PRODUCT INFORMATION SHEET

WYNN'S Diesel Particulate Filter Cleaner & Regenerator

Product Number: 31592 12 x 325ml

New technologies to reduce emissions with diesel engines

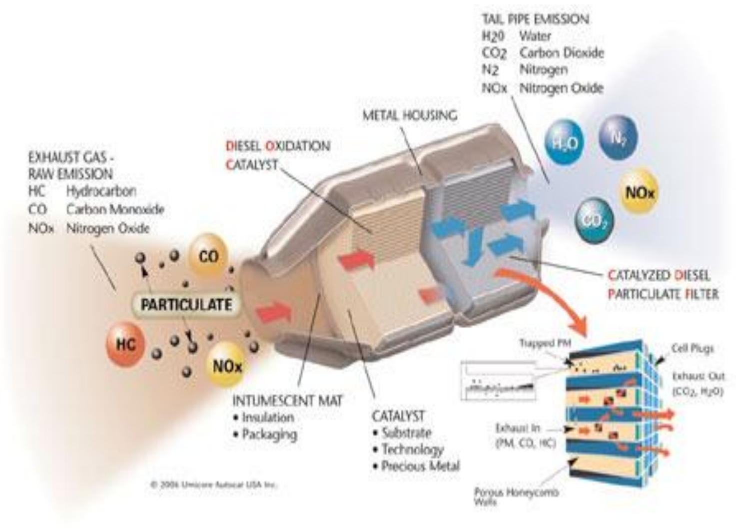
The emissions from diesel engines contain much higher levels of soot particles than petrol or LPG engines. Soot is caused by the incomplete combustion of fuel in the engine and is emitted with the exhaust gases. These fine particles are harmful to both humans and the environment. To reduce these harmful emissions vehicle manufacturers now fit soot filters to vehicles. The soot filters trap these harmful particles and prevent them from entering the atmosphere.

Exhaust gases produced by the engine can be reduced by after-treatments in the exhaust system:

➔Oxidation catalyst: reduces CO and HC
➔Selective Catalytic Reduction (SCR)
➔**Diesel Particulate Filter (DPF)**

Necessary for good operation

- ➔ SCR: catalytic component (on cat walls or injection of urea)
- ➔ Diesel Particulate Filter: becomes blocked – regeneration necessary
- ➔ Regeneration:
  - ➔ create heat
  - ➔ use catalyst



Typically there are three types of emissions control systems:

a. Oxidation Catalyst: Like a catalytic converter found in Petrol vehicles, to promote complete combustion of carbon and hydrogen so that CO and HC can be reduced.
b. Selective Catalytic Reduction (SCR): Using nitrogen compound (Typically called Adblue) to promote complete combustion of Nitrogen so that NO can be reduced.
c. Diesel Particulate Filter (DPF): to trap dust like particles called Particulate Matter (PM) in the exhaust stream. These particles are soot and smoke particles and are essentially carbon.

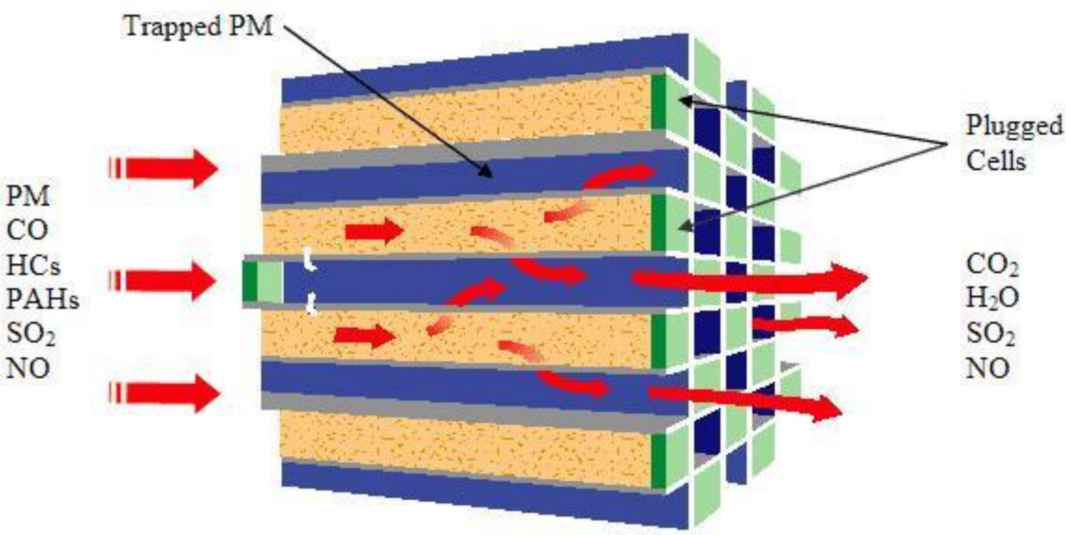
d. Typically vehicles will have one or more of the above systems but in general DPF's present in post 2009 diesel vehicles as it is needed to meet the latest European emission control criteria, i.e. Euro-5 and Euro-6.

While oxidation catalyst and SCR become less effective with use, they normally do not present operational problems. DPF on the other hand, by nature, needs to be regularly cleaned as a normal oil filter to get rid of the trapped materials. The cleaning process is called "Regeneration".

Working principle of a Diesel Particulate Filter

With the popularity of diesel vehicles worldwide increasing, the particulates from emissions mainly containing carbon has increased air pollution levels. The diesel particulate filter (DPF) was designed to reduce soot emissions and is able to filter out more than 80% of the carbon smoke particulates.

Before explaining how DPF can be regenerated, we need to look at the structure of a typical DPF.

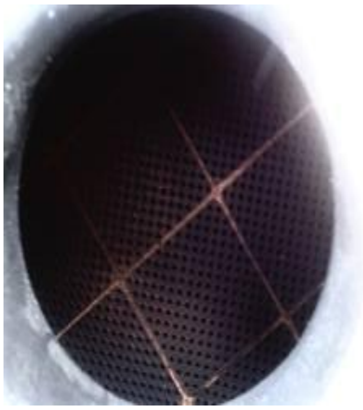


The DPF resembles a muffler and is formed in a honeycomb like manner. It is made of inert ceramic and noble metals and because of this complex construction the typical cost of such a unit is upwards of $2,500 each. This structure facilitates the trapping of the Particulate Matter. Exhaust gases pass through the porous channel walls of dead end cells, allowing the gas to escape through the neighbouring channel while as much as 90% of the solid Particulate Matter (PM) is trapped in the cells.

When particulate adsorption reaches a specific level, the PM trapped inside needs to be removed. The operation is usually performed automatically by a controlled "Burn Off" process inside the DPF without input from the driver. This process is referred to as "DPF regeneration".

If the automatic "Burn Off" process doesn't activate the DPF will stop functioning and a DPF warning light will come on. If the problem is ignored, a signal will be sent to the ECU to activate "Limp" mode i.e. only limited power from the engine will be available to drive the vehicle back to a workshop to fix the problem.

Problem



Normally, Particulate Matter can be burned off at temperatures between 550- 650˚C. These temperatures are reached when driving continiously at a higher speed (e.g. 60 to 80 km/hr. on a highway) for a period of time (e.g. 30 minutes).
If the vehicle is driven mostly under these conditions, the DPF "regeneration" will usually occur perfectly. However, many vehicles are not driven under these conditions!

The lower the exhaust gas temperatures are the faster the PM build-up which leads to the Diesel Particulate Filter (DPF) blocking.

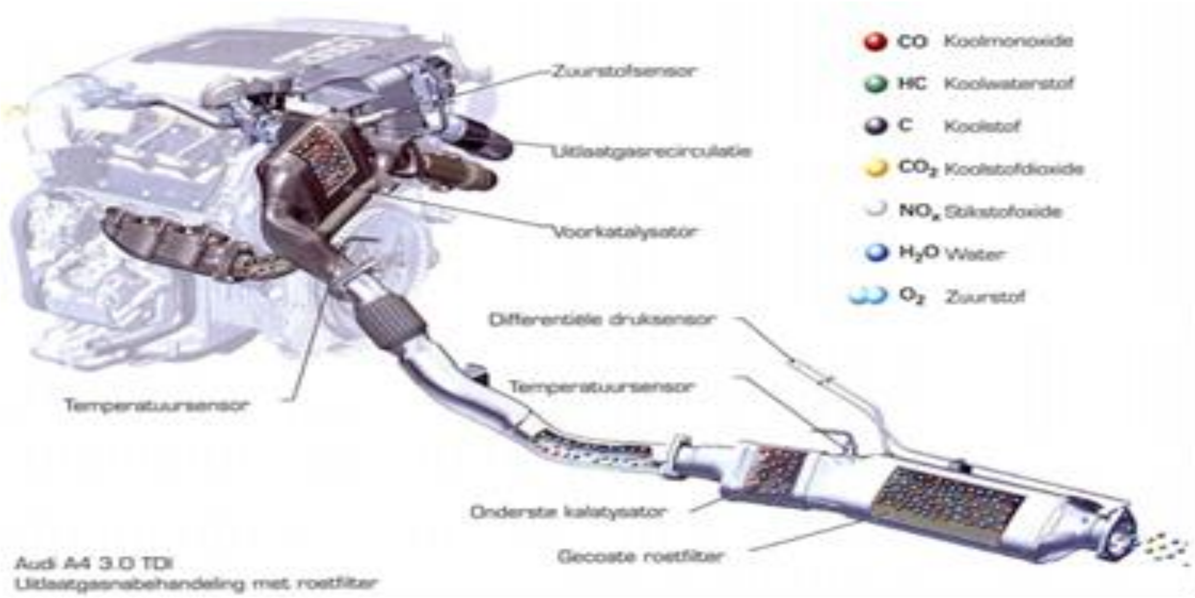
Short trips, city traffic, stop start traffic will result in lower exhaust gas temperatures and produce more PM which accelerates the blockage of the DPF.

The problem is compounded if the vehicle does not travel in the "optimum" conditions allowing a proper regeneration process to occur.

A blocked DPF causes increased resistance in the exhaust which leads to a loss of engine power then a warning light activation and if the problem is ignored activation of "Limp mode" to protect the vehicle.

Symptoms

Loss of engine power
Increased fuel consumption
Poor acceleration
DPF warning light activation
"Limp Mode" activation



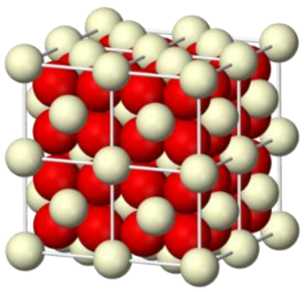
Solutions

The most expensive solution is changing the DPF unit.
A second solution, less expensive but still with a high cost is to go to the repair shop and let the technician do a forced regeneration. In a professional workshop with the right SCAN tool and software a technician can initiate a forced "Regeneration" and follow up with a complete oil and filter change (extra costs). The complete oil change is needed due to the extra fuel that is being delivered into the combustion chamber to force the "Regeneration" process. This extra fuel contaminates the engine oil and starts to break down its lubricating properties.

The most cost effective way to clean the filter is by using a chemical treatment.

The revolutionary solution to this problem is the use of Wynn's DPF Cleaner and Regenerator, which enables the regeneration process to occur at a lower exhaust gas temperature. This allows the vehicle to automatically regenerate more often, even though the driving conditions do not produce a high enough exhaust temperature.

By adding Wynn's DPF Cleaner and Regenerator into the diesel fuel, the Cerium component of the chemical reduces the carbon deposit decomposition (burning) temperatures to 450˚C to 500˚C. This greatly widens the window for the vehicles to regenerate the DPF. The effect of this phenomenon is more frequent burn off at lower driving speeds, overcoming the problem of DPF blocking in city driving cycles described earlier.



New Cerium component:

CERIUM TECHNOLOGY
BURNS SOOT
IMPROVES HYDROCARBON COMBUSTION
CERIUM CATALYST REGENERATES AUTOMATICALLY

- Oxidation catalyst: Cerium ions switch in oxidation state
- Thermally stable
- Works as an oxygen sponge to store O^2 molecules and release the at an appropriate time during the regeneration process
- Improves combustion
- Burns off soot particles
- Removes carbon deposits in combustion chamber

Cerium Powder

Wynn's Diesel Particulate Filter Cleaner & Regenerator

Wynn's Diesel Particulate Filter Cleaner & Regenerator for Professional use is a chemical treatment for diesel engines that clears blocked particulate filters and reduces soot emissions.

PROPERTIES

- Clears and regenerates blocked soot filters
- Burns off soot particles while driving
- Avoids frequent maintenance costs due to clogged soot filter
- Optimizes combustion and lowers fuel consumption
- Especially suited for stop, start city driving

APPLICATIONS

For diesel engines with all types of diesel particulate filter
For diesel and biodiesel up to B30

DIRECTIONS

Add one bottle of 325ml to partially empty diesel fuel tank and top up with diesel. Use every 3rd tank or 3000 km.

TECHNICAL DATA

DPF Cleaner & Regenerator

Appearance	: clear yellow liquid
Density at 20°C	: 0,812 kg/dm³
Flash Point	: 75°C
Refractive Index at 20°C	: 1,453

PACKAGING

31592 - 12x325ml

R&D Laboratory Report on Wynn's Fuel-Borne Catalyst

The following is an extract of a significant project report carried out in Wynn's Technical R&D facility in Belgium.

1. Objectives

The objective of this investigation was the test and characterization of the Wynn's cerium based fuel-borne catalysts with respect to its influence on the exhaust emission and its applicability for the regeneration of a particulate trap. Thereby different additive concentrations were examined. All investigations were carried out according to the defined loading and regeneration procedure as agreed. For all tests a SiC-particulate trap was used.

2. Plan of investigation

2.1 Test schedule

A test procedure has been set up which consists of two steps. The first one was the loading of the particulate trap and the second one was the regeneration of the filter.

Loading cycle

During the whole loading cycle the engine speed and engine load have been kept constant while the exhaust gas was about 250 °C in front of the particulate trap.

Regeneration cycle

For this cycle the engine speed has been kept constant again whereas the engine load has been raised step by step. The duration of each step was 15 min. The temperature of the exhaust gas in front of the trap increased simultaneously by about 25 °C.

The investigation of each trap consisted of 7 steps as shown in Table 2.

Table 2.1: Steps of trap investigation (overview)

no.	step	comment	speed rpm	torque Nm	duration
1	1. weigh				
2	**loading procedure**				
	engine warm up				
	trap loading		3000	30	7h
3	trap cooling				> 3h
4	2. weigh				
5	**regeneration procedure**				
	engine warm up				
	trap regeneration		3000	30 to 245	165 min
6	trap cooling				> 3h
7	3. weigh				

After measuring the weight of the trap it was mounted in the diesel engine exhaust system. Both the loading and regeneration procedures started with the same engine warm up as specified below:

1500 rpm / 25 Nm until TWater, cooler outlet > 50 deg. C
1700 rpm / 40 Nm until TWater, cooler outlet > 70 deg. C
1700 rpm / 95 Nm until TWater, cooler outlet > 80 deg. C

The raw emission of particulate matter (without additive) in the loading point was about 2.65 g/h. Table 2.2 shows the composition of particulate matter for the selected loading point.

Table 2.2: Raw emission of particulate in loading point

	loading point	
speed	3000	rpm
load	30	Nm
particulate matter (PM)	**2.651**	g/h
soluble organic fraction (SOF)	**1.435**	g/h
	54.0%	
soluble inorganic fraction (SIOF)	**0.265**	g/h
	10.0%	
insoluble fraction, soot (ISF)	**0.954**	g/h
	36.0%	

The loading procedure took 7h and the TPM-load was accounted for 15-17g. After cooling down the trap was weighed again. The regeneration procedure started with the same engine warm up as the loading procedure. The regeneration procedure consisted of 12 steps. Each step lasted 15 min.

Table 2.3 shows the selected operating points which were used during regeneration.

Step Number	trap inlet temperature [Deg. C]	engine speed [rpm]	Md [Nm]	duration [min]
Step 1	225	3000	30	15
Step 2	250	3000	41	15
Step 3	275	3000	54	15
Step 4	300	3000	67	15
Step 5	325	3000	84	15
Step 6	350	3000	102	15
Step 7	375	3000	127	15
Step 8	400	3000	146	15
Step 9	425	3000	171	15
Step 10	450	3000	201	15
Step 11	475	3000	219	15
Step 12	500	3000	245	15

Table 2.4: raw emission of particulate matter (without additive) in the operating points of the trap regeneration

Step Number	PM [g/h]	ISF [g/h]	SIOF [g/h]	SOF [g/h]
Step 1	2.651	0.954	0.265	1.435
Step 2	1.394	0.446	0.446	0.502
Step 3	2.380	1.523	0.238	0.619
Step 4	2.497	1.398	0.549	0.550
Step 5	2.549	1.733	0.280	0.536
Step 6	2.575	1.416	0.489	0.670
Step 7	2.657	1.860	0.452	0.345
Step 8	2.632	2.053	0.289	0.290
Step 9	2.895	2.142	0.376	0.377
Step 10	3.261	2.511	0.261	0.489
Step 11	4.239	3.391	0.339	0.509
Step 12	5.718	4.632	0.572	0.514

2.2 Test bench

load generated by:	direct-current machine (DC-machine)
maximum rated power output [kW]:	134
torque [Nm]:	350 / 135
speed [rpm]:	3500 / 9000
test bench automation:	CATS NT by Siemens
fuel consumption measuring instrument:	AVL 733 S
exhaust gas emission measuring instrument:	CO, THC, CO_2, O_2: Advance Optima (Fa. ABB) NOx: CLD 700 (Fa. Eco physics)
air mass sensor:	Sensyflow
smoke number measurement:	AVL 415S
soot measuring instrument:	NOVA Microtunnel

3 Test configuration

The test engine has been integrated on the test bench as can be seen in Figure 1. All required media like fuel, cooling water and fresh air were connected with the engine. Due to the objectives of the investigations some special test facilities were integrated in addition to the regular sensors of the test bench.

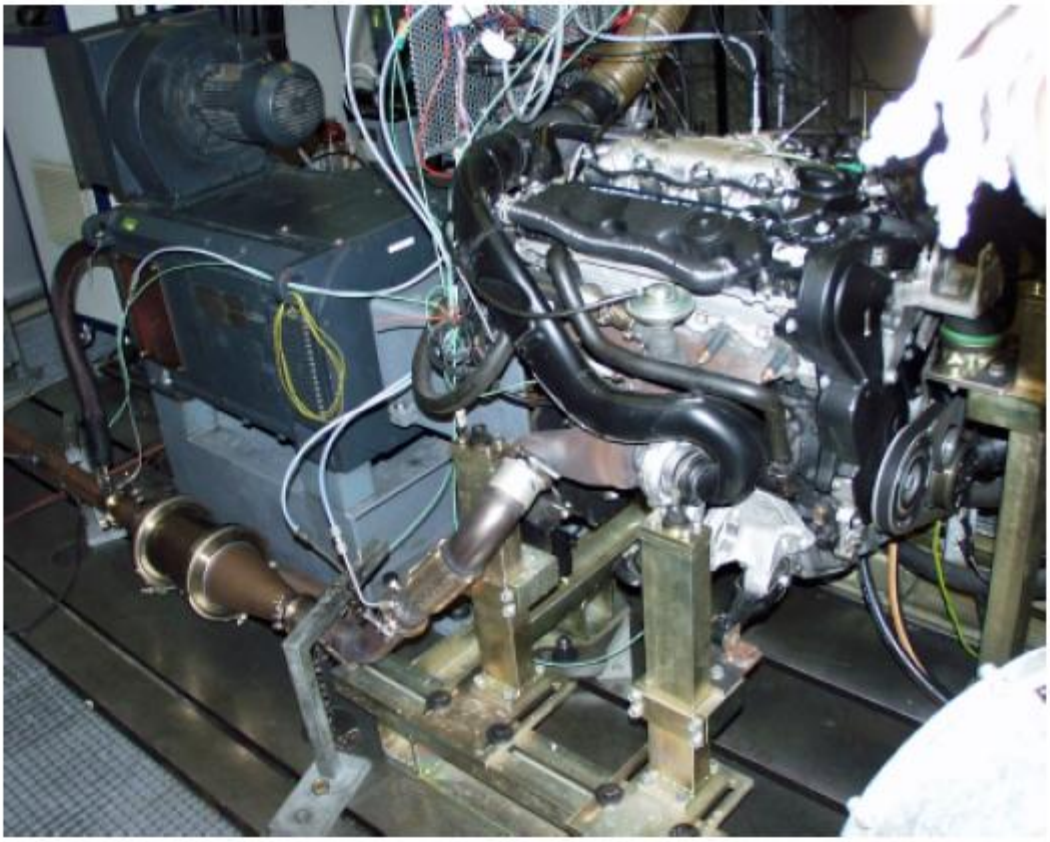


Figure 1: Test engine DW12TED4/L4 and particulate trap at the test bench

Table 3.1 shows all measurement values with the realised measuring interval. For example during the regeneration procedure all values were measured every 5 minutes. The marked values of the rightmost column were measured with an 1 second intervals.

Table 3.1: All measured values including the intervals of measurement

Measurement value		Time between measurement			
Description	Dimension	Loading		Regeneration	
		15 min	10s	5 min	1 s
Date	tt.mm.jj	✓	✓	✓	✓
Time	h:m:s/ms	✓	✓	✓	✓
Speed	rpm	✓	✓	✓	✓
Torque	Nm	✓	✓	✓	✓
Throttle angle	%	✓		✓	
Exhaust temperature before charger	deg. C	✓	✓	✓	✓
Exhaust temperature before trap	deg. C	✓	✓	✓	✓
Exhaust temperature after trap	deg. C	✓	✓	✓	✓
Trap differential pressure	mbar	✓	✓	✓	✓
Exhaust backpressure	mbar	✓	✓	✓	✓
Intake air mass flow rate	kg/h	✓	✓	✓	✓
CO emission	ppm	✓	✓	✓	✓
CO_2 emission	Vol%	✓	✓	✓	✓
THC emission	mgC/m^3	✓	✓	✓	✓
NOx emission	ppm	✓	✓	✓	✓
O_2 emission	Vol%	✓	✓	✓	✓
Smoke number	FSN	✓		✓	
Oil temperature	deg. C	✓		✓	
cooling water inlet temperature	deg. C	✓		✓	
cooling water outlet temperature	deg. C	✓		✓	
Air temperature after charger	deg. C	✓	✓	✓	✓
Air temperature after cooler	deg. C	✓		✓	
Intake air temperature	deg. C	✓		✓	
Intake air pressure	mbar	✓		✓	
Fuel consumption	g/min	✓		✓	
injection rate	mm3/stroke	✓		✓	
Specific fuel consumption	g/kWh	✓		✓	
Oil pressure	bar	✓		✓	
cooling-water pressure	bar	✓		✓	
Power output	kW	✓	✓	✓	✓
Mean pressure	bar	✓		✓	
Air humidity	%	✓		✓	
Ambient air pressure	mbar	✓		✓	

Figure 2 shows the trap and the configuration of the most important measurement points like trap differential pressure (pressure loss), backpressure, trap inlet temperature, trap outlet temperature and emission measurement. The trap differential pressure has been measured with a special sensor for differential pressure. The distance between the turbocharger outlet and the trap inlet is about 55 cm.

Figure 2: particulate trap at test bench

4 Results of investigation

Table 4.1 contains all investigated fuel borne catalysts and some characteristic values of trap loading and trap regeneration. The TPM load is defined as the difference between trap weights before and after loading procedure. The TPM burn is the difference between the trap weights before and after trap regeneration procedure. The value Ce/C is calculated as follows:

$$Ce/C = \frac{fuel\ consumption \bullet Ce\ concentration \bullet loading\ time}{soot\ load}$$

The shown value Ce/TPM is calculated as follows:

$$Ce/TPM = \frac{fuel\ consumption \bullet Ce\ concentration \bullet loading\ time}{TPM\ load}$$

Figure 3 contains a typical chart of measured trap differential pressure during loading procedure. As can be seen, the trap differential pressure increases nearly linear.

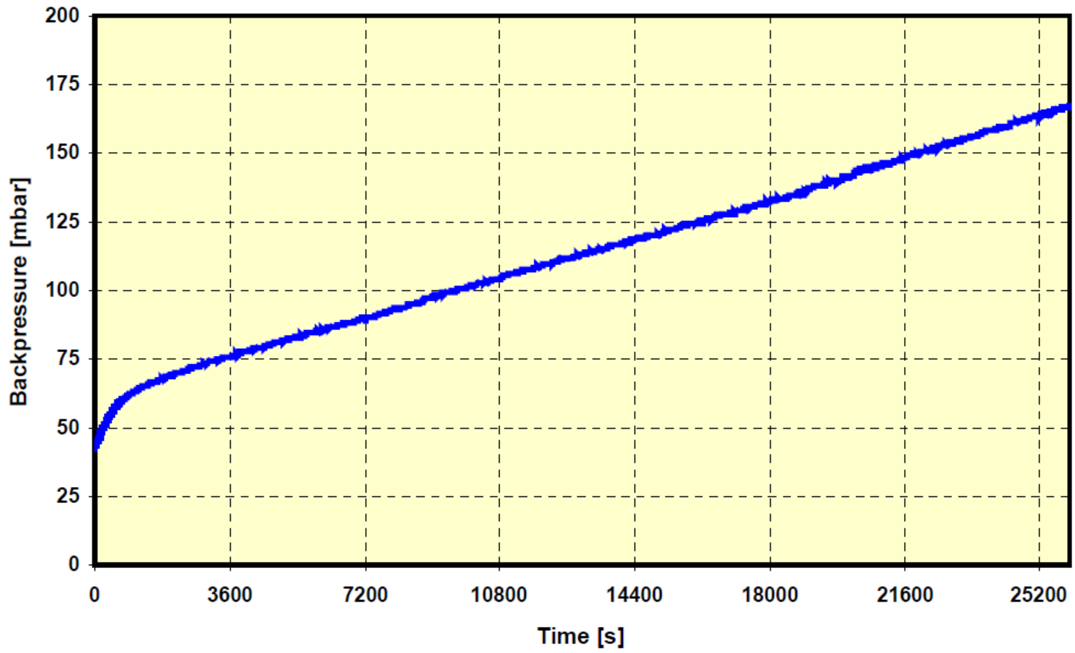


Figure 4 shows a typical chart of the trap differential pressure during regeneration procedure.

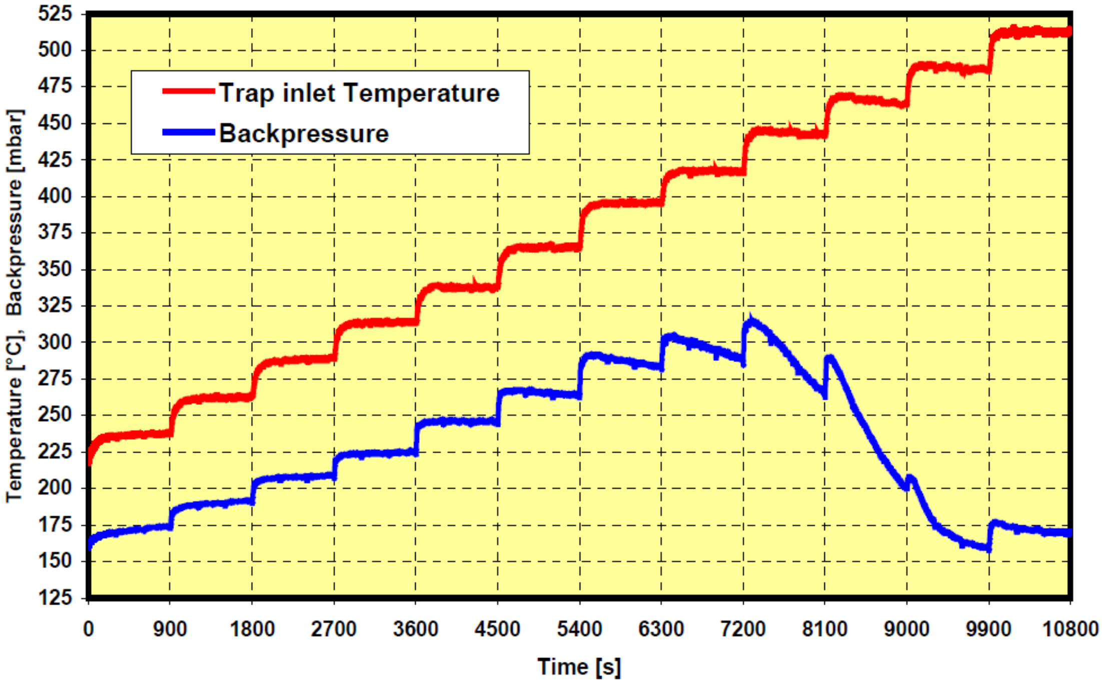


Table 4.1: Investigated fuel-borne catalysts and characteristic values of trap loading and trap regeneration

Additive	Ce concentration in fuel	Weight of trap before loading procedure [g]	Weight of trap after loading procedure [g]	TPM load [g]	Fuel consumption [kg/h]	Ce consumption [g/7h]	Ce/TPM [%]	Weight of trap after regeneration [g]	TPM burn [g]
Without FBC	0	4386,4	4401,6	15,2	4,08	0	0	4397,6	4,0
Wynn's	concentration A	4402,4	4419,5	17,1	4,1	0,086	0,50	4408,0	11,5
Wynn's	concentration B	4365,0	4381,8	16,8	4,13	0,14	0,83	4368,4	13,4
Wynn's	concentration C	4306,6	4323,2	16,6	4,08	0,29	1,75	4306,0	16,6
FBC 1	concentration A	4380,0	4394,8	14,8	4,1	0,29	1,96	4379,6	15,2
FBC 1	concentration B	4306,6	4322,6	16,0	4,16	0,73	4,56	4307,2	15,4
FBC 2	concentration A	4306,4	4322,0	15,6	4,07	0,27	1,73	4307,0	15,0

The behaviour of differential pressure for all measured additives during the loading time is shown in Figure 5. As can be seen, the trap differential pressure increases for all measurements in the same way. The curves differ from each other only in their progressivity. During the loading procedure the differential pressure increases from about 60 mbar to values between 155 and 210 mbar.

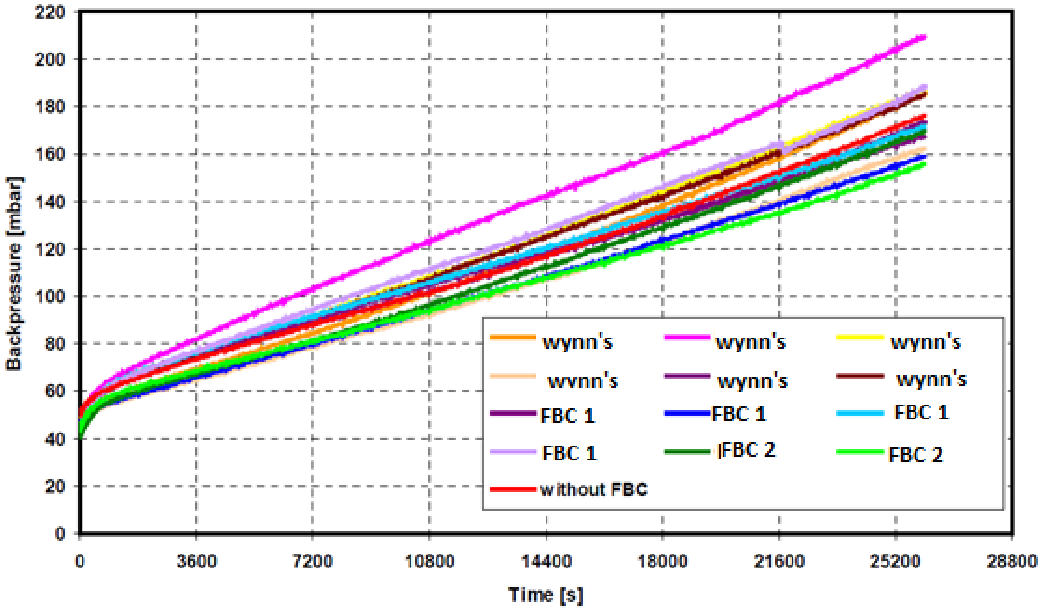


Table 4.2 and figures 7 and 8 show a comparison between regeneration rates for the investigated catalysts in dependence of the regeneration temperatures.

	Temperature [Deg. C]								
	300	325	350	375	400	425	450	475	500
FBC	RR [mbar/min]								
wynn's conc A Test 1	0,0	0,0	0,0	0,0	0,2	0,9	3,3	5,3	5,7
RR-Temperature [Deg. C]	319	343	370	400	415	445	468	486	510
wynn's conc A Test 2	0,0	0,0	0,0	0,2	0,4	1,2	4,2	5,3	6,0
RR-Temperature [Deg. C]	320	345	370	400	415	448	470	488	515
wynn's conc B Test 1	0,0	0,0	0,0	0,2	0,3	0,9	3,3	5,5	5,1
RR-Temperature [Deg. C]	320	345	370	400	420	450	472	490	512
wynn's conc B Test 2	0,0	0,0	0,0	0,1	0,5	0,8	4,1	4,9	3,5
RR-Temperature [Deg. C]	318	344	370	400	425	448	471	488	513
wynn's conc C Test 1	0,0	0,0	0,0	0,4	1,0	3,2	5,9	2,8	0,4
RR-Temperature [Deg. C]	315	338	366	396	418	445	465	488	514
wynn's conc C Test 2	0,0	0,0	0,0	0,4	1,2	4,1	8,0	2,2	0,3
RR-Temperature [Deg. C]	323	448	370	402	422	445	470	488	415
FBC 1 conc A Test 1	0,0	0,0	0,3	1,0	1,4	3,8	4,4	0,1	0,3
RR-Temperature [Deg. C]	310	335	365	392	410	435	460	485	510
FBC 1 conc A Test 2	0,0	0,0	0,8	1,1	2,0	5,2	1,6	0,3	0,1
RR-Temperature [Deg. C]	318	345	371	395	415	438	460	488	515
FBC 1 conc B Test 1	0,0	0,6	2,0	1,9	2,3	3,4	0,7	0,6	0,5
RR-Temperature [Deg. C]	320	342	366	389	408	432	460	481	511
FBC 1 conc B Test 2	0,0	0,6	3,2	2,1	2,4	3,5	0,2	0,1	0,0
RR-Temperature [Deg. C]	316	340	365	386	403	430	452	478	504
FBC 2 Test 1	0,0	0,0	0,4	0,7	1,3	4,9	3,7	0,2	0,1
RR-Temperature [Deg. C]	306	332	360	388	405	428	453	480	508
FBC 2 Test 2	0,0	0,0	0,3	0,7	1,6	5,6	2,4	0,3	0,1
RR-Temperature [Deg. C]	315	340	368	390	408	428	456	480	507

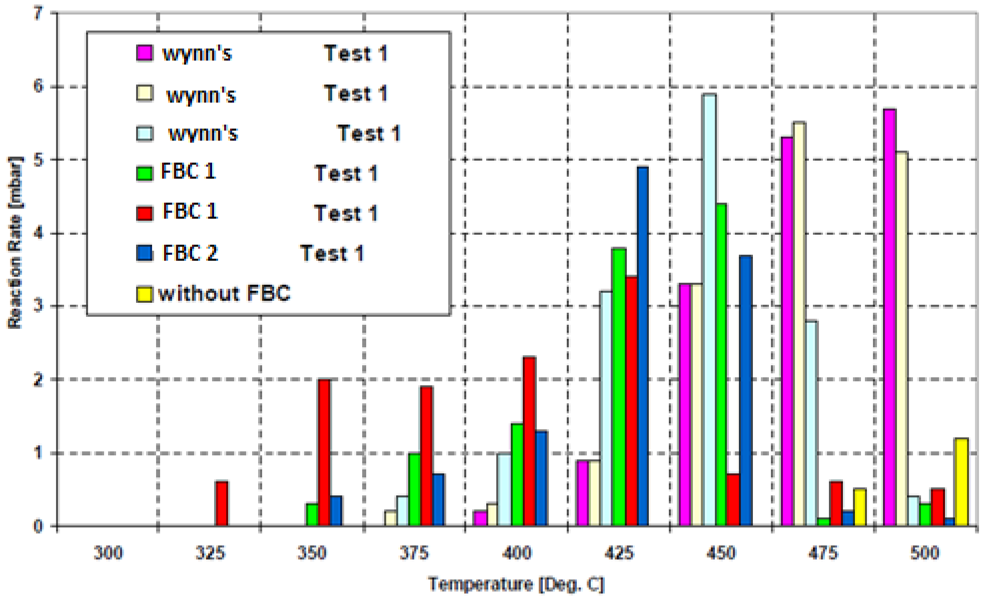


Figure 7: Comparison between Regeneration Rates (Test 1)

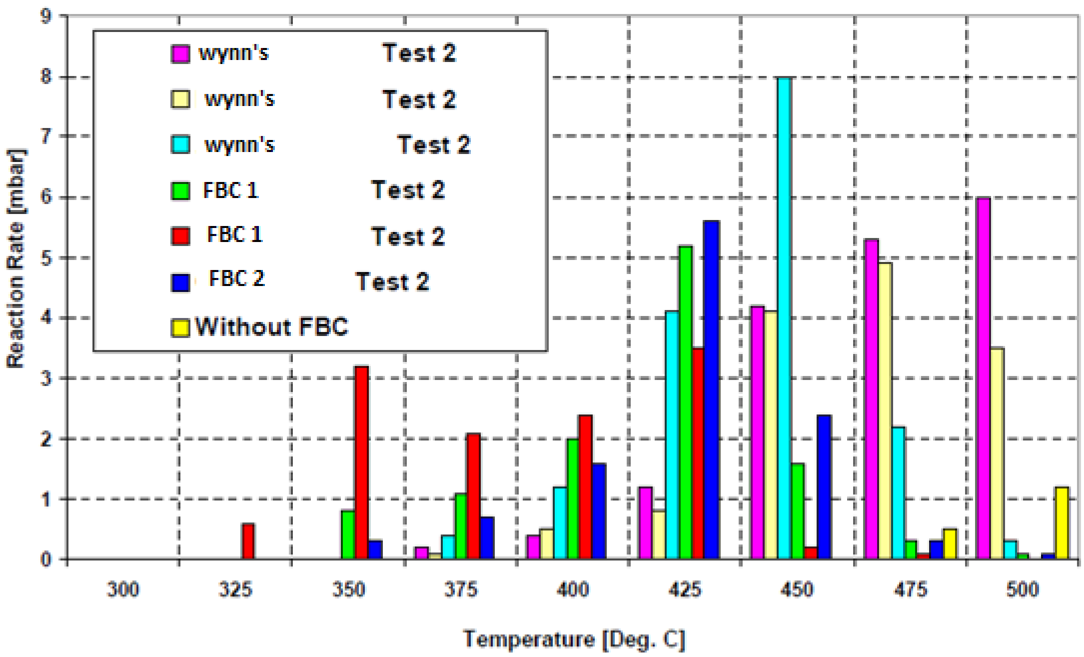


Figure 8: Comparison between Regeneration Rates (Test 2)

The following results were obtained:

By using Wynn's DPF Cleaner & Regenerator with concentrations of "A" and "B" ppm a significant regeneration of the particulate trap only starts above 450 °C. On the other hand the observed regeneration rate at this temperature is very fast compared to other catalysts. For the fuel borne catalyst 1 and 2 a distinct catalytic activity below a temperature of 450 °C only occurs for the measured concentrations of "C" ppm. Above a temperature of about 350 °C considerable regeneration rates could be observed.
Summarizing the results it could be concluded that a "C" concentration of Wynn's FBC gives reliable particulate trap regeneration at temperature below 450 °C.

Examples of Field Trial Test Results

Citroën C8 of 2002, 193 000 km. Used DPF Cleaner & Regenerator 325 ml.

Soot readout by GOCA vzw (GROUPING OF COMPANIES RECOGNIZED FOR LICENCE and VEHICLE TEST)

Before treatment: 0,69/m
After treatment: 0,38/m
Lowering soot emissions by 45%

Audi A5 2.0 TDI of 2008. Used DPF Cleaner& Regenerator 325ml.

Analysis done by Audi workshop Mertens

Before treatment: 5,06g of soot
After treatment: 3,49g of soot
Lowering soot emissions by 31%