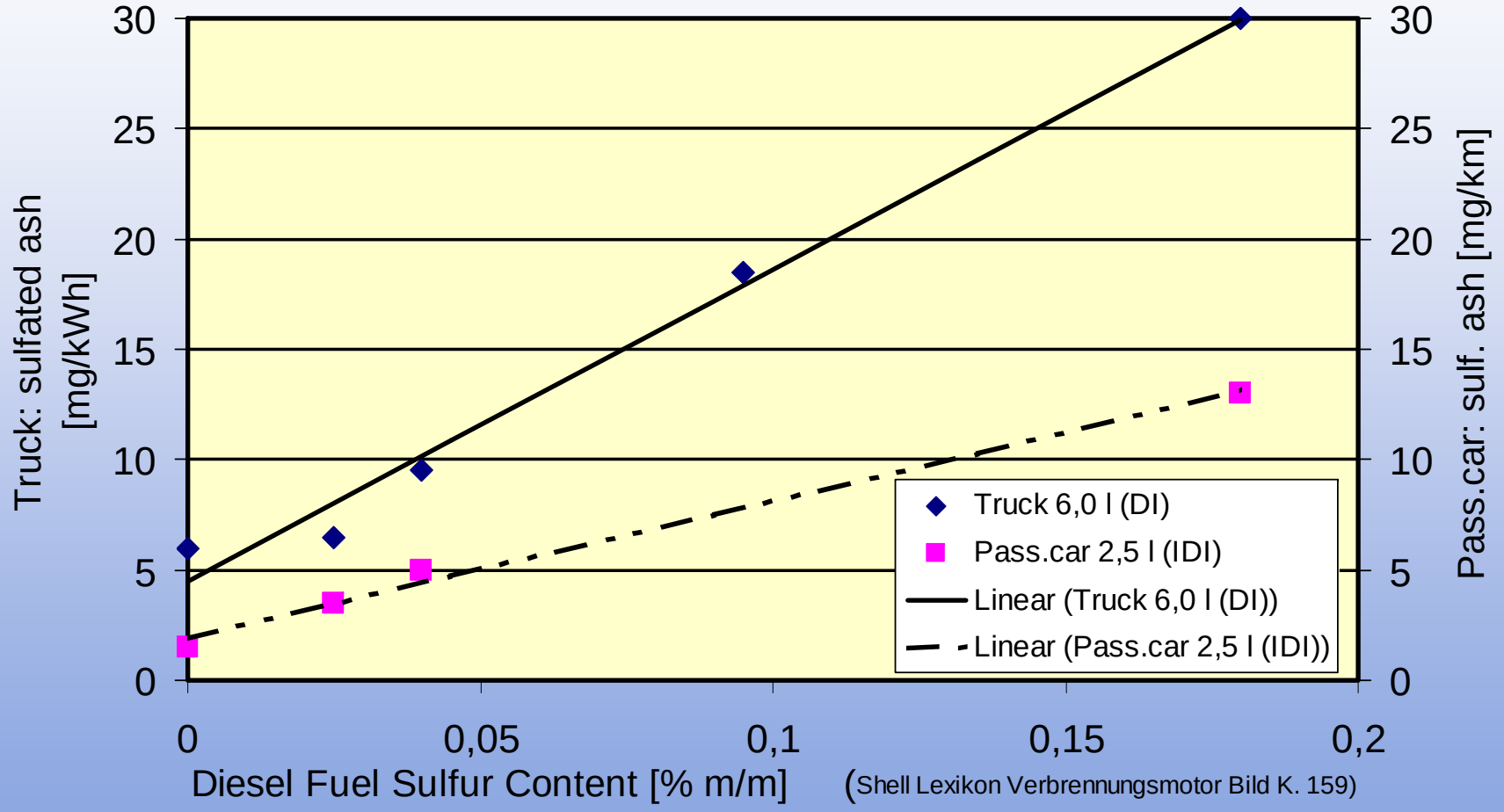
Content

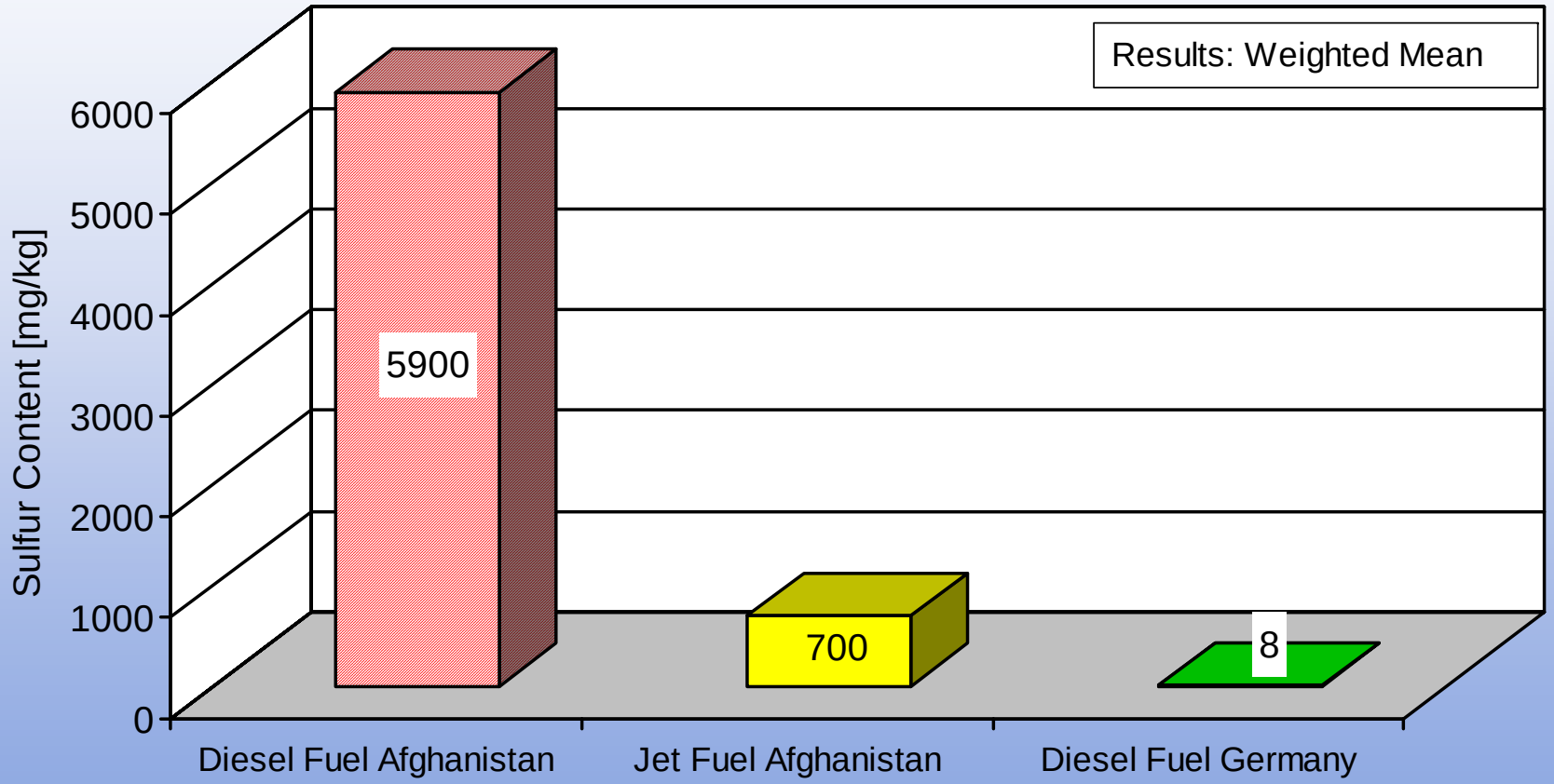
- Effect of Fuel Sulfur Content on Particulate Emissions
- Sulfur, Aromatic Content and CFPP of Kerosene and Diesel Fuel in Germany and in the ISAF Mission Region
- Technologies to Meet Euro 4/5 Exhaust Gas Legislation Limits with Application Examples
- Compatibility Tests with F-34 and O-236 in an Euro 4 Diesel Engine for Heavy Duty Truck Application

Fuel Sulfur Content Influences Particulate Emissions

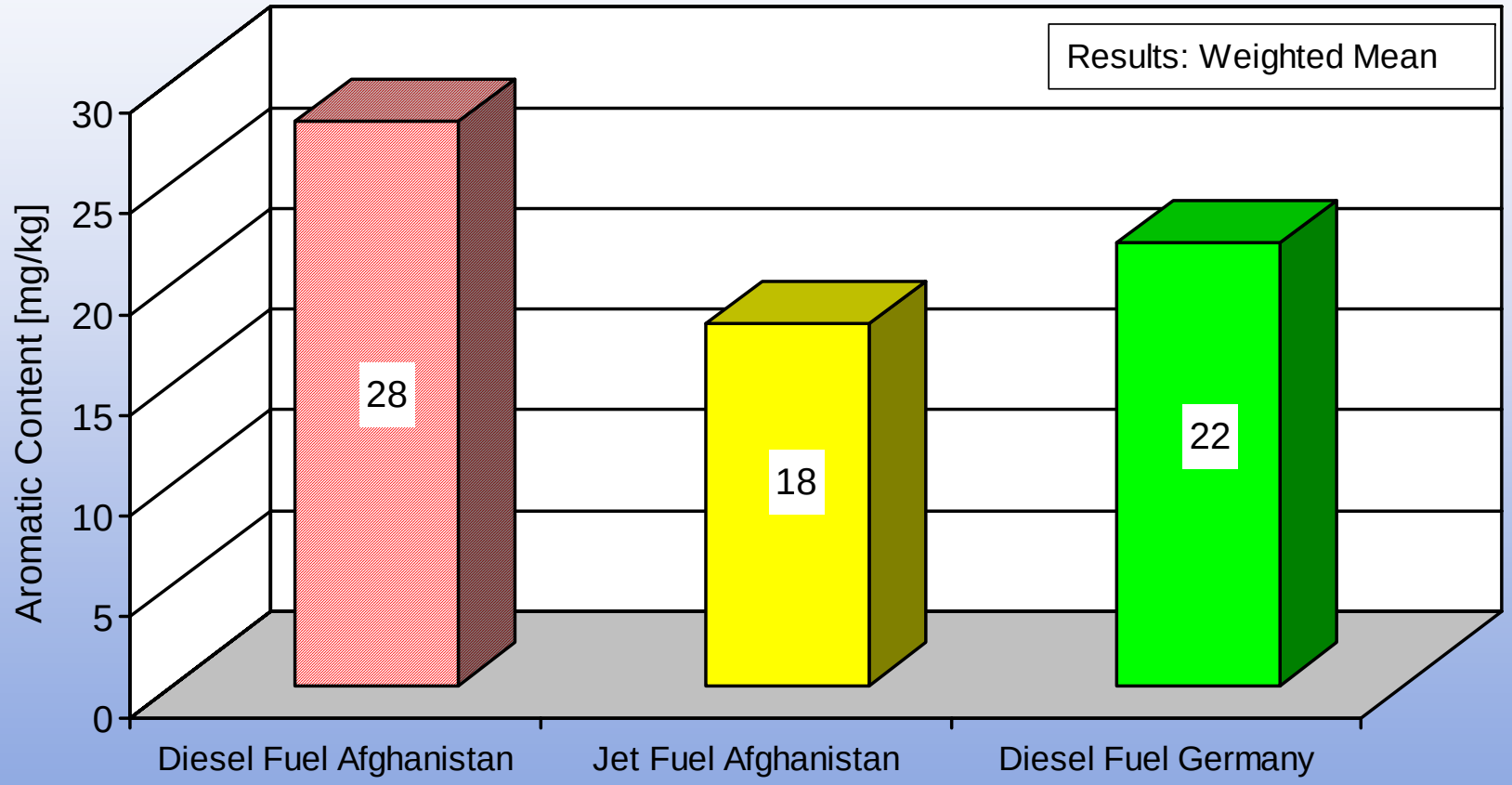


(Shell Lexikon Verbrennungsmotor Bild K. 159)

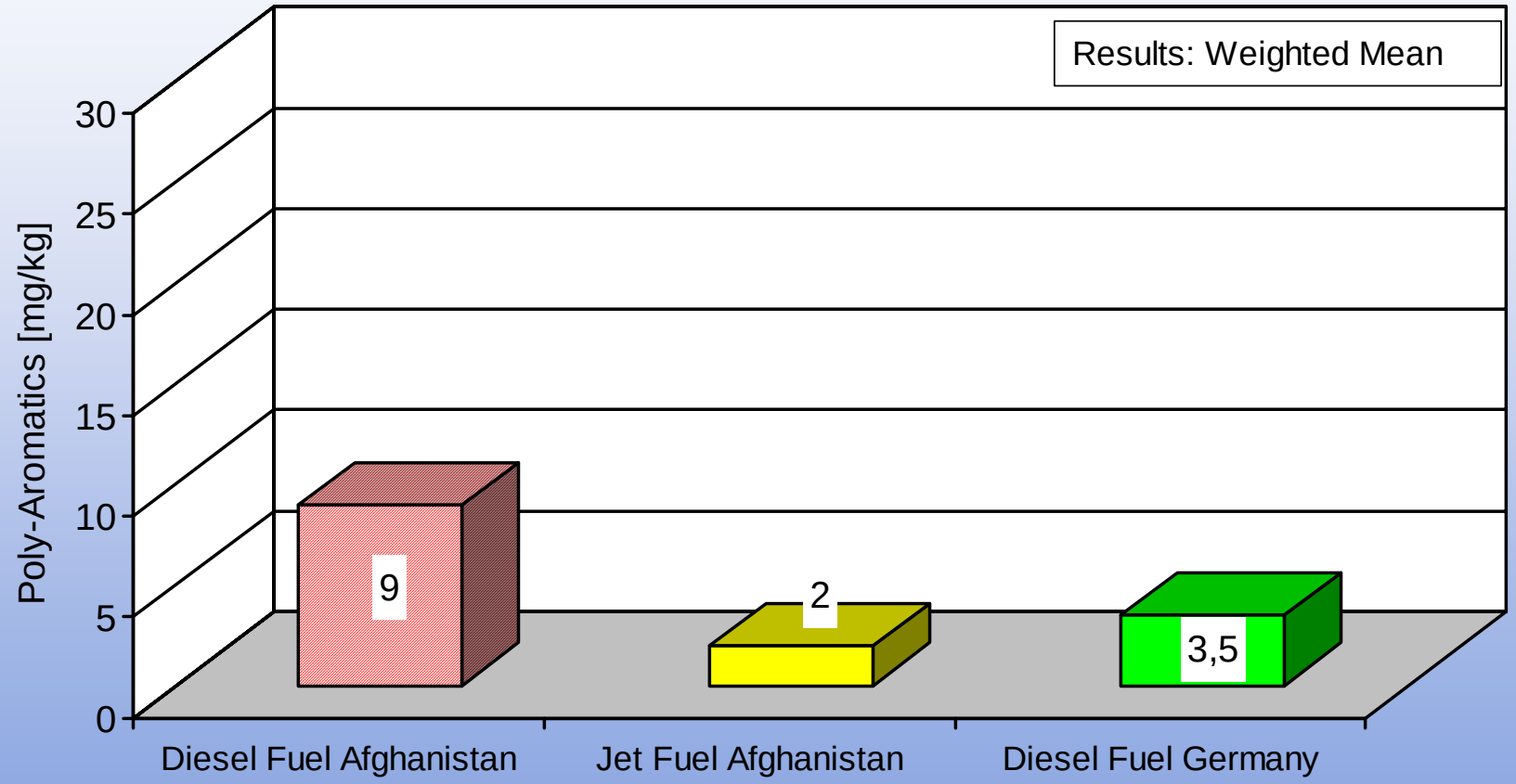
Fuels: Total Sulfur Content



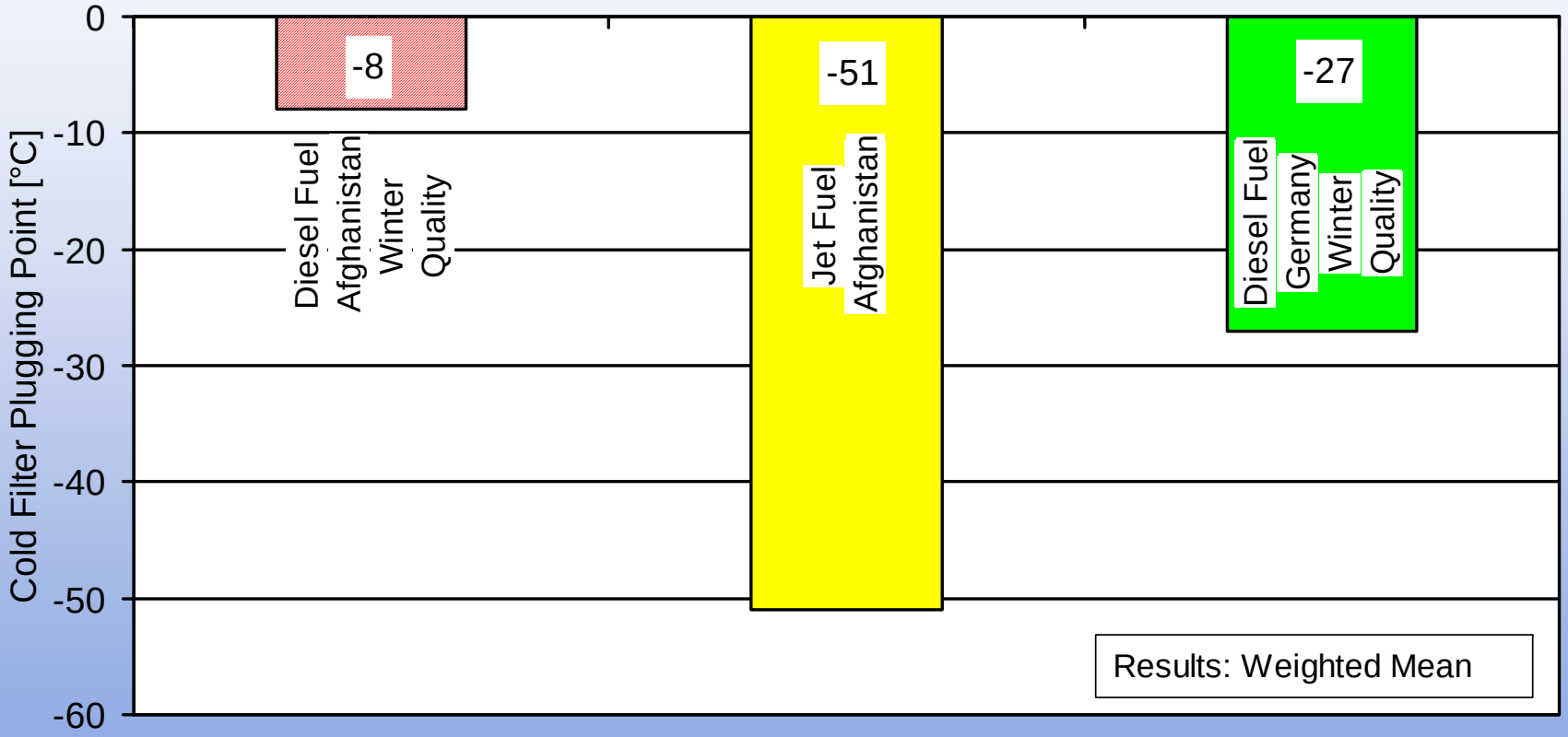
Fuels: Total Aromatic Content



Fuels: Poly-Aromatic Content



Fuels: Cold Temperature Behavior



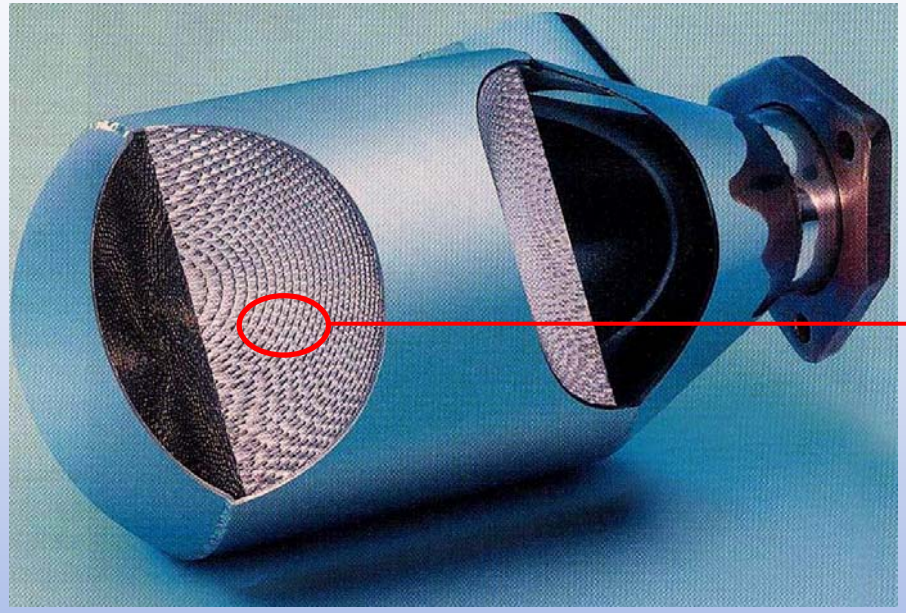
Technologies To Meet EURO 4/5 Exhaust Gas Limits

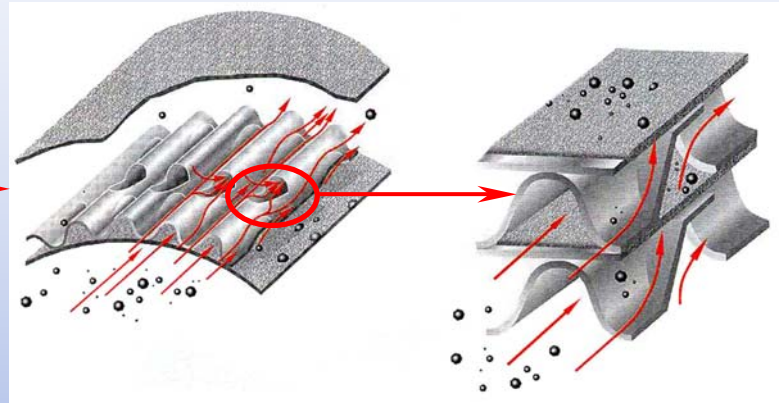
- **H**omogeneous **C**harge **C**ompression **I**gnition (HCCI):
  Cumbustion principle with external air-fuel mixture formation to avoid soot **and** nitrogene-oxide formation;
  Today not available for series application!

- **E**xhaust **G**as **R**ecirculation (EGR) to avoid nitrogene-oxide formation in combination with exhaust gas aftertreatment via **P**articulate **M**atter **F**ilter (PMF).

- High temperature combustion to avoid soot formation combinated with exhaust gas aftertreatment to reduce nitrogene-oxides [DeNOX-Catalyst or **S**elective **C**atalytic **R**eduction (SCR)];
  Detailed explanation by Mr Bienenda.

Flow-Through Metallic PM Filter (M-PMF)

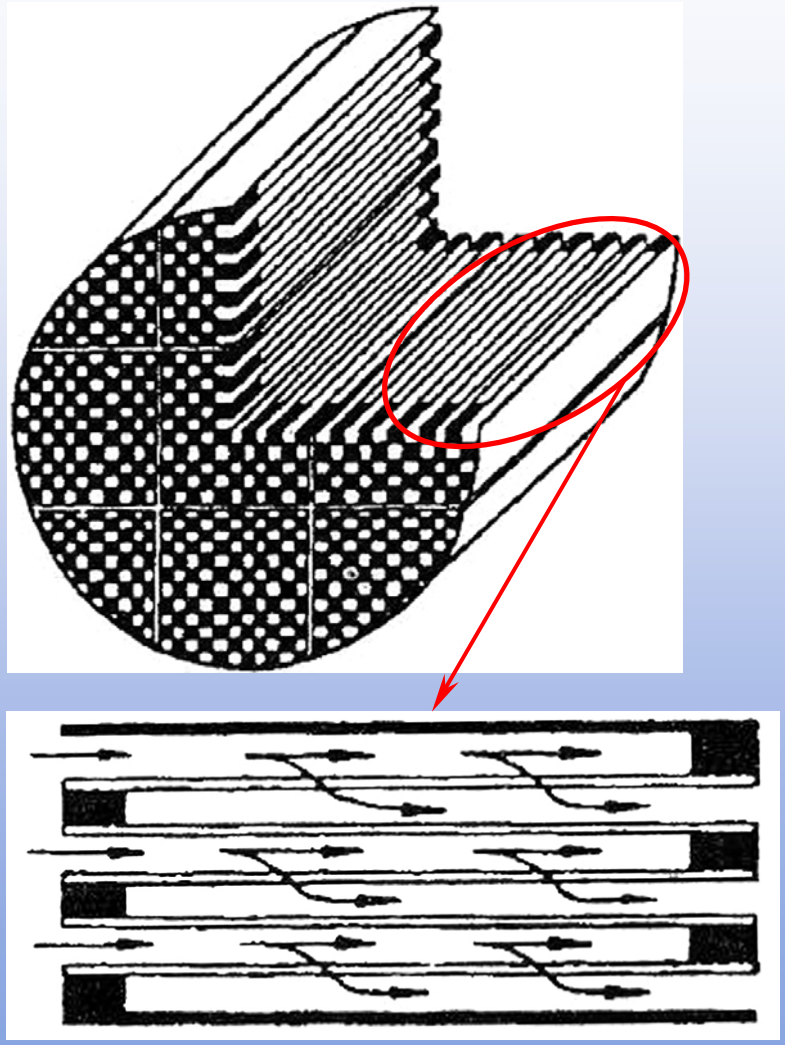




<u>Principle of the M-PMF</u>

M-PMF is structured as layers stack consisting of corrugation foil with shovels and porous fleece. Exhaust gas will be introduced to up and down side of fleeces by shovels, and then soot can be trapped while gaseous components pass the fleece. With the help of the nitrogene oxides produced in the oxidation pre-catalyst the soot particles will be burned continuously.

Wall Flow Diesel Particulate Filter (DPF)



Principle of the DPF

The DPF is structured like a honey comb with parallel pipelines. These pipelines are alternating closed. The inlet pipeline at the end and the outlet pipeline at the front. Thus the gas flow has only the chance to go through wall of filter. Soot particles will be collected in the inlet pipeline.

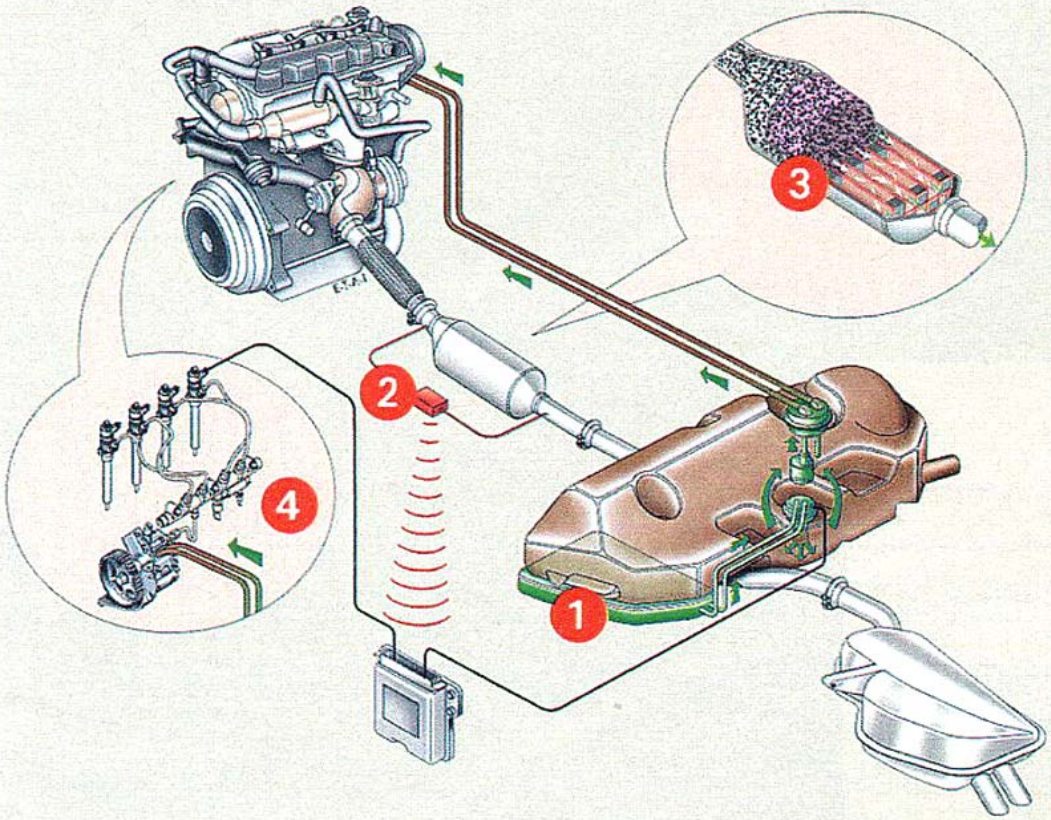
When the difference pressure limit between DPF-inlet and –outlet is exceeded a regenerating process has to be carried out by arising the exhaust gas temperature for soot oxidation. In order to remove the therefore needed temperature some OEM especially the French use a catalytic additive. But depending on the fuel and engine oil quality and the operating profile, the durability of this filter type is limited. If the inlet pipelines will be clogged by sulphated ash or reaction products of other ash forming components (e.g. engine oil additives) the DPF has to be replaced.

→ Not suitable for military use!

Diesel Particulate Filter (DPF) Application Example 1

Filtersystem mit Additiv bei Peugeot und Citroën

Das erste System am Markt hält nahezu 100 Prozent der Partikel zurück



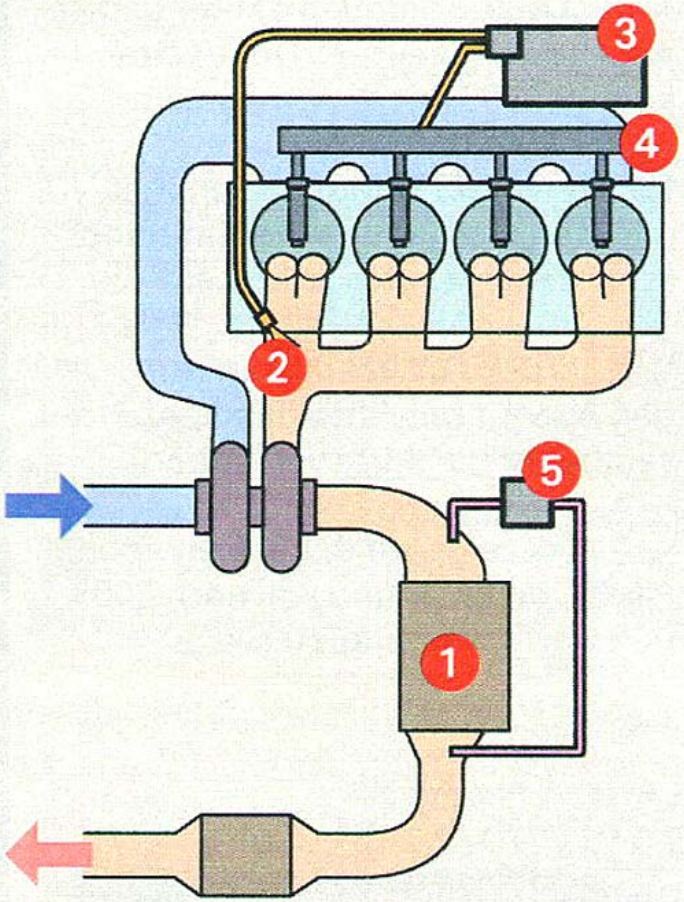
Beim PSA-System wird das Additiv Cer in einem eigenen Tank 1 mitgeführt und dem Dieselkraftstoff vom Motorsteuergerät permanent beigemischt. Ein Drucksensor 2 erkennt die Ruß-Beladung des Filters 3 und gibt über die Motorelektronik den Befehl an das Common-Rail-System 4 für eine Nacheinspritzung. So steigt die Abgastemperatur, und die heißeren Gase führen zusammen mit Cer zum Abbrennen des Rußes.

Diesel Particulate Filter (DPF) Application Example 2

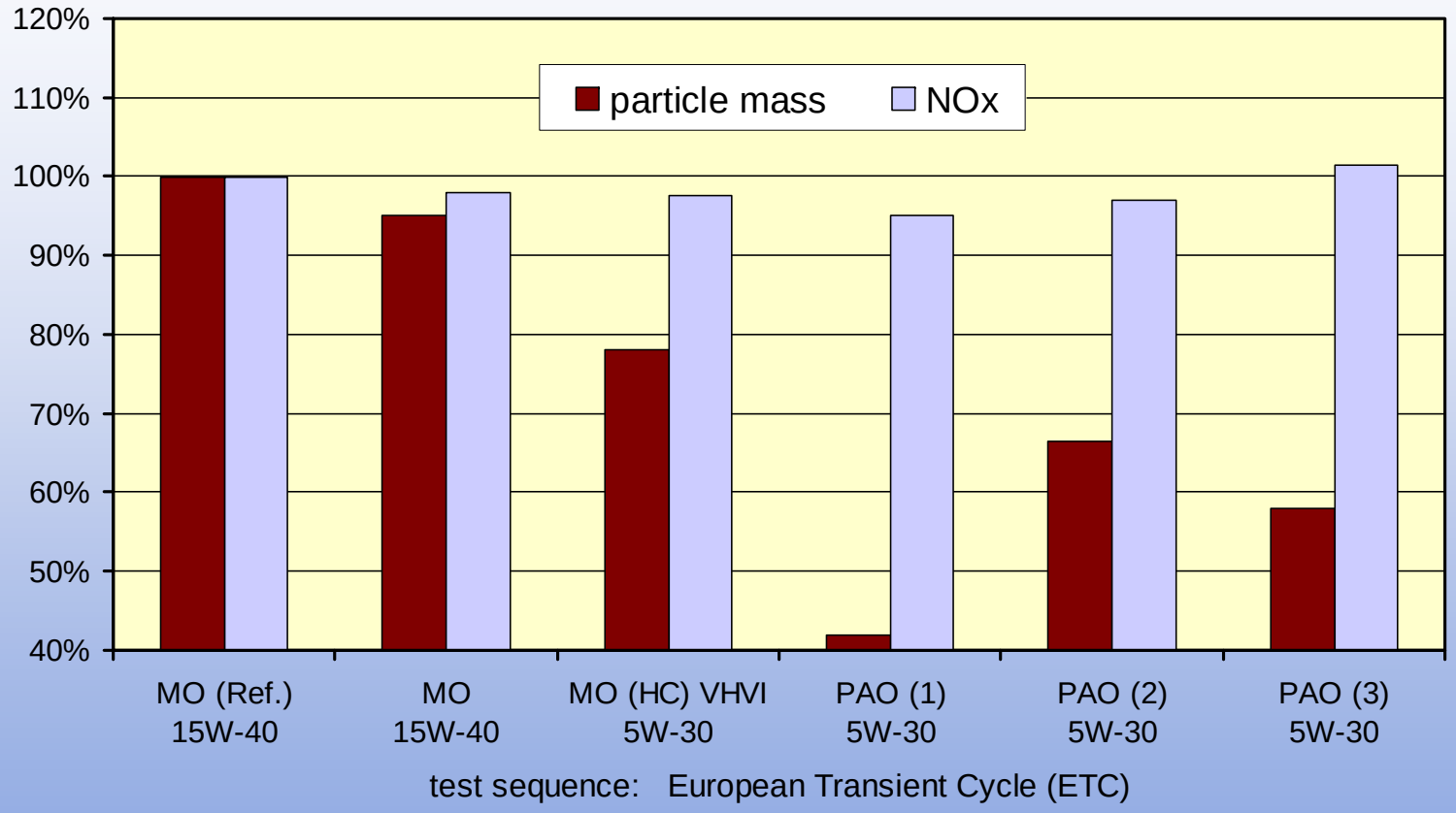
Toyota arbeitet mit einer zusätzlichen Einspritzdüse

Extradiesel im Abgastrakt reinigt den Filter

Auch Toyota erhöht zum Regenerieren des Filters 1 die Abgastemperatur, allerdings kann hier zum Verbrennen des Rußes auf ein Additiv verzichtet werden. Im Auspuffkrümmer des Motors sitzt eine zusätzliche Einspritzdüse 2. Wann aus ihr eine Zusatzportion Diesel in den Abgasstrom gemischt wird, entscheidet die Steuerelektronik 3 der Common-Rail-Einspritzung 4. Auch hier liefert ein Drucksensor 5 die notwendigen Informationen. Er misst die Druckverhältnisse vor und nach dem Filter. Ist der Unterschied zu groß, wird regeneriert.



Influence of Engine Oil on to the Emission Quality



MO: Mineral Oil **HC**: Hydrocrack Oil **VHVI**: Very High Viscosity Index **PAO**: Poly-Alpha-Olefine (Synthetic Oil)

Quelle: Bleimschein, Fotheringham, Plomer, Reboul: „Lubricant Base Oil Effects on Regulated Euro 2 Heavy Duty Diesel Engine“ published in Mineralöl Technik, Ausgabe 5/2003

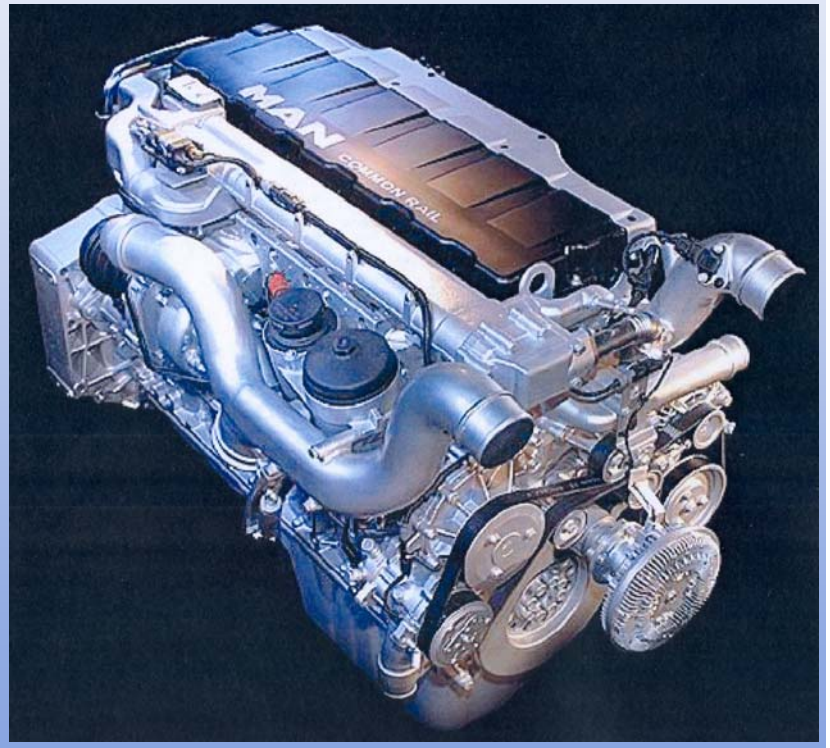
Compatibility Test with F-34 and O-236 in an Euro 4 Engine

Full Scale Engine Test in Cooperation with MAN and WTD 41

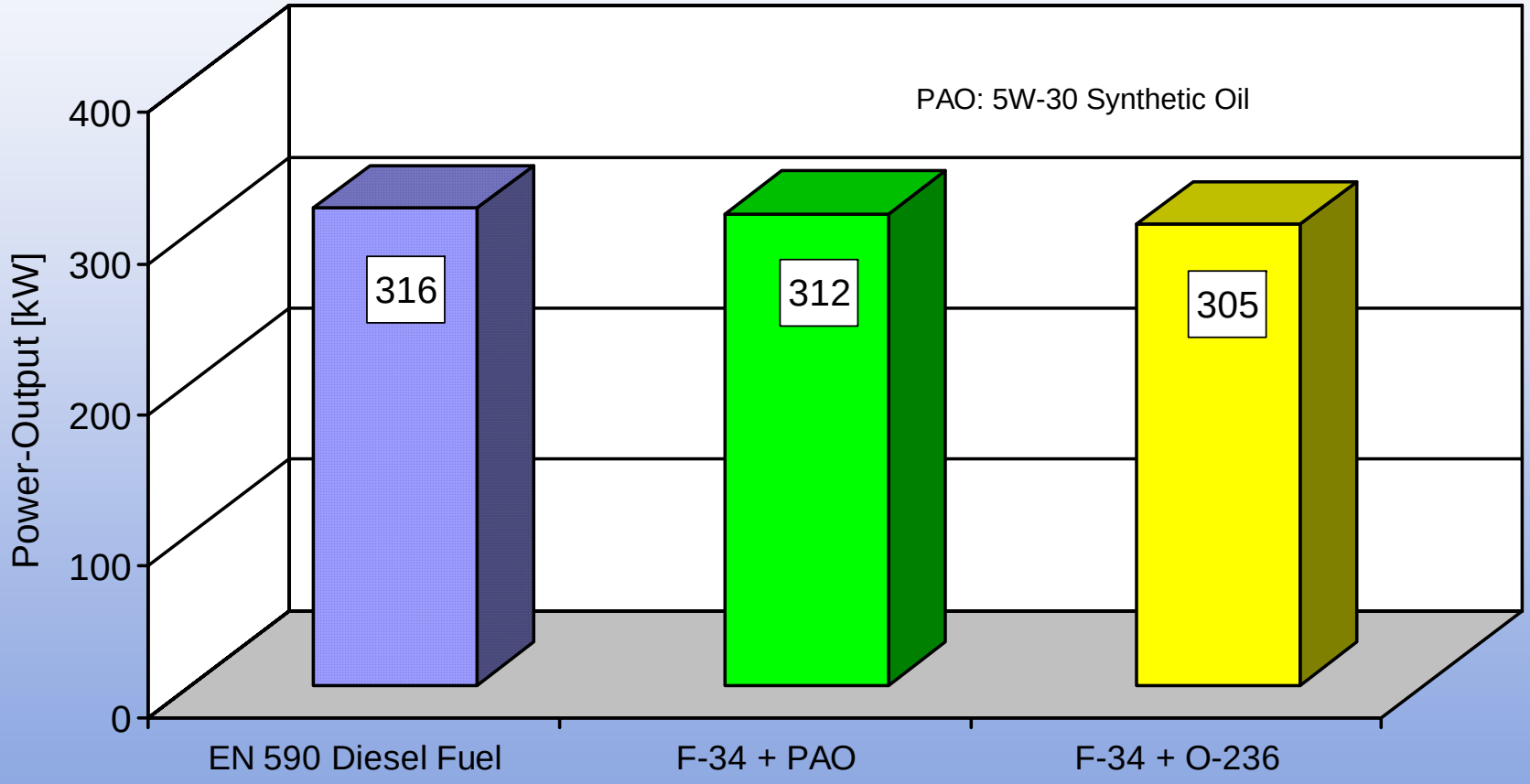
Duration: 1000 h (2,5x 400 h Test according to NATO AEP 5)

Test Item:
MAN D2066 LF 11 6-Cyl. (in-line) turbocharged intercooled DI Engine, with EGR and PM-Catalyst (M-PMF)

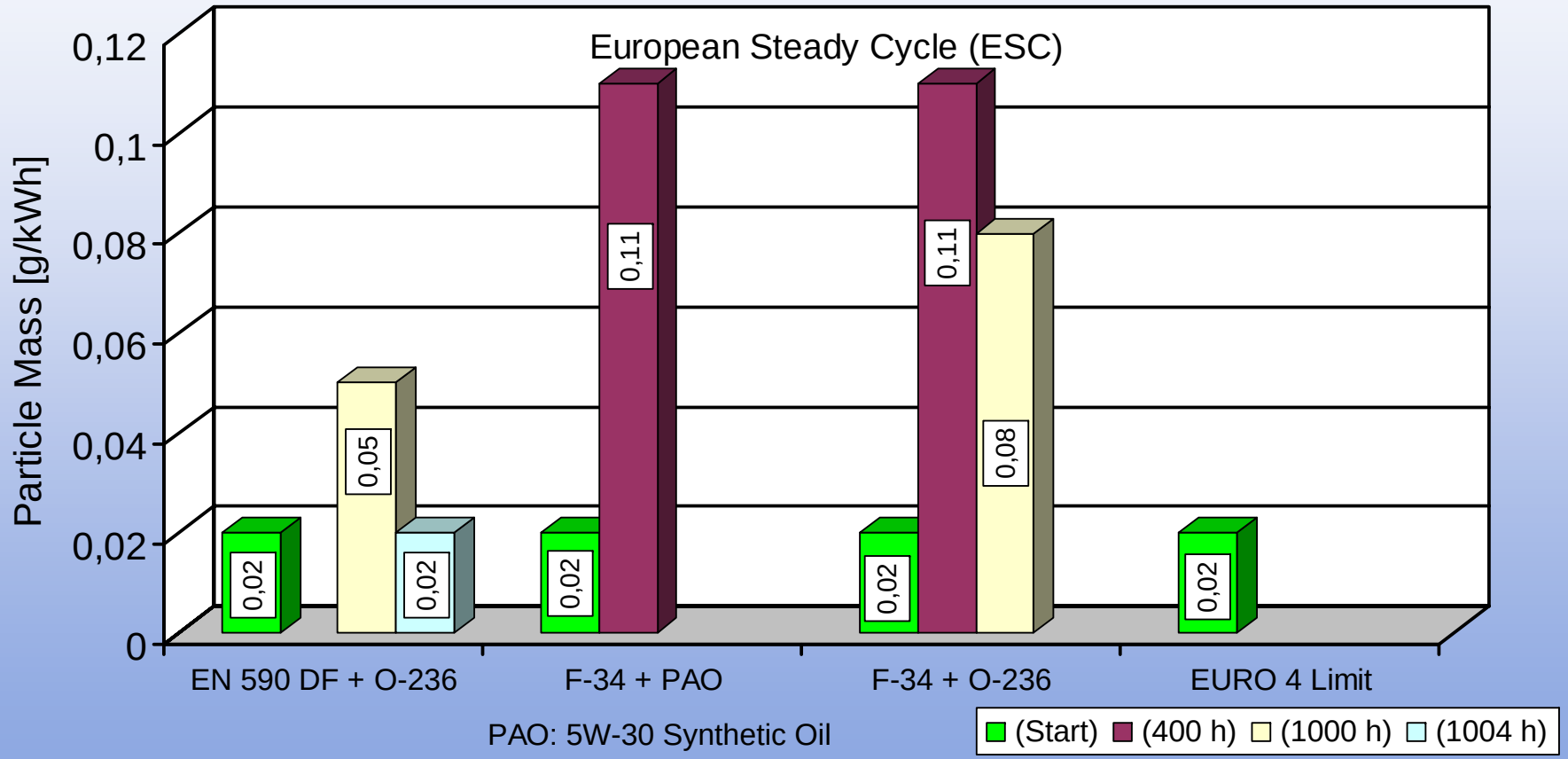
Inject.-System: Common-Rail, fuel-lubricated, hardened for military application
Stroke Volume: 10,52 ltrs
Rated Torque: 2100 Nm (1000-1400) rpm Rated Power: 316 kW (1900 rpm)



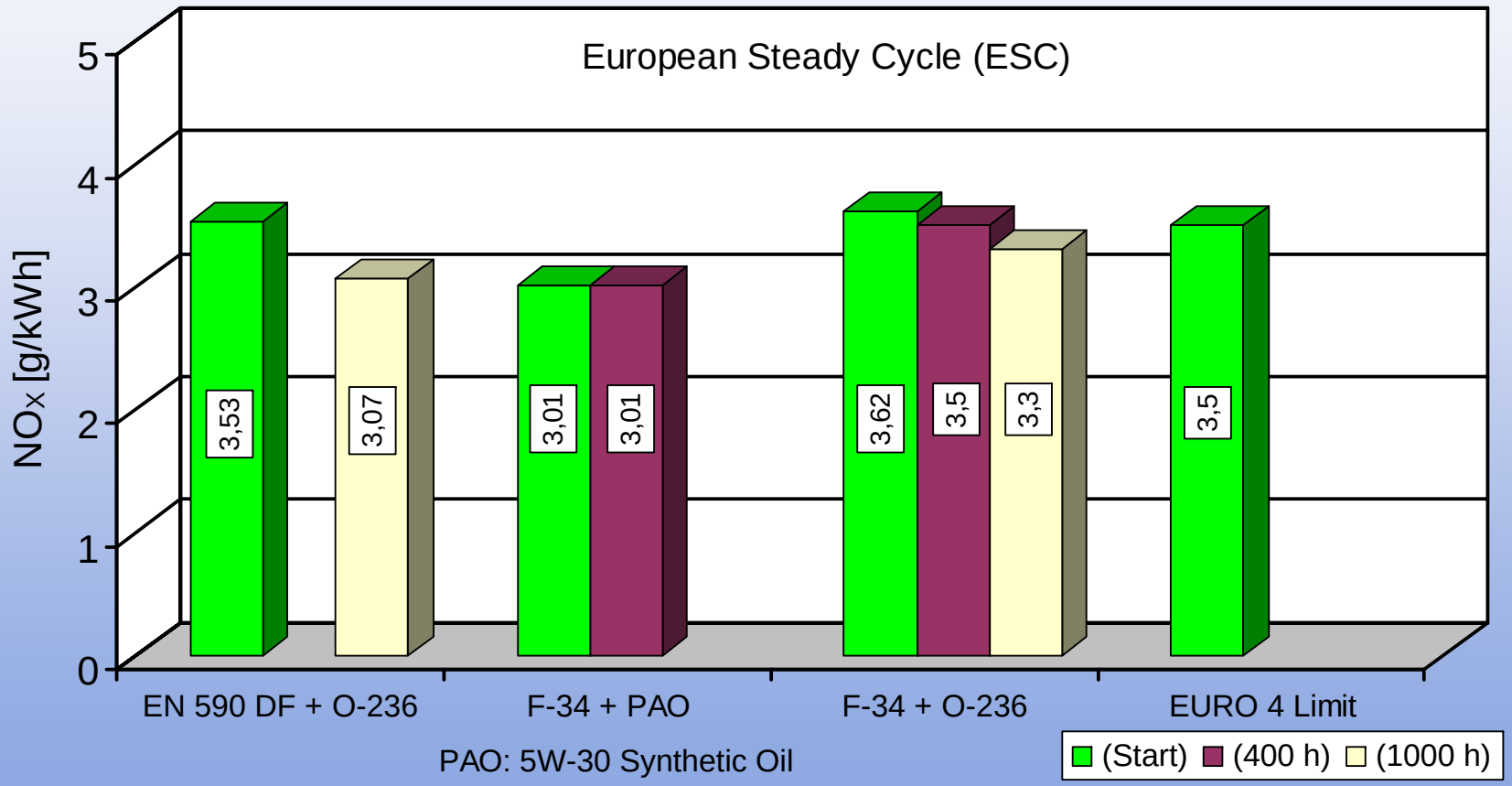
MAN D2066LF11 Engine: Power-Output



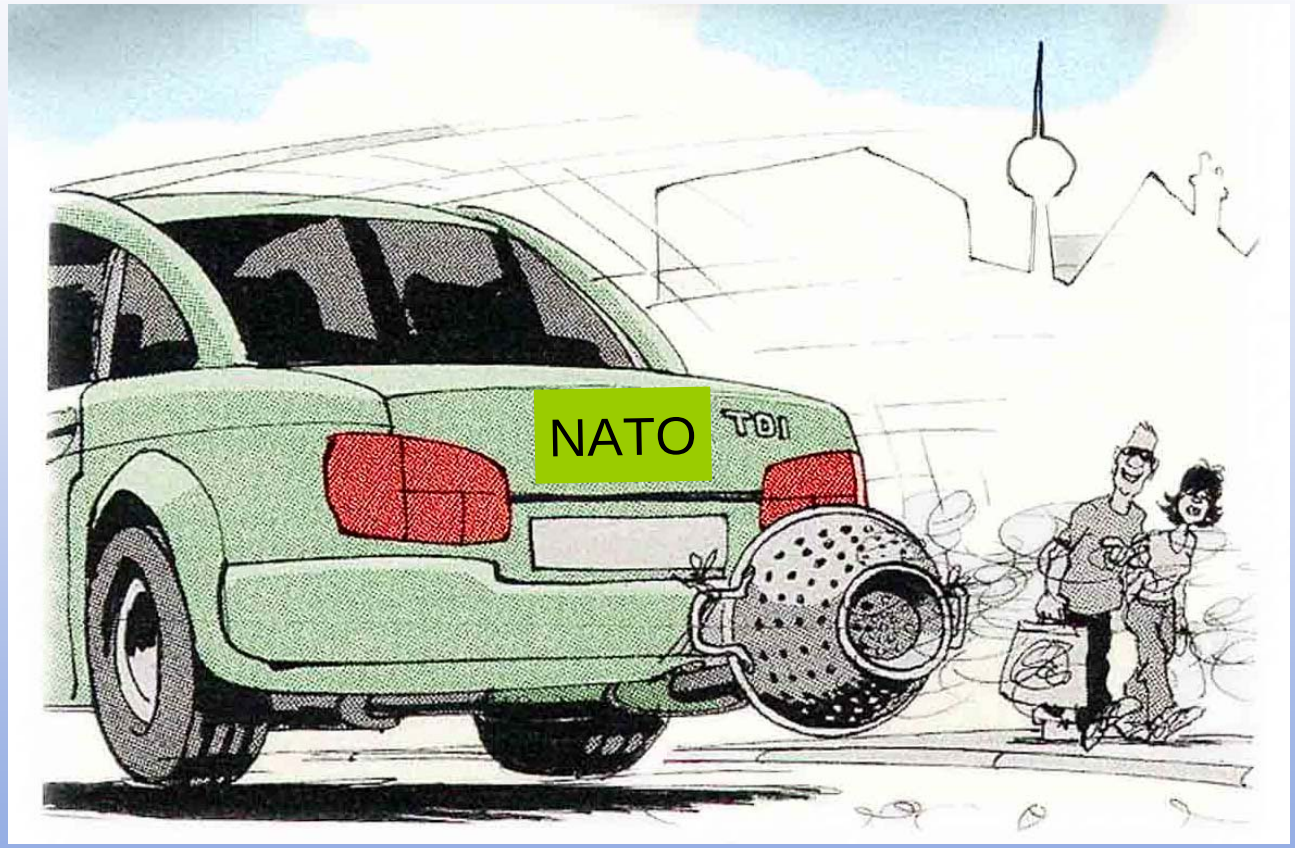
MAN D2066LF11 Engine: Particle Mass



MAN D2066LF11 Engine: NO_X Emission



This solution is quite doubtfully.



Thank you for attention !