Cleaning of Diesel Particle Filters

BACKGROUND

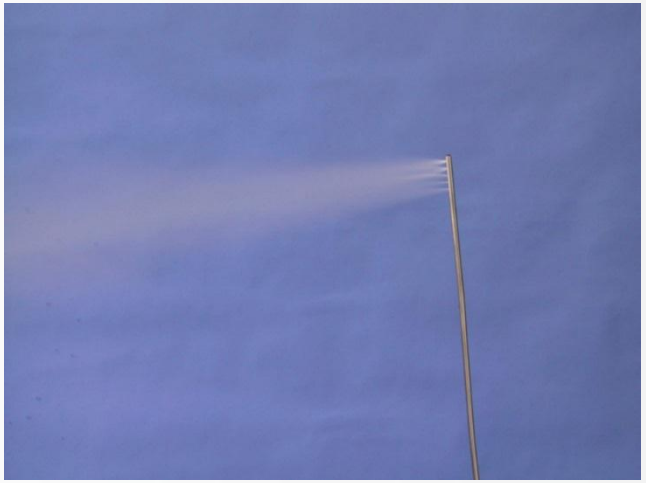
- The particle filter is loaded up with soot particles from combustion in the engine.
- The level of loading in the filter is determinded by a differential sensor and regernation is initiated.
- The soot particles are burnt off by passive or active regeneration.

BACKGROUND

- Sometimes required temperature for regeneration can not be reached (city traffic / traffic jam).
- If that happens multiple times, soot is accumulated over a critical limit
- In this case, regeneration must be initiated manually with a tester in a service centre or workshop.
- If the loading condition (differental pressure) is too high, regeneration is no longer permitted.
- Often the particle filter must be replaced in these cases.
- Also faults e.g. in the electronic system can lead to failures in the regeneration.

SOLUTION: CLEANING THE PARTICLE FILTER

- By a mechanical-chemical cleaning, regeneration of the filter is possible again.
- The particle filter does not need to be removed.
- Uses of a pressure cup spray gun with a special probe.



CLEANER AND FLUSHING LIQUID

- not inflammable
- free of ash
- metal-free
- compatible with the materials used

RESULTS BEFORE AND AFTER CLEANING

Description complaint
Filled DPF ; static regeneration impossible; errorcode P190175; loss of power

ID vehicle	
Werkordernr	365985
Brand + Type	Saab 9.3 150 HP
ID	WOLOAHM759G003019
km stand ?	149.954 km
Warranty Kulantz ?	No

Used Tunap products and duration		
Art Nr	DPF cleaner Mr-Nr 09259	
Art Nr	Nachspüll Mr-Nr 09260	
Art Nr		Total duration

Dealer		
Name	Beherman Woluwe	
Contact		
Adress		Telnr:
Postal Code		Email
Place	BXL	

Result + extra info		
Before		
% saturation DPF iddle	90%	=very high
% saturation DPF 3000 rpm	90%	=very high
difference Pressure DPF (with atmosphere) at iddle	11.2kPa	
difference Pressure DPF 3000 rpm	43.5kPa	
After Cleaning; no testdrive		
% saturation DPF iddle	90%	=very high
% saturation DPF 3000 rpm	90%	=very high
difference Pressure DPF iddle	5.4kPa	=improvem
difference Pressure DPF 3000 rpm	33.5kPa	=improvem
After Cleaning + testdrive (15km)		
% saturation DPF iddle	10%	= good
% saturation DPF 3000 rpm	10%	= good
difference Pressure DPF iddle	0kPa	
difference Pressure DPF 3000 rpm	3.8kPa	

EXTRA INFO

During Testdrive we noticed a regained full power; during testdrive also a dynamic RG occured: temp bis 670°; no enforced static RG was done after testdrive because saturation of DPF was normal again

RESULTS BEFORE AND AFTER CLEANING

Filled DPF ; static regeneration impossible; errorcode

ID vehicle	
Werkordernr	
Brand + Type	KIA Sportage 136 HP
ID	?
km stand ?	7.406
Warranty Kulantz ?	yes

Used Tunap products and duration		
Art Nr	DPF cleaner Mr-Nr 09259	
Art Nr	Nachspüll Mr-Nr 09260	
Art Nr		Total duration

Dealer		
Name	Dewoede Koksijde	
Contact		
Adress		Telnr:
Postal Code		Email
Place	Koksijde	

Result + extra info

Before		
soot mass (russ massa) DPF iddle (leerlauf)	5,49 gram	
soot mass (russ massa) DPF 3000 rpm	5,49 gram	
difference Pressure DPF (with atmosphere) at iddle	0	
difference Pressure DPF 3000 rpm	0	
After Cleaining + Testdrive		
soot mass (russ massa) DPF iddle (leerlauf)	4,71 gram	= good improvement
soot mass (russ massa) DPF 3000 rpm	4,71 gram	
difference Pressure DPF (with atmosphere) at iddle	0	
difference Pressure DPF 3000 rpm	0	
After Cleaning + Testdrive + Static RG		
Static Regenaration	**Succes**	
soot mass (russ massa) DPF iddle (leerlauf)	3,91 gram	= very good
soot mass (russ massa) DPF 3000 rpm	3,91 gram	
difference Pressure DPF (with atmosphere) at iddle	0	
difference Pressure DPF 3000 rpm	0	

RESULTS BEFORE AND AFTER CLEANING

Filled DPF ; static regeneration impossible

ID vehicle	
Werkordernr	AT01004553
Brand + Type	Opel Corsa 1,3 ZDTJ
ID	WOLOSDL0896033061
Warranty Kulantz ?	unknown

Used Tunap products and duration			
Art Nr	DPF cleaner Mr-Nr 09259		
Art Nr	Nachspüll Mr-Nr 09260		
Art Nr		Total duration	1,5h

Dealer		
Name	Opel Peeters Waterloo	
Contact	Anastasio	
Adress		Telnr:
Postal Code		Email
Place	Waterloo	

Result + extra info		
Before		
% saturation DPF iddle	45%	
% saturation DPF 3000 rpm	45%	
difference Pressure DPF (with atmosphere) at iddle	~~8kPa~~	
difference Pressure DPF 3000 rpm	30kPa	
After Cleaning + test drive 15 km		
% saturation DPF iddle	47%	
% saturation DPF 3000 rpm	47%	
difference Pressure DPF iddle	~~3 kPa~~	
difference Pressure DPF 3000 rpm	26kPa	
After Cleaning + test drive 15 km + Stat RG; no test drive after stat RG		
Static Regenaration	success	
% saturation DPF iddle	73%	= normal for Opel after stat RG
% saturation DPF 3000 rpm	73%	= normal for Opel after stat RG
difference Pressure DPF iddle	~~6 kPa~~	Super !
difference Pressure DPF 3000 rpm	2 kPa	Super !

BENCH TESTS DPF CLEANING

TARGETS OF BENCH TESTS

- Verification of the efficiency of TUNAP particle filter cleaning System under different basic conditions
- Testing of the stability of the filter coating against the cleaning agent
- Monitoring of the temperature profile during regeneration of a treated filter

ENGINE TEST RIG

Engine: VM R425 2,5 l 100 kW

Particle Filter: DINEX X25
Siliziumkarbid ø5,66” x 8”

Coating: Platinium

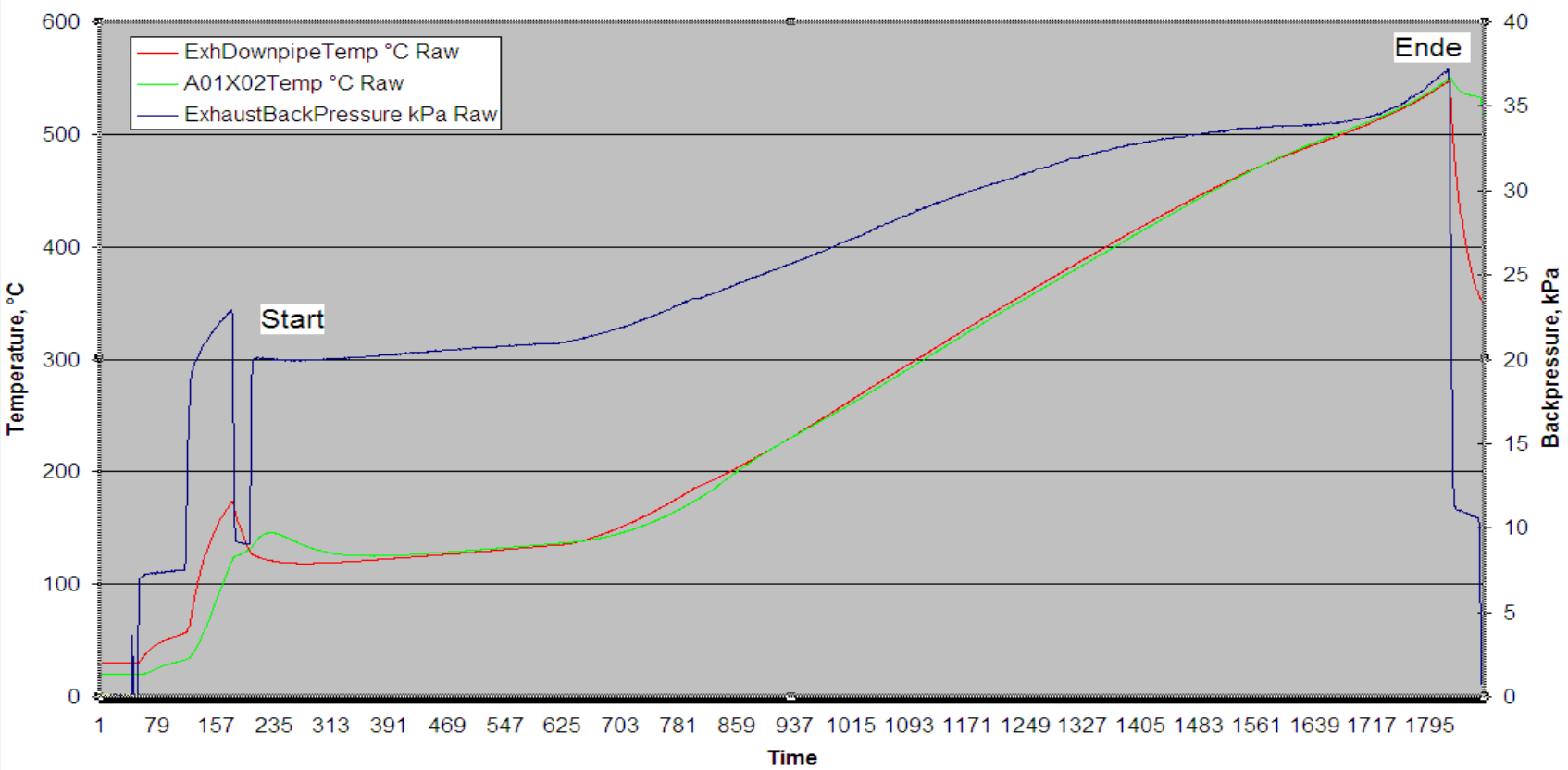
LOADING OF THE FILTER

- Exhaust gas back pressure of the clean filter: 3,9kPa
- Loading of the filter through repeated acceleration cycles of 4.5 seconds over one hour
- After one hour the back pressure reaches a back pressure of 20kPa (corresponds to fully loaded filter)

SIMULATION OF REGENERATION

- The filter is run over a load ramp from 0 to 240 Nm at 1800 rpm.
- The ramp time is 20 min.
- Back pressure, temperature before and after the filter, particle number and size distribution and gas composition after the filter is monitored

REGENERATION UNTREATED FILTER

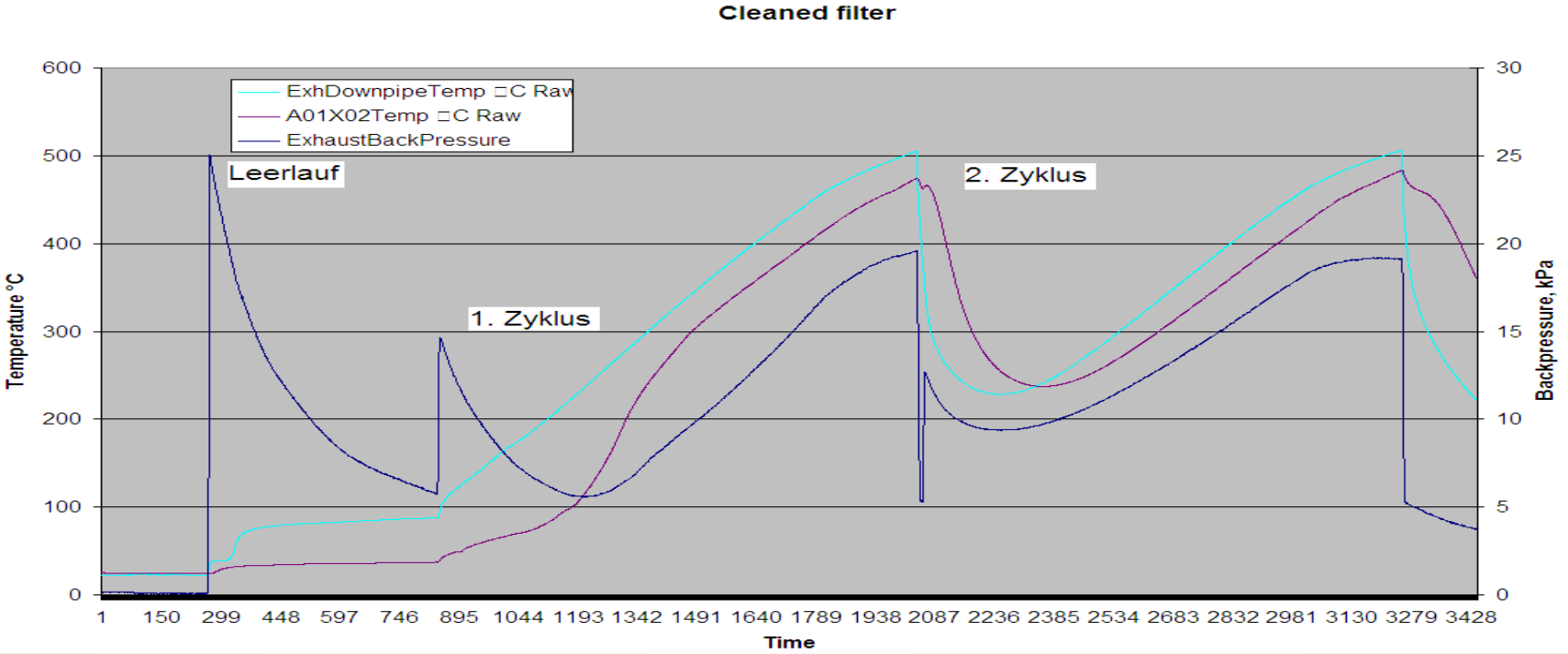


BP at start:	20,0 kPa	Due to exothermic reaction the temperature after filter surpasses the temperature before the filter quickly	
BP at maximum load:	37,2kPa	Maximum temperature after filter:	547°C
BP at end of test:	10,6 kPa	Maximum temperature before filter:	549°C
BP fresh filter:	3,9 kPa		

RESULTS

- Exhaust backpressure increases continuously until the start of regeneration. Start with 20 kPa.
- The temperature downstream the filter is rapidly higher than upstream the filter , because the exothermic reaction of combustion of soot generated an addition temperature.
- The exhaust back pressure at test end and after regeneration is 10.9kPa . For a new filter this value is at ca.4kPa
- The maximum temperature is around 550 ° C

REGENERATION OF A TREATED FILTER



BP at start ideling:	25,0 kPa
BP after ideling:	5,7 kPa (20,0 kPa)
BP at maximum load:	19,5 kPa (37,2 kPa)
BP at end of test:	4,0 kPa (10,6 kPa)
BP fresh filter:	3,9 kPa

Werte in Klammern sind Werte vor Reinigung.

Temperature after filter distinctive lower than before filter

Maximum temperature after filter:	475°C (547°C)
Maximum temperature before filter :	504°C (549°C)

RESULTS AND CONCLUSION

- At engine start the exhaust backpressure rises briefly to about 20kPa. This is due to the fact that there is still a amount of cleaning liquid in the filter, which is pressed with the exhaust gas through the filter.

- Thereafter, the exhaust backpressure drops at idle to 5,7kPa and at full load on 19,5kPa. This is a proof that a large amount of soot was flushed through the cleaning.The comparison value of the untreated filter was after regeneration 20kPa at idle and at full load 37,2kPa.

- The exhaust backpressure at test end after regeneration was 4kPa, which corresponds to a new filter. In comparison, the value for a only regenerated filter was 10,6kPa.

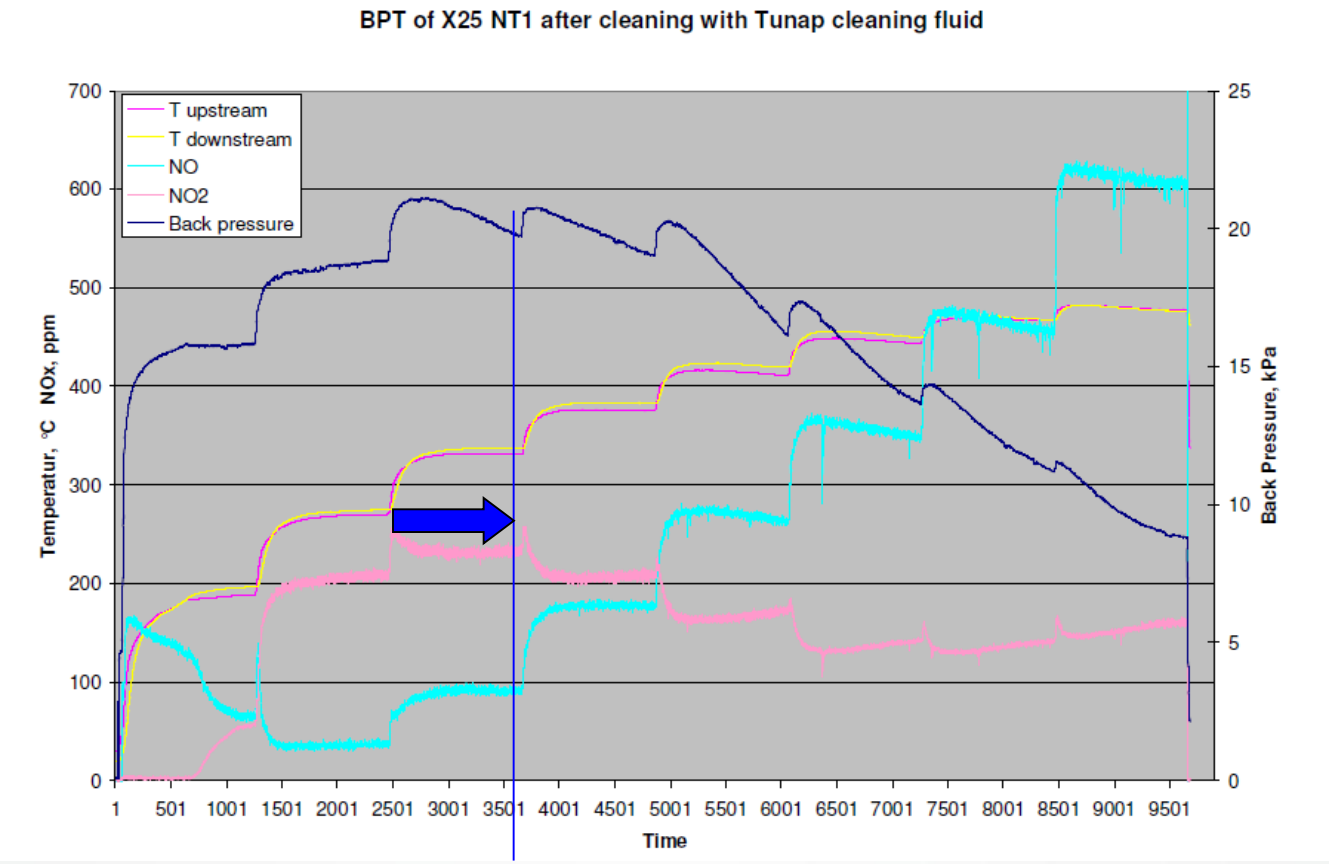
RESULTS AND CONCLUSION

- The tempertures are generally at a much lower level between 504°C before filter and 475°C after the filter. An untreated filter reaches in comparison both before and after the filter temperatures around 550°C.

- Striking is also that the temperature before filter never exceeds the temperature after the flter. Rather, it is always a difference of at least 25°C to see.

- The rise of the temperture after filter is due to a exothermic reaction in the oxidation of the soot during regeneration. A lower temperature rise, therefore means that already much of the soot has been rinsed during the cleaning.

DETERMINATION OF THE BALANCE POINT



The balance point temperature of the treated filter is 320°C, which is within normal for Dines X25 coated filters.

The balance point is the point where sampled particles are as much as the oxidised particles. This is the point with the highest backpressure before the backpressure curve drops down.

RESULTS AND CONCLUSION

- The balance point of the cleaned filter is exactly the same as of an uncleaned filter.
- It can be concluded that the catalytic coating of the purified filter works the same way that a crude filter.
- In case of a damage to the coating the balance point would be higher , and there would higher temperatures required for combustion of the soot.

TEST OF THE EFFECT ON ASH LOADED FILTERS

Sample material:

Silicon carbide filters from Volvo V50 after 145278 km. FBC has been used on the vehicle
Silicon carbide filter from Toyota Corolla after 104270 km. No use of FBC

Test Equipment:

VM Motori R4 R425-1, 2,5 l 100 kW
T250 Horiba engine test bench with standard data collection system, especially difference pressure upstream of filter and temperatures upstream and downstream
MEXA FTIR gas measurement system
EECPC particle counter, TSI
EEPS particle sizer, TSI
Thermo Dilution system, Matter Engineering

ASH LOADED FILTERS
TESTING PROCESS

1.) Weighing of untreated filter m(1)
2.) Heating to 625°C for 2 hours
3.) Weighing of Filter m(2)
4.) Cleaning Procedure (includes regeneration)
5.) Weighing of Filter m(3)
6.) Heating to 625°C for 2 hours
7.) Weighing of filter m(4)
8.) Cleaning of the filter with compressed air
9.) Weighing of filter m(5)

Δ(m1, m2) = Soot
Δ(m2, m3) = Weight difference before/after cleaning
Δ(m3, m4) = Soot produced during regeneration/cleaning
Δ(m2, m4) = Ash removed
Δ(m4, m5) = Rest of ash remaining in filter

RESULTS

		m(1)	m(2)	m(3)	m(4)	m(5)
Volvo V50	From car running FBC	8059	8045	8038	8035	8032
Toyota Corolla	No FBC	7129	7093	7063	7065	7065

		Soot in filter Δ(m1, m2)	Ash removed Δ(m2, m3)	Soot 2 Δ(m3, m4)	Ash remaining Δ(m4, m5)
Volvo V50	From car running FBC	14	7	3	3
Toyota Corolla	No FBC	36	30	-2	0

Weight changes during processing and testing of the filters (all figures in g)

RESULTS AND CONCLUSION

- According to the performed test, the Tunap cleaning fluid entrains the accumulated ash through the filter medium.
- It is surprising that the filter running without FBC apparently has higher ash content.
- The PM-counts in both filters after the test indicates a good filtration efficiency of the filters.
- The filtering efficiency is normal, after the cleaning fluid has been forced through the filter medium and evaporated.

MECHANISM AND FURTHER TESTING

- The mechanism of the TUNAP cleaning fluid is a combination of chemical and physical effects

- The fluid reacts with components in the soot which contains not only carbon based soot, but also partially oxidised hydrocarbons and ash components

- Liquid pressure helps to compress particles and “wash” them out of the filter

Thank you for your Attention!