World Harmonized Duty Cycle (WHDC) Test Programme on WHDC Option No. 5

Final Report
Version 1

26th WHDC Meeting
13th January 2009
Geneve

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PM variables to be investigated - I

•47 mm vs. 70 mm filter size for
- TX40 EMFAB (PTFE coated glass fibre) and
- TEFLO Filter using bonded ring (PTFE membrane)
  => 70 mm TEFLO filter with ring not available

•Correlation
- Partial and full flow systems for PM.
- Full flow sampling and raw gas sampling for gaseous components.
- CPC according to PMP at full flow and partial flow system for at least 7 cycles.

•Sampling probes
- CVS PM probe with 8 mm internal diameter to be used (min. 12 mm requested by current EC regulation).
- Partial flow PM probe min. 4mm according to WHDC GTR

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PM variables to be investigated - II

Influence of sampling system residence time and filter face velocity

- Requested residence time for dilution systems 1 to 5 seconds from inlet of tunnel until filter face for full flow and partial flow system.
- For CVS at least 0.5 seconds residence time for secondary dilution.
- On CVS (FF) two different CVS flow with one Filter Face Velocity.
- CVS flow constant, FFV variation via Gprobe.
- On partial flow system Gtot variation => FFV / Residence time variation.

Other sampling conditions

- Sample line length for partial flow system as short as possible.
- Dilution ratio minimum at full load between 5:1 – 7:1 with at least 2:1 in pri. tunnel
- Variation in partial flow system via Gdil with Gtot = const. (FFV / FFT = const.) to archive 5:1 and 10:1 overall dilution ration in the partial flow system

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Test engines – Test cycles

• Engine No. 1

- IVECO F4AE with SCRT System, Euro V / EEV
- V_H = 5883 cm³, P = 205 kW @ 2500 1/min

• Engine No. 2

- Mercedes Benz OM501 with SCR System, Euro V / EEV
- V_H = 11946 cm³, P = 350 kW @ 1800 1/min

• WHTC, every first cycle per day cold, all other hot and WHSC

- Each test to be run 7 times (at least)
- Pre-conditioning for the cold cycle to be performed as last cycle per day
- Soak Time to be considered: 10 min

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Parameter set-up – Engine I

Full flow / CVS (FF)

variation [-]	filter [mm]	venturi [-]	Gtot [g/s]	FFV [cm/s]	dilution prim.	dilution sec.	dilution total [-]	r [%]
1	47	1+2	0,9	63	3:1	2:1	6:1	0,042
	70			26				
2	47		1,4	98				0,065
3	47	1+3	0,9	63	6:1	-	6:1	0,046
4			1,4	98				0,072
				Limitation: max. 100 cm/s	Limitation: min. 2:1		Limitation: 5:1 - 7:1	

CVS Distance: mixer - probe [cm]	SPC Distance: probe inlet - filter [cm]	CVS	SPC Residence time [s]	total Residence time [s]	CVS flow [kg/h]
360	see sheet "Residence time SPC"	0,39	2,02	2,41	~ 4000
			2,29	2,68	
			1,95	2,34	
		0,23	1,37	1,60	~ 7000
			1,30	1,53	
			Limitation: mind. 0,5 s	Requested: 1 - 5 s	

Partial flow (PF)

variation [-]	filter [mm]	Gtot [g/s]	dilution q [-]	FFV [cm/s]	r [%]
1	47	0,9	5	63	0,06
	70			26	
2	47	1,4		98	0,093
3	47	0,9	10	63	0,03
4		1,4		98	0,046
		Limitation by SPC: 0,8 - 2,0 g/s		Limitation: max. 100 cm/s	
	47	0,8		56	
		2,0		139	
	70	0,8		23	
		2,0		57	

SPC Distance: probe inlet - filter [cm]	SPC Residence time [s]
see sheet "Residence time SPC"	1,65
	1,93
	1,06
	1,24
	1,65
	1,06
	Requested: 1 - 5 s

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Parameter set-up – Engine II

Full flow / CVS (FF)

variation [-]	filter [mm]	venturi [-]	Gtot [g/s]	FFV [cm/s]	dilution prim.	dilution sec.	dilution total [-]	r [%]
1	47	2+3	0,9	63	3,4:1	1,8:1	~ 6:1	0,021
	70			26				
2	47		1,4	98				0,033
3	47	1+2+3	0,9	63	4:1	1,5:1	~ 6:1	0,023
4			1,4	98				0,035
				Limitation: max. 100 cm/s	Limitation: min. 2:1		Limitation: 5:1 - 7:1	

CVS Distance: mixer - probe [cm]	SPC Distance: probe inlet - filter [cm]	CVS	SPC Residence time [s]	total Residence time [s]	CVS flow [kg/h]
360	see sheet "Residence time SPC"	0,16	2,02	2,18	~ 8400
			2,29	2,45	
			1,95	2,11	
		0,14	1,37	1,51	~ 9600
			1,30	1,44	
			Limitation: mind. 0,5 s	Requested: 1 - 5 s	

Partial flow (PF)

variation [-]	filter [mm]	Gtot [g/s]	dilution q [-]	FFV [cm/s]	r [%]
1	47	0,9	5	63	0,034
	70			26	
2	47	1,4		98	0,052
3	47	0,9	10	63	0,017
4		1,4		98	0,026
		Limitation by SPC: 0,8 - 2,0 g/s		Limitation: max. 100 cm/s	
	47	0,8		56	
		2,0		139	
	70	0,8		23	
		2,0		57	

SPC Distance: probe inlet - filter [cm]	SPC Residence time [s]
see sheet "Residence time SPC"	1,65
	1,93
	1,06
	1,24
	1,65
	1,06
	Requested: 1 - 5 s

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Results

1. Gaseous Components
   - Overview
   - NO_X Comparison CVS (FF) vs. raw gas (PF)
   - CO_2 Comparison CVS (FF) vs. raw gas (PF)
2. PM - Particulate Matter
   - Overview
   - Parameter Variations
   - Teflo vs. TX sampling filter

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Results - Engine I - Gaseous Components - Overview 1

All WHTC cold + hot, CoV not to be used

	diluted gas [g/kWh]				raw gas [g/kWh]				perc. dev. (FF as basis)			
	HC	CO	NOx	CO2	HC	CO	NOx	CO2	HC	CO	NOx	CO2
arithmetic mean, all c+h	0,042	0,091	2,517	720,0	0,006	0,103	2,540	724,4	-	18,9	1,3	0,6
standard deviation, all c+h	0,0161	0,0494	0,8416	9,1033	0,0025	0,0506	0,8396	9,5913				
coeffi. of variance, all c+h	38,10	54,23	33,44	1,26	43,21	49,31	33,06	1,32				

CVS and raw gas show remarkable good agreement for NO_x and CO_2.

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Results - Engine I - Gaseous Components - Overview 2

All WHTC hot (all hot with pre-conditioning, see slide NOx comparision)

	diluted gas [g/kWh]				raw gas [g/kWh]				perc. dev. (FF as basis)			
	HC	CO	NOx	CO2	HC	CO	NOx	CO2	HC	CO	NOx	CO2
arithmetic mean, only h	0,040	0,069	2,050	718,7	0,005	0,077	2,079	722,8		16,2	1,4	0,5
standard deviation, only h	0,0165	0,0142	0,1494	8,1772	0,0011	0,0103	0,1596	8,4496				
coeff. of variance, only h	41,14	20,59	7,29	1,14	24,15	13,36	7,68	1,17				

CoV for CVS and raw gas well below 10 for NO_x and CO_2.

CVS and raw gas show remarkable good agreement for NO_x and CO_2.

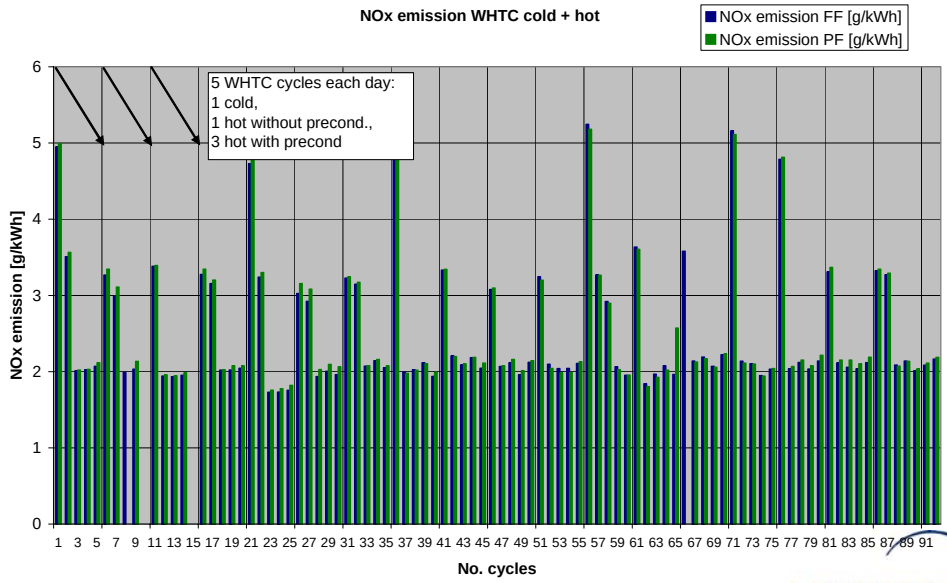
Results - Engine I - Gaseous Components - Overview 3

All WHSC (hot)

	diluted gas [g/kWh]				raw gas [g/kWh]				perc. dev. (FF as basis)			
	HC	CO	NOx	CO2	HC	CO	NOx	CO2	HC	CO	NOx	CO2
arithmetic mean value	0,028	0,066	2,478	677,2	0,003	0,064	2,546	683,4	-	-0,3	2,7	0,9
standard deviation	0,0106	0,0101	0,0894	5,4621	0,0059	0,0082	0,0811	8,8654				
coefficient of variance	37,97	15,27	3,61	0,81	171,25	12,83	3,19	1,30				

CoV and percentage deviation good to very good for NO_x and CO_2.

Engine I – Gas. Components - NO_X Comparison CVS (FF) vs. raw gas (PF) - 1



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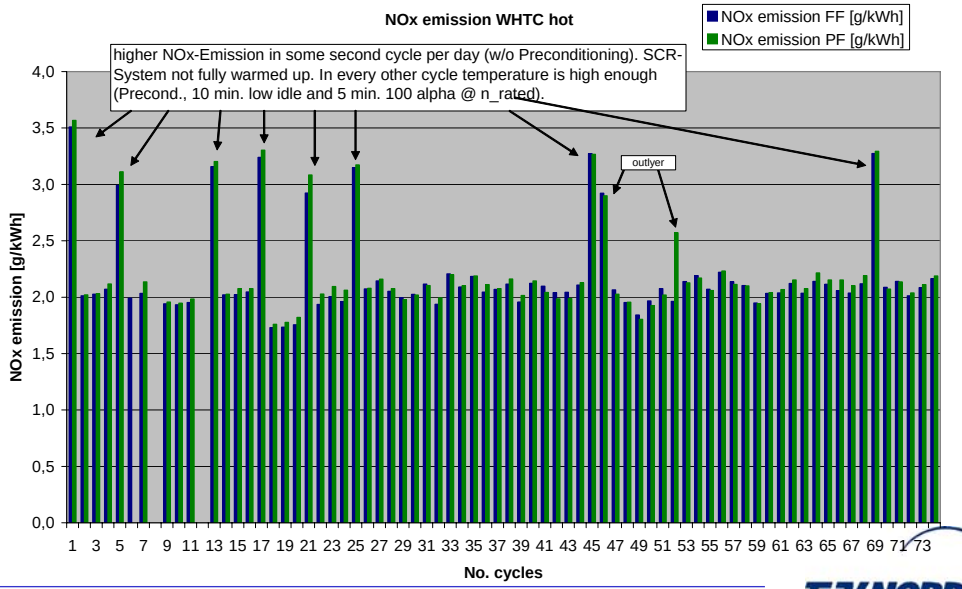
Engine I – Gas. Components - NO_X Comparison CVS (FF) vs. raw gas (PF) – 2



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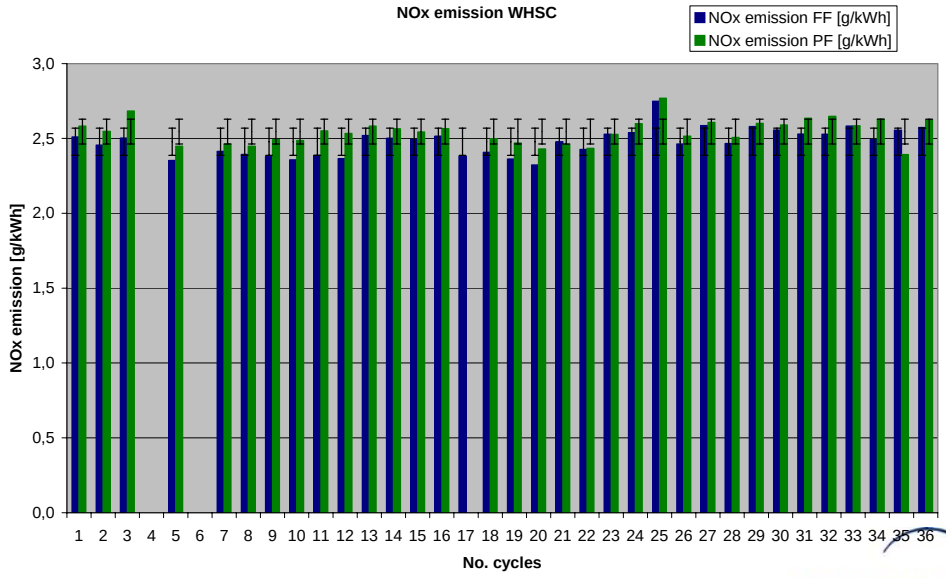
Engine I – Gas. Components - NO_X Comparison CVS (FF) vs. raw gas (PF) – 3



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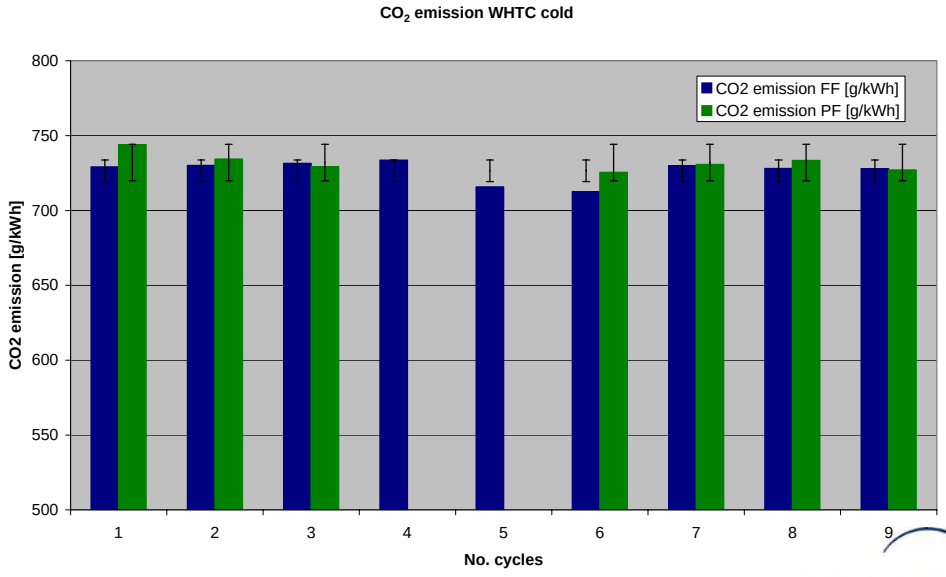
Engine I – Gas. Components - CO_2 Comparison CVS (FF) vs. raw gas (PF) - 1



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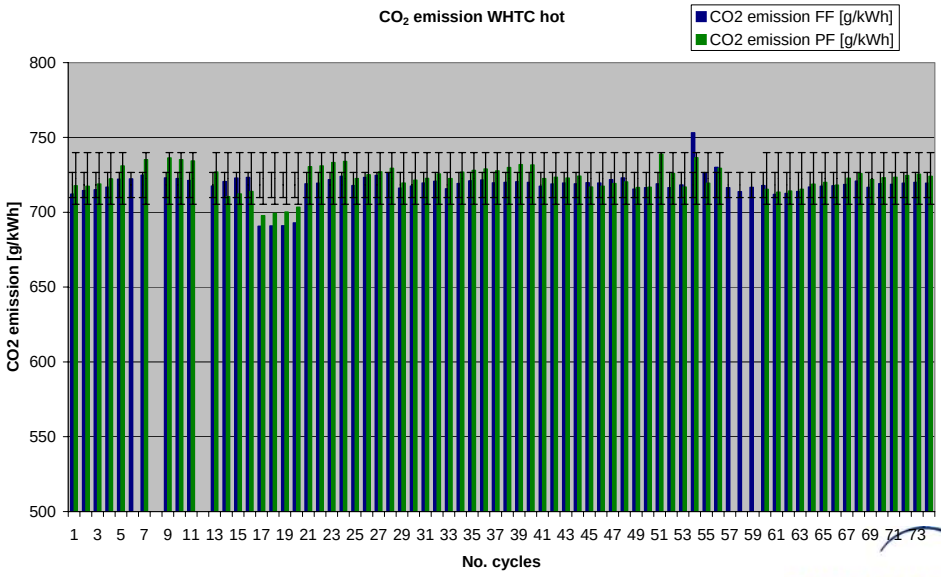
Engine I – Gas. Components - CO_2 Comparison CVS (FF) vs. raw gas (PF) - 2



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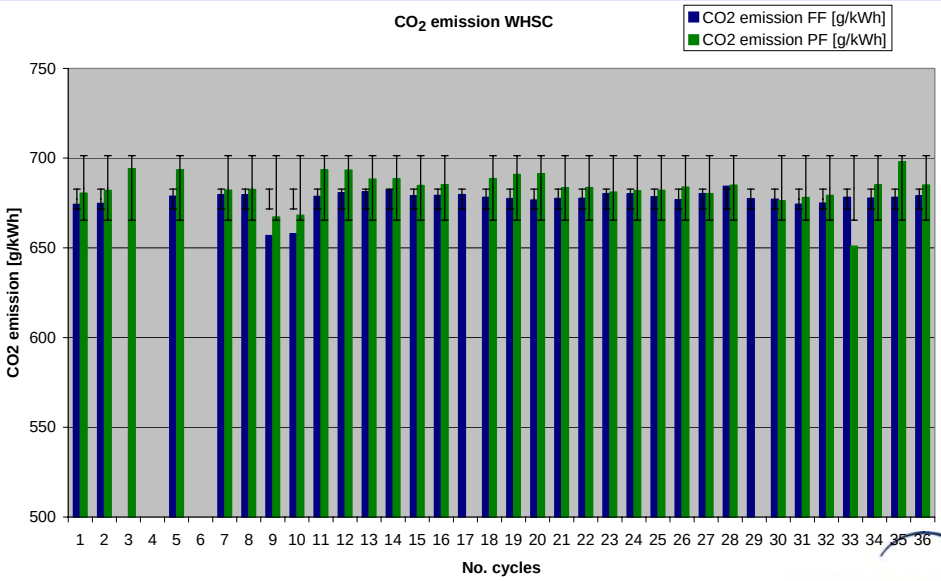
Engine I – Gas. Components - CO2 Comparison CVS (FF) vs. raw gas (PF) - 3



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Results - Engine II - Gaseous Components - Overview 1

All WHTC cold + hot, CoV not to be used

	diluted gas [g/kWh]				raw gas [g/kWh]				perc. dev. (FF as basis)			
	HC	CO	NOx	CO2	HC	CO	NOx	CO2	HC	CO	NOx	CO2
arithmetic mean, all c+h	0,047	2,687	2,699	670,4	0,017	2,562	2,770	672,7	-	-4,3	2,5	0,3
standard deviation, all c+h	0,0146	0,1925	1,1863	6,6809	0,0030	0,2001	1,2127	6,4131				
coeffi. of variance, all c+h	31,34	7,16	43,96	1,00	17,63	7,81	43,78	0,95				

CVS and raw gas show good to very good agreement for NO_x, CO and CO_2.

Results - Engine II - Gaseous Components - Overview 2

All WHTC hot (all hot with pre-conditioning, see slide NOx comparision)

	diluted gas [g/kWh]				raw gas [g/kWh]				perc. dev. (FF as basis)			
	HC	CO	NOx	CO2	HC	CO	NOx	CO2	HC	CO	NOx	CO2
arithmetic mean, only h	0,048	2,698	1,822	668,3	0,015	2,584	1,867	671,0	-	-3,8	2,6	0,4
standard deviation, only h	0,018	0,190	0,124	4,1951	0,001	0,170	0,185	4,7255				
coeff. of variance, only h	36,98	7,05	6,82	0,63	6,00	6,57	9,92	0,70				

CoV for CVS and raw gas well below 10 for NO_x, CO and CO_2.
HC CoV much better for PF System.

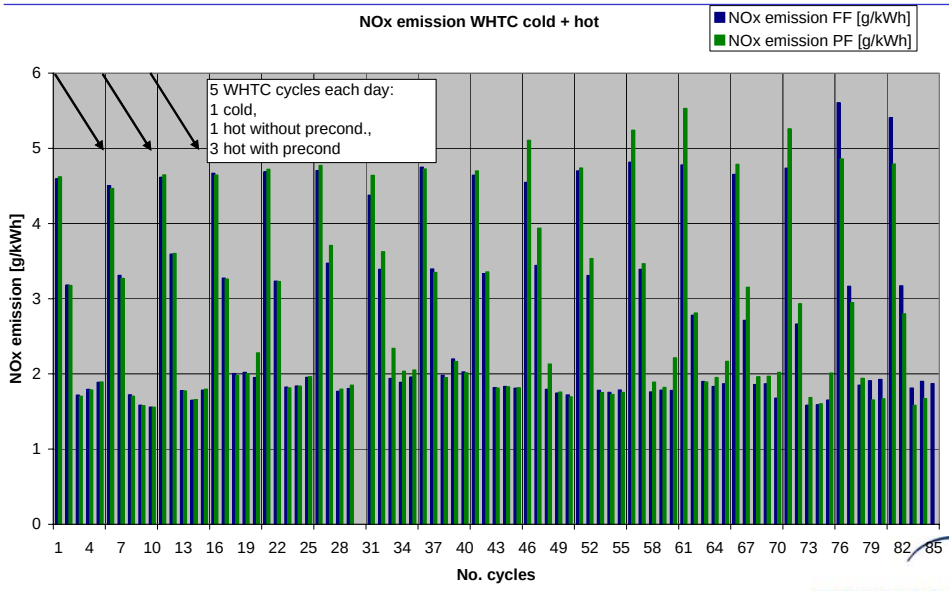
CVS and raw gas show remarkable good agreement for NO_x, CO and CO_2.

Results - Engine II - Gaseous Components - Overview 3

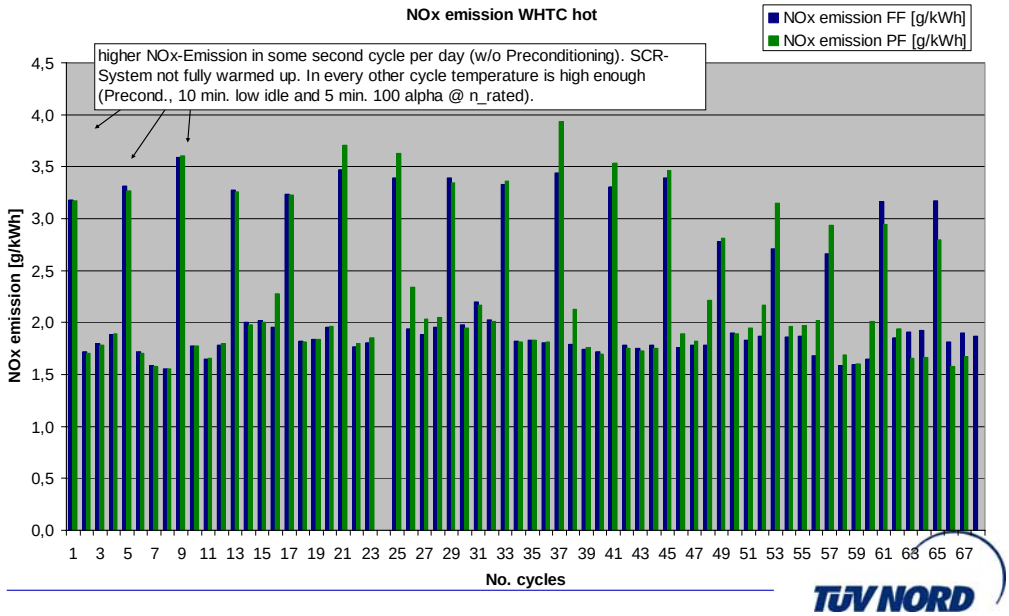
All WHSC (hot)

	diluted gas [g/kWh]				raw gas [g/kWh]				perc. dev. (FF as basis)			
	HC	CO	NOx	CO2	HC	CO	NOx	CO2	HC	CO	NOx	CO2
arithmetic mean value	0,034	0,553	1,301	632,3	0,007	0,539	1,342	629,6	-	-2,3	3,6	-0,4
standard deviation	0,018	0,038	0,090	3,262	0,002	0,014	0,132	3,924				
coefficient of variance	52,84	6,80	6,88	0,52	29,40	2,67	9,85	0,62				

Engine II – Gas. Components - NO_x Comparison CVS (FF) vs. raw gas (PF) - 1



Engine II – Gas. Components - NO_x Comparison CVS (FF) vs. raw gas (PF) - 2



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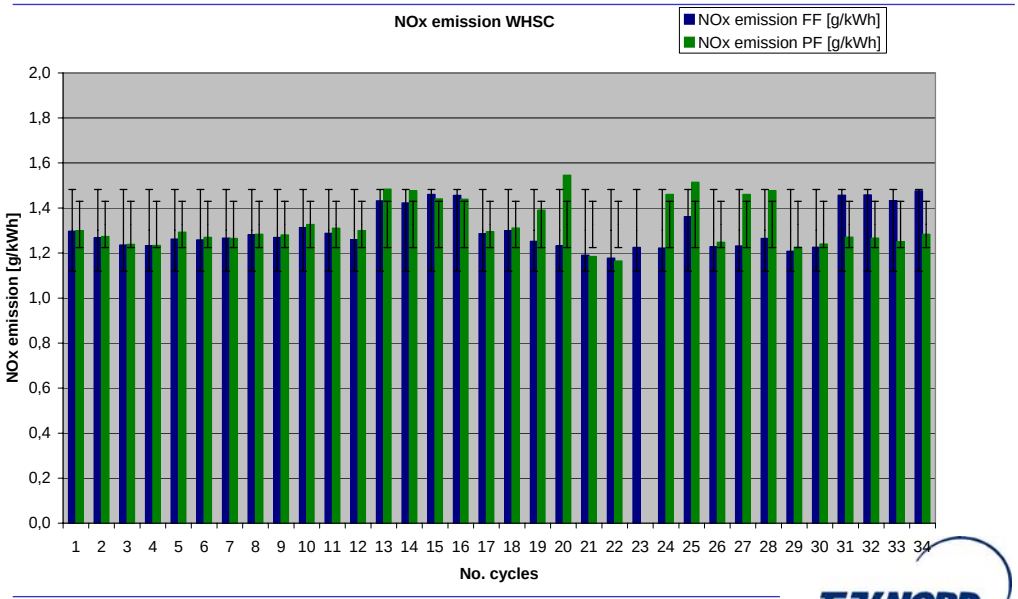
Engine II – Gas. Components - NO_x Comparison CVS (FF) vs. raw gas (PF) - 3



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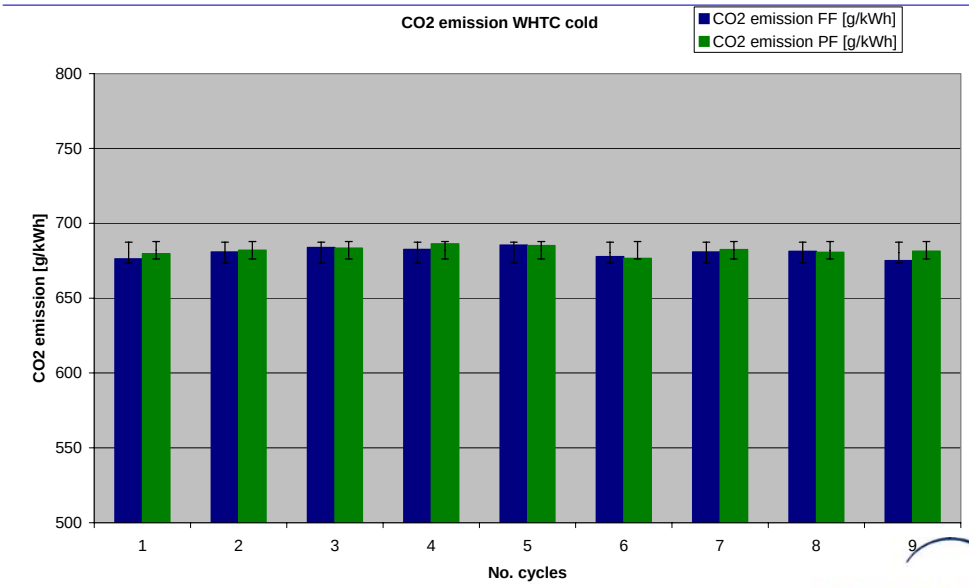
Engine II – Gas. Components - CO2 Comparison CVS (FF) vs. raw gas (PF) - 1



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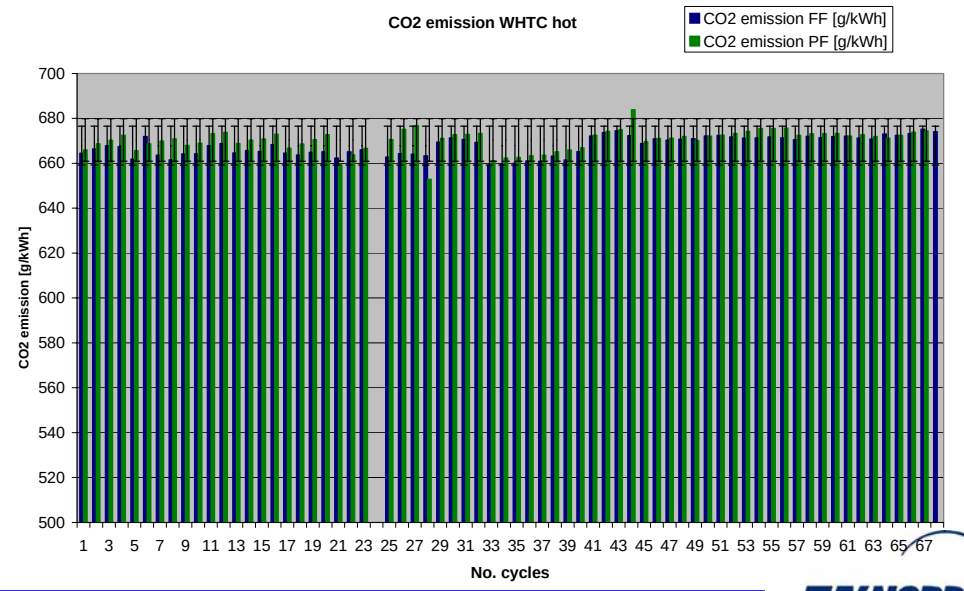
Engine II – Gas. Components - CO2 Comparison CVS (FF) vs. raw gas (PF) - 2



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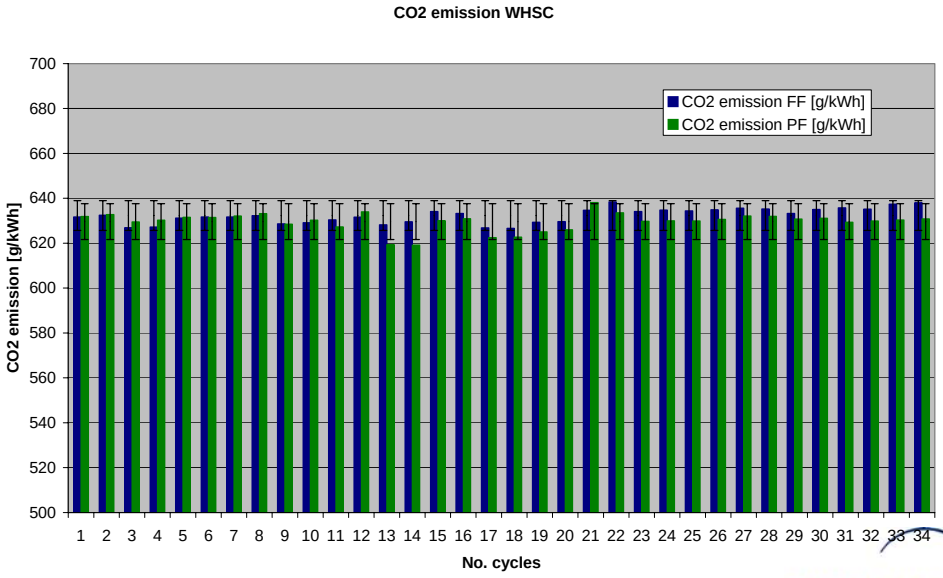
Engine II – Gas. Components - CO2 Comparison CVS (FF) vs. raw gas (PF) - 3



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Gaseous Components - Conclusions

The gaseous components NO_x, CO, HC and CO_2 sampled in the raw exhaust according to ISO 16183 respectively GTR No. 4 showed again good to very good agreement when compared to the CVS procedure (sampling in diluted exhaust gas).

The coefficient of variation showed good to very good repeatability. The NO_x and CO_2 CoV's for the raw gas sampling are on the same level as for the CVS.

For the very low emssion values of HC and CO (aftertreatment) the raw gas sampling showed better applicabilty based on the CoV then the CVS.

Since both engines were equipped with SCR systems the pre-conditioning has significant influence on the test-to-test repeatability.

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Results - Engine I – Particulate Matter - Overview 1

Variation	FF Filtertype	PF Filtertype	FF Gtot [g/s]	FF Index Gtot	FF CVS flow (venturi comb)	FF Index CVS flow	FF r [%]	FF FFV [cm/s]	FF Index FFV	PF Gtot [g/s]	PF DF q	PF Index DF	PF r [%]	PF FFV [cm/s]	diluted gas, PM FF [g/kWh] PMm 1.	diluted gas, PM FF [g/kWh] PMm 2.	raw gas, PM PF [g/kWh] PMm 1.	raw gas, PM PF [g/kWh] PMm 2.
results WHTC cold																		
1	TX47	TX47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,006	0,006	0,007	0,007
2	0	0	1,4	2	1+2	1	0,065	98	2	1,4	5	1	0,093	98	0,004	0,004	0,004	0,004
3	0	0	0,9	1	1+3	2	0,046	63	1	0,9	10	2	0,03	63	0,006	0,006	0,008	0,006
4	0	0	0,9	1	1+3	2	0,046	63	1	0,9	5	1	0,06	63	0,005	0,004	0,005	0,005
5	0	0	1,4	2	1+3	2	0,072	98	2	1,4	10	2	0,046	98	0,004	0,005	0,006	0,005
6	TX70	TX70	0,9	1	1+2	1	0,042	26	3	0,9	5	1	0,06	26	0,005	0,005	0,008	0,008
7	TEF47	TEF47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,026	0,030	0,030	0,038
8	0	0	1,4	2	1+2	1	0,065	98	2	1,4	5	1	0,093	98	0,013	0,000	0,023	0,003
9	TX47	TEF47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,004	0,004	0,045	**0,000**
results WHTC hot																		
1	TX47	TX47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,005	0,005	0,006	0,006
2	0	0	1,4	2	1+2	1	0,065	98	2	1,4	5	1	0,093	98	0,004	0,004	0,003	0,003
3	0	0	0,9	1	1+3	2	0,046	63	1	0,9	10	2	0,03	63	0,004	0,004	0,005	0,006
4	0	0	0,9	1	1+3	2	0,046	63	1	0,9	5	1	0,06	63	0,004	0,004	0,005	0,004
5	0	0	1,4	2	1+3	2	0,072	98	2	1,4	10	2	0,046	98	0,003	0,003	0,004	0,004
6	TX70	TX70	0,9	1	1+2	1	0,042	26	3	0,9	5	1	0,06	26	0,005	0,005	0,006	0,006
7	TEF47	TEF47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,035	0,030	0,025	0,025
8	0	0	1,4	2	1+2	1	0,065	98	2	1,4	5	1	0,093	98	0,013	0,002	0,021	0,002
9	TX47	TEF47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,004	0,004	0,027	0,013
results WHSC																		
1	TX47	TX47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,006	0,006	0,006	0,006
2	0	0	1,4	2	1+2	1	0,065	98	2	1,4	5	1	0,093	98	0,004	0,004	0,003	0,003
3	0	0	0,9	1	1+3	2	0,046	63	1	0,9	10	2	0,03	63	0,006	0,006	0,006	0,006
4	0	0	0,9	1	1+3	2	0,046	63	1	0,9	5	1	0,06	63	0,005	0,005	0,005	0,004
5	0	0	1,4	2	1+3	2	0,072	98	2	1,4	10	2	0,046	98	0,003	0,003	0,003	0,003
6	TX70	TX70	0,9	1	1+2	1	0,042	26	3	0,9	5	1	0,06	26	0,009	0,009	0,008	0,008
7	TEF47	TEF47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,018	0,016	0,013	0,013
8	0	0	1,4	2	1+2	1	0,065	98	2	1,4	5	1	0,093	98	0,006	0,002	0,026	0,002
9	TX47	TEF47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,005	0,004	0,009	0,001

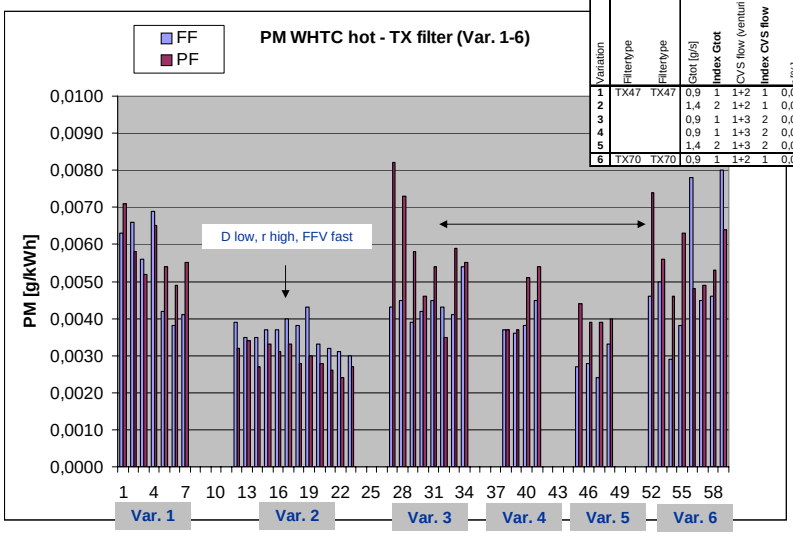
All mean values over all parameter variations.

Results - Engine I – Particulate Matter – Parameter variations WHTC 1

Mean values (WHTC hot)

Variation	FF Filtertype	PF Filtertype	FF Gtot [g/s]	FF Index Gtot	FF CVS flow (venturi comb)	FF Index CVS flow	FF r [%]	FF FFV [cm/s]	FF Index FFV	PF Gtot [g/s]	PF DF q	PF Index DF	PF r [%]	PF FFV [cm/s]	diluted gas, PM FF [g/kWh] HC	diluted gas, PM FF [g/kWh] CO	diluted gas, PM FF [g/kWh] NOx	diluted gas, PM FF [g/kWh] CO2	diluted gas, PM FF [g/kWh] PMm 1.	diluted gas, PM FF [g/kWh] PMm 2.	raw gas, PM PF [g/kWh] HC	raw gas, PM PF [g/kWh] CO	raw gas, PM PF [g/kWh] NOx	raw gas, PM PF [g/kWh] CO2	raw gas, PM PF [g/kWh] PMm 1.	raw gas, PM PF [g/kWh] PMm 2.
1	TX47	TX47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,037	0,067	2,376	718,248	**0,005**	**0,005**	0,004	0,077	2,498	723,763	**0,006**	**0,006**
2			1,4	2	1+2	1	0,065	98	2	1,4	5	1	0,093	98	0,035	0,069	2,052	719,057	**0,004**	**0,004**	0,005	0,084	2,053	725,282	**0,003**	**0,003**
3			0,9	1	1+3	2	0,046	63	1	0,9	10	2	0,03	63	0,066	0,055	2,257	718,922	**0,004**	**0,004**	0,005	0,087	2,309	721,486	**0,005**	**0,006**
4			0,9	1	1+3	2	0,046	63	1	0,9	5	1	0,06	63	0,063	0,071	2,156	731,960	**0,004**	**0,004**	0,004	0,084	2,147	725,535	**0,005**	**0,004**
5			1,4	2	1+3	2	0,072	98	2	1,4	10	2	0,046	98	0,061	0,085	2,056	716,170	**0,003**	**0,003**	0,005	0,076	2,049	715,352	**0,004**	**0,004**
6	TX70	TX70	0,9	1	1+2	1	0,042	26	3	0,9	5	1	0,06	26	0,032	0,065	2,161	706,210	**0,005**	**0,005**	0,004	0,075	2,241	716,145	**0,006**	**0,006**
7	TEF47	TEF47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,036	0,076	2,128	718,744	-	-	0,006	0,070	2,162	721,005	-	-
8			1,4	2	1+2	1	0,065	98	2	1,4	5	1	0,093	98	0,025	0,067	2,229	719,082	-	-	0,005	0,076	2,244	724,878	-	-
9	TX47	TEF47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,040	0,066	2,218	720,825	**0,004**	**0,004**	0,005	0,082	2,261	723,835	**0,027**	**0,013**
			all 9 variations							arithmetic mean value					0,044	0,069	2,181	718,802	**0,004**	**0,004**	0,005	0,079	2,218	721,920	**0,008**	**0,006**
										standard deviation					0,0143	0,0076	0,0965	6,1751	**0,0008**	**0,0008**	0,0004	0,0051	0,1305	3,6162	**0,0078**	**0,0029**
										coefficient of variance					32,50	11,04	4,42	0,86	**n.a.**	**n.a.**	8,69	6,47	5,88	0,50	**n.a.**	**n.a.**
Filtertype TX			**Variations 1 to 5**							arithmetic mean value					0,052	0,070	2,180	720,871	**0,004**	**0,004**	0,005	0,082	2,211	722,284	**0,005**	**0,005**
										standard deviation					0,0133	0,0095	0,1240	5,6396	**0,0007**	**0,0009**	0,0004	0,0042	0,1714	3,7531	**0,0010**	**0,0011**
										coefficient of variance					25,37	13,70	5,69	0,78	**18,31**	**21,24**	7,98	5,10	7,75	0,52	**21,46**	**23,44**
			Variations 1 to 6							arithmetic mean value					0,049	0,069	2,176	718,428	**0,004**	**0,004**	0,005	0,081	2,216	721,261	**0,005**	**0,005**
										standard deviation					0,0143	0,0089	0,1134	7,5074	**0,0008**	**0,0009**	0,0004	0,0045	0,1568	4,1196	**0,0010**	**0,0011**
										coefficient of variance					29,04	12,89	5,21	1,04	**19,59**	**21,11**	7,65	5,60	7,08	0,57	**20,83**	**22,20**
Filtertype TEFLO			**Variations 7 to 8**							arithmetic mean value					0,030	0,071	2,178	718,913	-	-	0,005	0,073	2,203	722,942	-	-
										standard deviation					0,0054	0,0041	0,0504	0,1690	-	-	0,0005	0,0028	0,0410	1,9364	-	-
										coefficient of variance					17,86	5,79	2,31	0,02	**n.a.**	**n.a.**	9,26	3,81	1,86	0,27	**n.a.**	**n.a.**
			Variations 7 to 9							arithmetic mean value					0,033	0,070	2,192	719,551	-	-	0,005	0,076	2,222	723,239	-	-
										standard deviation					0,0064	0,0041	0,0452	0,9118	-	-	0,0004	0,0049	0,0432	1,6361	-	-
										coefficient of variance					19,15	5,86	2,06	0,13	**n.a.**	**n.a.**	8,38	6,47	1,95	0,23	**n.a.**	**n.a.**

Results - Engine I – Particulate Matter – Parameter variations WHTC 2



Variation	FF Filtertype	PF Filtertype	FF Gtot [g/s]	FF Index Gtot	FF CVS flow (venturi comb)	FF Index CVS flow	FF r [%]	FF FFV [cm/s]	FF Index FFV	PF Gtot [g/s]	PF DF q	PF Index DF	PF r [%]	PF FFV [cm/s]
1	TX47	TX47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63
2			1,4	2	1+2	1	0,065	98	2	1,4	5	1	0,093	98
3			0,9	1	1+3	2	0,046	63	1	0,9	10	2	0,03	63
4			0,9	1	1+3	2	0,046	63	1	0,9	5	1	0,06	63
5			1,4	2	1+3	2	0,072	98	2	1,4	10	2	0,046	98
6	TX70	TX70	0,9	1	1+2	1	0,042	26	3	0,9	5	1	0,06	26

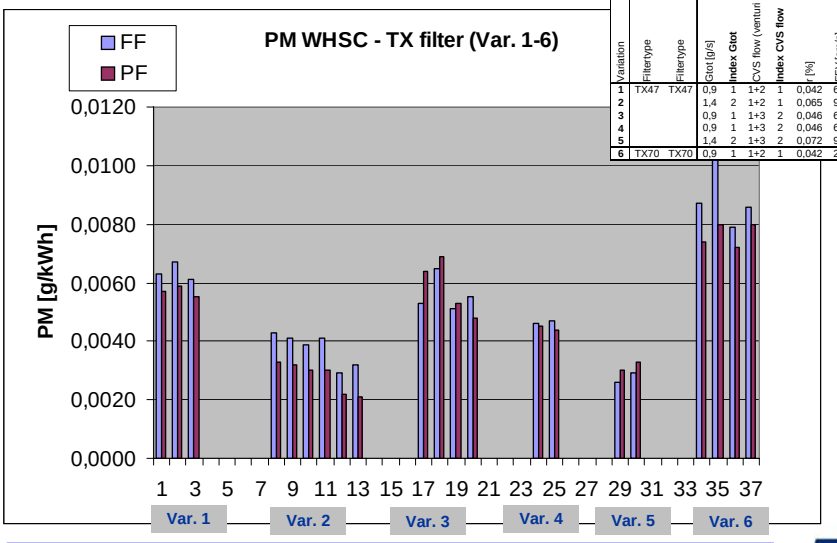
Results - Engine I – Particulate Matter – Parameter variations WHSC 1

Mean values (WHSC)

Variation	FF Filtertype	PF Filtertype	FF Gtot [g/s]	FF Index Gtot	FF CVS flow (venturi comb)	FF Index CVS flow	FF r [%]	FF FFV [cm/s]	FF Index FFV	PF Gtot [g/s]	PF DF q	PF Index DF	PF r [%]	PF FFV [cm/s]	diluted gas, PM FF [g/kWh] HC	CO	NOx	CO2	PMm 1.	PMm 2.	raw gas, PM PF [g/kWh] HC	CO	NOx	CO2	PMm 1.	PMm 2.
1	TX47	TX47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,028	0,069	2,490	674,513	0,006	0,006	0,002	0,059	2,605	685,575	0,006	0,006
2			1,4	2	1+2	1	0,065	98	2	1,4	5	1	0,093	98	0,022	0,062	2,433	677,920	0,004	0,004	0,003	0,071	2,484	686,566	0,003	0,003
3			0,9	1	1+3	2	0,046	63	1	0,9	10	2	0,03	63	0,046	0,061	2,570	678,905	0,006	0,006	0,003	0,071	2,603	682,236	0,006	0,006
4			0,9	1	1+3	2	0,046	63	1	0,9	5	1	0,06	63	0,041	0,066	2,526	682,253	0,005	0,005	0,003	0,069	2,557	682,578	0,005	0,004
5			1,4	2	1+3	2	0,072	98	2	1,4	10	2	0,046	98	0,044	0,071	2,568	677,228	0,003	0,003	0,003	0,064	2,596	676,201	0,003	0,003
6	TX70	TX70	0,9	1	1+2	1	0,042	26	3	0,9	5	1	0,06	26	0,021	0,057	2,372	668,543	0,009	0,009	0,002	0,058	2,516	680,554	0,008	0,008
7	TEF47	TEF47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,028	0,075	2,444	677,459	0,018	0,016	0,002	0,056	2,528	683,102	0,013	0,013
8			1,4	2	1+2	1	0,065	98	2	1,4	5	1	0,093	98	0,023	0,070	2,479	678,732	0,006	0,002	0,002	0,062	2,505	690,532	0,026	0,002
9	TX47	TEF47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63	0,029	0,069	2,524	679,882	0,005	0,004	0,011	0,063	2,590	678,234	0,009	0,001

			HC	CO	NOx	CO2	PMm 1.	PMm 2.	HC	CO	NOx	CO2	PMm 1.	PMm 2.
Filtertype TX	all 9 variations	arithmetic mean value	0,031	0,067	2,489	677,270	0,007	0,006	0,003	0,064	2,554	682,842	0,009	0,005
		standard deviation	0,0092	0,0054	0,0617	3,6620	0,0041	0,0040	0,0026	0,0054	0,0441	4,1036	0,0069	0,0033
		coefficient of variance	29,48	8,13	2,48	0,54	n.a.	n.a	79,73	8,41	1,73	0,60	n.a.	n.a
	Variations 1 to 5	arithmetic mean value	0,036	0,066	2,517	678,164	0,005	0,005	0,003	0,067	2,569	682,631	0,005	0,004
		standard deviation	0,0096	0,0039	0,0514	2,5114	0,0013	0,0013	0,0003	0,0046	0,0460	3,6238	0,0012	0,0013
		coefficient of variance	26,55	6,00	2,04	0,37	26,53	27,81	12,72	6,91	1,79	0,53	26,72	28,66
	Variations 1 to 6	arithmetic mean value	0,034	0,064	2,493	676,560	0,005	0,005	0,002	0,065	2,560	682,285	0,005	0,005
		standard deviation	0,0104	0,0049	0,0716	4,2559	0,0019	0,0020	0,0004	0,0054	0,0464	3,3974	0,0016	0,0017
		coefficient of variance	30,90	7,57	2,87	0,63	35,13	37,21	17,85	8,23	1,81	0,50	31,80	33,89
Filtertype TEFLO	Variations 7 to 8	arithmetic mean value	0,026	0,072	2,461	678,095	-	-	0,002	0,059	2,517	686,817	-	-
		standard deviation	0,0029	0,0027	0,0176	0,6364	-	-	0,0001	0,0034	0,0117	3,7151	-	-
		coefficient of variance	11,41	3,79	0,71	0,09	n.a.	n.a.	6,02	5,83	0,46	0,54	n.a.	n.a.
	Variations 7 to 9	arithmetic mean value	0,027	0,071	2,482	678,691	-	-	0,005	0,060	2,541	683,956	-	-
		standard deviation	0,0028	0,0028	0,0328	0,9896	-	-	0,0040	0,0035	0,0360	5,0569	-	-
		coefficient of variance	10,68	3,94	1,32	0,15	n.a.	n.a.	79,05	5,77	1,42	0,74	n.a.	n.a.

Results - Engine I – Particulate Matter – Parameter variations WHSC 2



Variation	FF Filtertype	PF Filtertype	FF Gtot [g/s]	Index Gtot	FF CVS flow (venturi comb.)	Index CVS flow	FF r [%]	FF FFV [cm/s]	Index FFV	PF Gtot [g/s]	PF DF q	Index DF	PF r [%]	PF FFV [cm/s]
1	TX47	TX47	0,9	1	1+2	1	0,042	63	1	0,9	5	1	0,06	63
2			1,4	2	1+2	1	0,065	98	2	1,4	5	1	0,093	98
3			0,9	1	1+3	2	0,046	63	1	0,9	10	2	0,03	63
4			0,9	1	1+3	2	0,046	63	1	0,9	5	1	0,06	63
5			1,4	2	1+3	2	0,072	98	2	1,4	10	2	0,046	98
6	TX70	TX70	0,9	1	1+2	1	0,042	26	3	0,9	5	1	0,06	26

Results - Engine II – Particulate Matter - Overview 1

All mean values over all parameter variations.

Variation	FF Filtertype	PF Filtertype	FF Gtot [g/s]	Index Gtot	FF CVS flow (venturi comb)	Index CVS flow	FF r [%]	FF FFV [cm/s]	Index FFV	PF Gtot [g/s]	PF DF q	Index DF	PF r [%]	PF FFV [cm/s]	diluted gas, PM FF [g/kWh] PMm 1.	diluted gas, PM FF [g/kWh] PMm 2.	raw gas, PM PF [g/kWh] PMm 1.	raw gas, PM PF [g/kWh] PMm 2.
results WHTC cold																		
1	TX47	TX47	0,9	1	2+3	1	0,021	63	1	0,9	5	1	0,034	63	0,021	0,022	0,021	0,022
2			1,4	2	2+3	1	0,033	98	2	1,4	5	1	0,052	98	0,019	0,020	0,020	0,017
3			0,9	1	1+2+3	2	0,023	63	1	0,9	10	2	0,017	63	0,019	0,020	0,020	0,019
4			0,9	1	1+2+3	2	0,023	63	1	0,9	5	1	0,034	63	0,019	0,021	0,020	0,021
5			1,4	2	1+2+3	2	0,035	98	2	1,4	10	2	0,026	98	0,019	0,020	0,020	0,021
6	TX70	TX70	0,9	1	2+3	1	0,021	26	3	0,9	5	1	0,034	26	0,020	0,024	0,026	0,029
7	TEF47	TEF47	0,8	1	2+3	1	0,019	64	1	0,8	5	1	0,03	64	0,020	0,022	0,016	0,015
8			1,22	2	2+3	1	0,029	98	2	1,22	5	1	0,046	98	0,021	0,022	0,020	0,020
9	TX47	TEF47	0,9	1	2+3	1	0,021	63	1	0,8	5	1	0,03	64	0,020	0,022	-	-
results WHTC hot																		
1	TX47	TX47	0,9	1	2+3	1	0,021	63	1	0,9	5	1	0,034	63	0,022	0,023	0,021	0,022
2			1,4	2	2+3	1	0,033	98	2	1,4	5	1	0,052	98	0,020	0,021	0,021	0,018
3			0,9	1	1+2+3	2	0,023	63	1	0,9	10	2	0,017	63	0,019	0,020	0,024	0,020
4			0,9	1	1+2+3	2	0,023	63	1	0,9	5	1	0,034	63	0,020	0,021	0,021	0,022
5			1,4	2	1+2+3	2	0,035	98	2	1,4	10	2	0,026	98	0,019	0,020	0,023	0,025
6	TX70	TX70	0,9	1	2+3	1	0,021	26	3	0,9	5	1	0,034	26	0,021	0,025	0,023	0,025
7	TEF47	TEF47	0,8	1	2+3	1	0,019	64	1	0,8	5	1	0,03	64	0,024	0,025	0,019	0,019
8			1,22	2	2+3	1	0,029	98	2	1,22	5	1	0,046	98	0,024	0,025	0,019	0,020
9	TX47	TEF47	0,9	1	2+3	1	0,021	63	1	0,8	5	1	0,03	64	0,023	0,024	-	-
results WHSC																		
1	TX47	TX47	0,9	1	2+3	1	0,021	63	1	0,9	5	1	0,034	63	0,014	0,014	0,012	0,013
2			1,4	2	2+3	1	0,033	98	2	1,4	5	1	0,052	98	0,013	0,013	0,013	0,012
3			0,9	1	1+2+3	2	0,023	63	1	0,9	10	2	0,017	63	0,012	0,013	0,012	0,013
4			0,9	1	1+2+3	2	0,023	63	1	0,9	5	1	0,034	63	0,013	0,013	0,012	0,012
5			1,4	2	1+2+3	2	0,035	98	2	1,4	10	2	0,026	98	0,012	0,013	0,013	0,014
6	TX70	TX70	0,9	1	2+3	1	0,021	26	3	0,9	5	1	0,034	26	0,013	0,015	0,013	0,014
7	TEF47	TEF47	0,8	1	2+3	1	0,019	64	1	0,8	5	1	0,03	64	0,015	0,016	0,012	0,012
8			1,22	2	2+3	1	0,029	98	2	1,22	5	1	0,046	98	0,015	0,015	0,012	0,012
9	TX47	TEF47	0,9	1	2+3	1	0,021	63	1	0,8	5	1	0,03	64	0,012	0,013	-	-

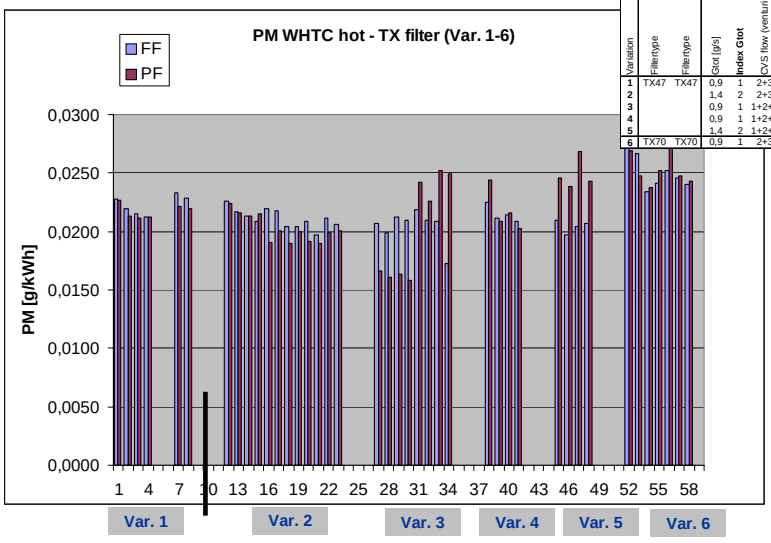
Results - Engine II – Particulate Matter – Parameter variations WHTC 1

Mean values

	FF	PF	FF						PF						diluted gas, PM FF [g/kWh]						raw gas, PM PF [g/kWh]					
Variation	Filtertype	Filtertype	Gtot [g/s]	Index Gtot	CVS flow (venturi comb)	Index CVS flow	[%]	FFV [cm/s]	Index FFV	Gtot [g/s]	DF q	Index DF	[%]	FFV [cm/s]	HC	CO	NOx	CO2	PMm 1.	PMm 2.	HC	CO	NOx	CO2	PMm 1.	PMm 2.
1	TX47	TX47	0,9	1	2+3	1	0,021	63	1	0,9	5	1	0,034	63	0,048	2,709	2,095	665,633	0,022	0,023	0,016	2,519	2,083	669,063	0,021	0,022
2			1,4	2	2+3	1	0,033	98	2	1,4	5	1	0,052	98	0,045	2,665	2,244	668,670	0,020	0,021	0,017	2,587	2,314	671,437	0,021	0,018
3			0,9	1	1+2+3	2	0,023	63	1	0,9	10	2	0,017	63	0,052	2,443	2,136	671,022	0,019	0,020	0,016	2,361	2,276	671,505	0,024	0,020
4			0,9	1	1+2+3	2	0,023	63	1	0,9	5	1	0,034	63	0,065	2,694	2,029	671,430	0,020	0,021	0,016	2,623	2,276	675,255	0,021	0,022
5			1,4	2	1+2+3	2	0,035	98	2	1,4	10	2	0,026	98	0,052	2,596	1,872	671,487	0,019	0,020	0,016	2,514	2,058	673,037	0,023	0,025
6	TX70	TX70	0,9	1	2+3	1	0,021	26	3	0,9	5	1	0,034	26	0,054	2,687	2,271	664,536	0,021	0,025	0,014	2,653	2,314	666,919	0,023	0,025
7	TEF47	TEF47	0,8	1	2+3	1	0,019	64	1	0,8	5	1	0,03	64	0,042	2,775	2,242	668,013	0,024	0,025	0,016	2,559	2,213	671,237	0,019	0,019
8			1,22	2	2+3	1	0,029	98	2	1,22	5	1	0,046	98	0,041	2,889	2,193	666,880	0,024	0,025	0,016	2,603	2,123	667,170	0,019	0,020
9	TX47	TEF47	0,9	1	2+3	1	0,021	63	1	0,8	5	1	0,03	64	0,032	2,939	2,294	663,613	0,023	0,024	0,014	2,990	2,512	668,858		

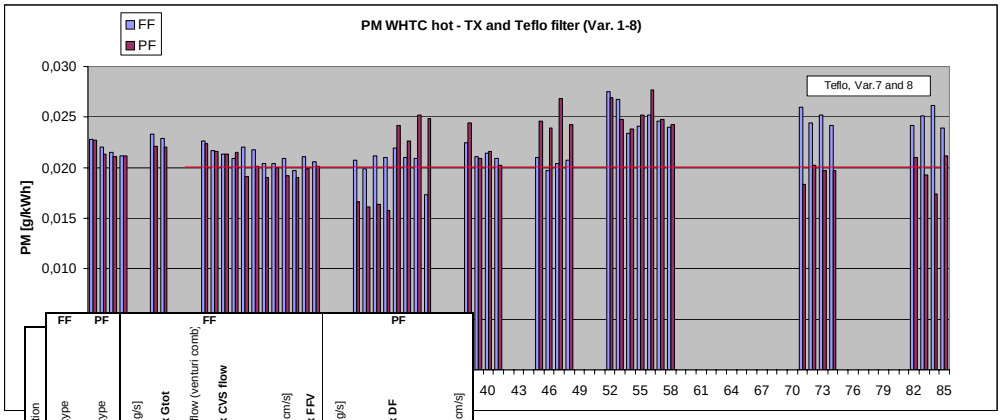
all 9 variations	arithmetic mean value	0,048	2,711	2,153	667,920	0,021	0,023	0,016	2,601	2,241	670,498	0,021	0,021
	standard deviation	0,0088	0,1398	0,1289	2,8197	0,0016	0,0018	0,0008	0,1591	0,1332	2,5852	0,0017	0,0024
	coefficient of variance	18,31	5,16	5,99	0,42	7,69	8,04	5,45	6,12	5,94	0,39	8,05	11,34
Filtertype TX: Variations 1 to 5	arithmetic mean value	0,052	2,621	2,075	669,648	0,020	0,021	0,016	2,521	2,201	672,060	0,022	0,021
	standard deviation	0,0069	0,0973	0,1233	2,2594	0,0009	0,0008	0,0005	0,0900	0,1078	2,0413	0,0011	0,0022
	coefficient of variance	13,09	3,71	5,94	0,34	4,62	3,74	3,11	3,57	4,90	0,30	4,87	10,47
Filtertype TX: Variations 1 to 6	arithmetic mean value	0,053	2,632	2,108	668,796	0,020	0,022	0,016	2,543	2,220	671,203	0,022	0,022
	standard deviation	0,0063	0,0921	0,1341	2,8079	0,0009	0,0016	0,0008	0,0957	0,1070	2,6727	0,0010	0,0025
	coefficient of variance	11,94	3,50	6,36	0,42	4,60	7,34	5,26	3,76	4,82	0,40	4,71	11,50
Filtertype TEFLO: Variations 7 to 8	arithmetic mean value	0,042	2,832	2,218	667,446	0,024	0,025	0,016	2,581	2,168	669,204	0,019	0,020
	standard deviation	0,0008	0,0569	0,0243	0,5667	0,0000	0,0001	0,0003	0,0220	0,0448	2,0335	0,0003	0,0001
	coefficient of variance	1,94	2,01	1,09	0,08	0,16	0,25	1,83	0,85	2,07	0,30	1,72	0,64
Filtertype TEFLO: Variations 7 to 9	arithmetic mean value	0,039	2,867	2,243	666,168	0,023	0,024	0,015	2,717	2,283	669,088	0,019	0,020
	standard deviation	0,0043	0,0685	0,0410	1,8656	0,0005	0,0006	0,0008	0,1935	0,1663	1,6683	0,0003	0,0001
	coefficient of variance	11,21	2,39	1,83	0,28	2,30	2,39	5,54	7,12	7,28	0,25	1,72	0,64

Results - Engine II – Particulate Matter – Parameter variations WHTC 2



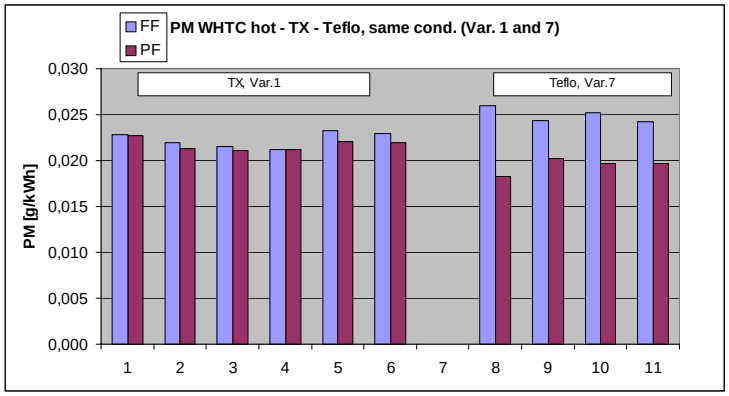
	FF	PF	FF						PF					
Variation	Filtertype	Filtertype	Gtot [g/s]	Index Gtot	CVS flow (venturi comb)	Index CVS flow	[%]	FFV [cm/s]	Index FFV	Gtot [g/s]	DF q	Index DF	[%]	FFV [cm/s]
1	TX47	TX47	0,9	1	2+3	1	0,021	63	1	0,9	5	1	0,034	63
2			1,4	2	2+3	1	0,033	98	2	1,4	5	1	0,052	98
3			0,9	1	1+2+3	2	0,023	63	1	0,9	10	2	0,017	63
4			0,9	1	1+2+3	2	0,023	63	1	0,9	5	1	0,034	63
5			1,4	2	1+2+3	2	0,035	98	2	1,4	10	2	0,026	98
6	TX70	TX70	0,9	1	2+3	1	0,021	26	3	0,9	5	1	0,034	26

Results - Engine II – Particulate Matter – Parameter variations WHTC 3



	FF	PF	FF						PF				
Variation	Filtertype	Filtertype	Gtot [g/s]	**Index Gtot**	CVS flow (venturi comb)	**Index CVS flow**	r' [%]	FFV [cm/s]	**Index FFV**	Gtot [g/s]	DF q	**Index DF**	r' [%]	FFV [cm/s]
1	TX47	TX47	0,9	1	2+3	1	0,021	63	1	0,9	5	1	0,034	63
2			1,4	2	2+3	1	0,033	98	2	1,4	5	1	0,052	98
3			0,9	1	1+2+3	2	0,023	63	1	0,9	10	2	0,017	63
4			0,9	1	1+2+3	2	0,023	63	1	0,9	5	1	0,034	63
5			1,4	2	1+2+3	2	0,035	98	2	1,4	10	2	0,026	98
6	TX70	TX70	0,9	1	2+3	1	0,021	26	3	0,9	5	1	0,034	26
7	TEF47	TEF47	0,8	1	2+3	1	0,019	64	1	0,8	5	1	0,03	64
8			1,22	2	2+3	1	0,029	98	2	1,22	5	1	0,046	98

Results - Engine II – Particulate Matter – Parameter variations WHTC 4



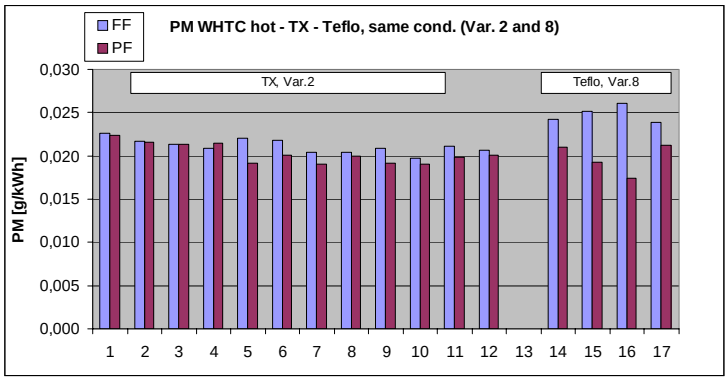
Index 1-1-1-1

Var. 1 vs. Var. 7

PMm 2. FF	PMm 2. PF
0,0228	0,0227
0,0220	0,0213
0,0215	0,0211
0,0212	0,0212
0,0233	0,0221
0,0229	0,0220
0,026	0,0183
0,0244	0,0202
0,0252	0,0197
0,0242	0,0197

	FF	PF	FF						PF					diluted gas, PM FF [g/kWh]						raw gas, PM PF [g/kWh]					
Variation	Filtertype	Filtertype	Gtot [g/s]	**Index Gtot**	CVS flow (venturi comb)	**Index CVS flow**	r' [%]	FFV [cm/s]	**Index FFV**	Gtot [g/s]	DF q	**Index DF**	r' [%]	FFV [cm/s]	HC	CO	NOx	CO2	PMm 1.	PMm 2.	HC	CO	NOx	CO2	PMm 1.	PMm 2.
1	TX47	TX47	0,9	1	2+3	1	0,021	63	1	0,9	5	1	0,034	63	0,048	2,709	2,095	665,633	0,022	0,023	0,016	2,519	2,083	669,063	0,021	0,022
7	TEF47	TEF47	0,8	1	2+3	1	0,019	64	1	0,8	5	1	0,03	64	0,042	2,775	2,242	668,013	0,024	0,025	0,016	2,559	2,213	671,237	0,019	0,019

Results - Engine II – Particulate Matter – Parameter variations WHTC 5



Index 2-1-2-1

Var. 2 vs. Var. 8

PMm 2. FF	PMm 2. PF
0,0226	0,0224
0,0217	0,0216
0,0213	0,0213
0,0209	0,0215
0,0220	0,0191
0,0218	0,0201
0,0204	0,0190
0,0204	0,0200
0,0209	0,0192
0,0197	0,0190
0,0211	0,0199
0,0206	0,0201
0,0242	0,0210
0,0251	0,0193
0,0261	0,0174
0,0239	0,0212

	FF	PF	FF						PF						diluted gas, PM FF [g/kWh]						raw gas, PM PF [g/kWh]					
Variation	Filtertype	Filtertype	Gtot [g/s]	**Index Gtot**	CVS flow (venturi comb)	**Index CVS flow**	[%]	FFV [cm/s]	**Index FFV**	Gtot [g/s]	DF q	**Index DF**	[%]	FFV [cm/s]	HC	CO	NOx	CO2	PMm 1.	PMm 2.	HC	CO	NOx	CO2	PMm 1.	PMm 2.
2			1,4	2	2+3	1	0,033	98	2	1,4	5	1	0,052	98	0,045	2,665	2,244	668,670	0,020	0,021	0,017	2,587	2,314	671,437	0,021	0,020
8			1,22	2	2+3	1	0,029	98	2	1,22	5	1	0,046	98	0,041	2,889	2,193	666,880	0,024	0,025	0,016	2,603	2,123	667,170	0,019	0,020

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Results - Engine II – Particulate Matter – Parameter variations WHSC 1

Mean values (WHSC)

	FF	PF	FF						PF						diluted gas, PM FF [g/kWh]						raw gas, PM PF [g/kWh]					
Variation	Filtertype	Filtertype	Gtot [g/s]	**Index Gtot**	CVS flow (venturi comb	**Index CVS flow**	[%]	FFV [cm/s]	**Index FFV**	Gtot [g/s]	DF q	**Index DF**	[%]	FFV [cm/s]	HC	CO	NOx	CO2	PMm 1.	PMm 2.	HC	CO	NOx	CO2	PMm 1.	PMm 2.
1	TX47	TX47	0,9	1	2+3	1	0,021	63	1	0,9	5	1	0,034	63	0,028	0,547	1,258	629,557	0,014	0,014	0,007	0,553	1,261	631,096	0,012	0,013
2			1,4	2	2+3	1	0,033	98	2	1,4	5	1	0,052	98	0,037	0,543	1,295	633,218	0,013	0,013	0,009	0,536	1,361	630,600	0,013	0,012
3			0,9	1	1+2+3	2	0,023	63	1	0,9	10	2	0,017	63	0,044	0,534	1,259	634,522	0,012	0,013	0,007	0,524	1,056	630,048	0,012	0,013
4			0,9	1	1+2+3	2	0,023	63	1	0,9	5	1	0,034	63	0,055	0,559	1,248	635,422	0,013	0,013	0,006	0,549	1,469	632,048	0,012	0,012
5			1,4	2	1+2+3	2	0,035	98	2	1,4	10	2	0,026	98	0,062	0,539	1,217	634,110	0,012	0,013	0,006	0,537	1,233	630,919	0,013	0,014
6	TX70	TX70	0,9	1	2+3	1	0,021	26	3	0,9	5	1	0,034	26	0,030	0,547	1,282	629,929	0,013	0,015	0,005	0,542	1,304	629,990	0,013	0,014
7	TEF47	TEF47	0,8	1	2+3	1	0,019	64	1	0,8	5	1	0,03	64	0,023	0,564	1,330	632,941	0,015	0,016	0,007	0,538	1,274	631,236	0,012	0,012
8			1,22	2	2+3	1	0,029	98	2	1,22	5	1	0,046	98	0,027	0,598	1,373	632,195	0,015	0,015	0,007	0,545	1,285	626,579	0,012	0,012
9	TX47	TEF47	0,9	1	2+3	1	0,021	63	1	0,8	5	1	0,03	64	0,019	0,532	1,427	628,866	0,012	0,013	0,006	0,519	1,480	619,229		
			all 9 variations							arithmetic mean value					0,036	0,552	1,299	632,307	0,013	0,014	0,007	0,538	1,303	629,083	0,012	0,013
										standard deviation					0,0139	0,0193	0,0631	2,2150	0,0010	0,0010	0,0010	0,0104	0,1208	3,7754	0,0004	0,0008
										coefficient of variance					38,38	3,50	4,85	0,35	7,52	7,32	15,30	1,93	9,27	0,60	3,23	6,07
	Filtertype TX		**Variations 1 to 5**							arithmetic mean value					0,045	0,545	1,255	633,366	0,013	0,013	0,007	0,540	1,276	630,942	0,012	0,013
										standard deviation					0,0124	0,0087	0,0248	2,0320	0,0005	0,0005	0,0011	0,0100	0,1379	0,6579	0,0003	0,0007
										coefficient of variance					27,33	1,59	1,97	0,32	4,15	3,82	14,69	1,86	10,81	0,10	2,60	5,67
			Variations 1 to 6							arithmetic mean value					0,043	0,545	1,260	632,793	0,013	0,014	0,007	0,540	1,281	630,783	0,012	0,013
										standard deviation					0,0126	0,0080	0,0247	2,2541	0,0005	0,0008	0,0012	0,0092	0,1263	0,6976	0,0003	0,0008
										coefficient of variance					29,44	1,46	1,96	0,36	3,88	5,81	17,22	1,70	9,87	0,11	2,72	6,31
	Filtertype TEFLO		**Variations 7 to 8**							arithmetic mean value					0,025	0,581	1,352	632,568	0,015	0,015	0,007	0,542	1,280	628,907	0,012	0,012
										standard deviation					0,0019	0,0171	0,0216	0,3731	0,0000	0,0002	0,0000	0,0037	0,0052	2,3286	0,0003	0,0003
										coefficient of variance					7,54	2,94	1,59	0,06	0,17	1,47	0,67	0,69	0,41	0,37	2,71	2,48
			Variations 7 to 9							arithmetic mean value					0,023	0,564	1,377	631,334	0,014	0,015	0,006	0,534	1,346	625,681	0,012	0,012
										standard deviation					0,0033	0,0272	0,0396	1,7713	0,0013	0,0012	0,0004	0,0113	0,0946	4,9428	0,0003	0,0003
										coefficient of variance					14,08	4,81	2,88	0,28	9,02	8,15	6,57	2,12	7,02	0,79	2,71	2,48

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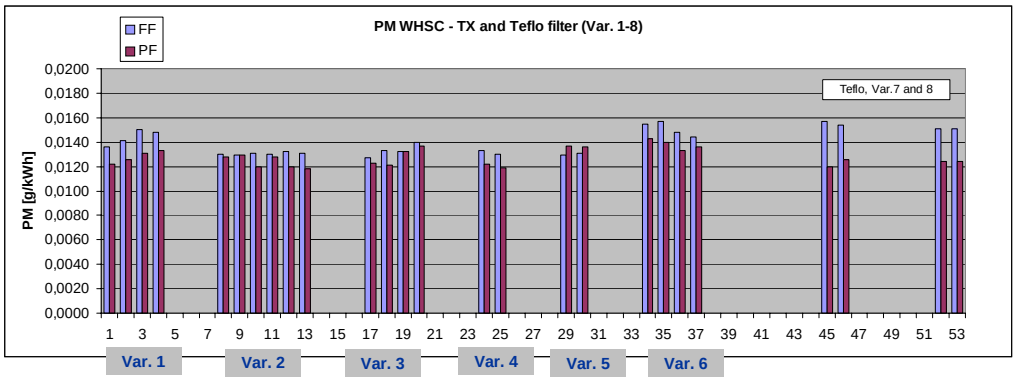
Results - Engine II – Particulate Matter – Parameter variations WHSC 2

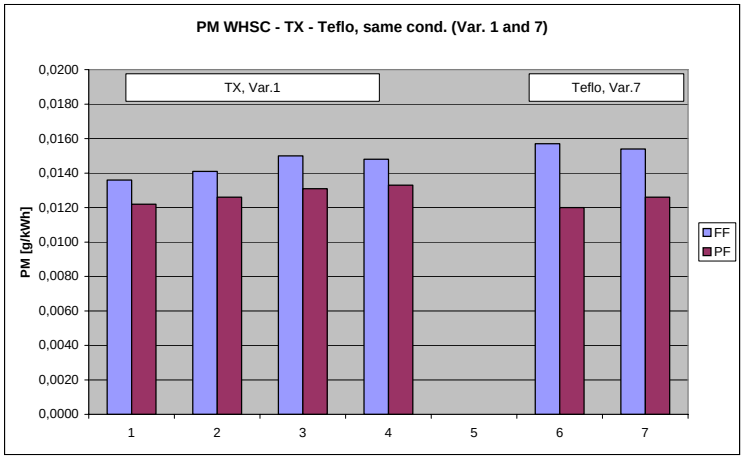


Results - Engine II – Particulate Matter – Parameter variations WHSC 3

Index 1-1-1-1

Var. 1 vs Var. 7

PMm 2. FF	PMm 2. PF
0,0136	0,0122
0,0141	0,0126
0,0150	0,0131
0,0148	0,0133
0,0157	0,0120
0,0154	0,0126

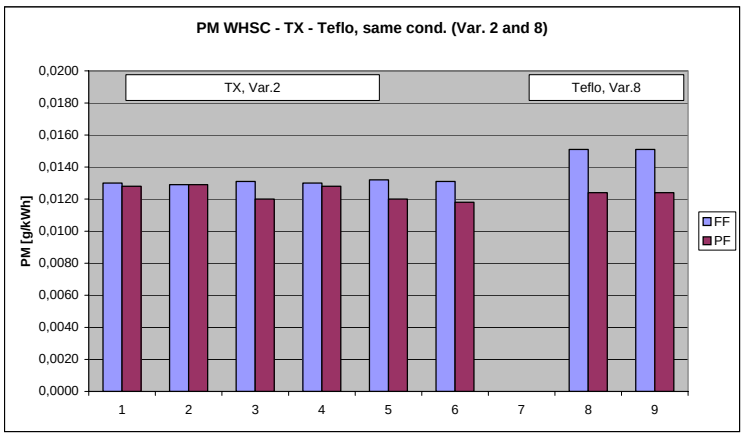


Results - Engine II – Particulate Matter – Parameter variations WHSC 4

Index 2-1-2-1

Var. 2 vs. Var. 8

PMm 2. FP	Mm 2. PF
0,0130	0,0128
0,0129	0,0129
0,0131	0,0120
0,0130	0,0128
0,0132	0,0120
0,0131	0,0118
0,0151	0,0124
0,0151	0,0124



Particulate Matter – Conclusions

The partial flow particulate matter measurement according to ISO 16183 respectively GTR No. 4 showed again good to very good agreement in comparison to the CVS procedure.

Lowest variability was observed with low dilution ratios and high filter face velocities.

Filter diameter influence was not observed. Teflo filter in 70mm with bonded ring not commercially available.

Teflo filter results slightly higher with FF than with PF; statistcal significants when results from engine 1 are available. With PF system no influence of the filter material (Teflo vs. TX) was observed.

TX Filter vs. Teflo Filter

- **Both filter materials came from same supplier.**

- **Teflo filter is hard to handle.**

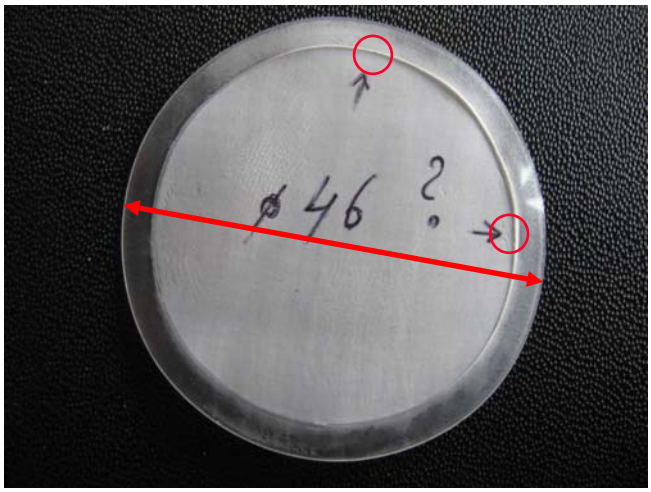
  => e.g. sticks to filter holder form PF system

- **Teflo weighing results on engine I not reliable.**

  => less filter weight / much higher filter weight
  (electrostatic charge not completely removed)

- **Teflo filter showed further remarkable details such as:**

Teflo Filter - I



Several filters show small perforation at the edge between filter and ring as delivered.

Teflo Filter – II, Discharging essential

§1065.190 PM-stabilization and weighing environments for gravimetric analysis.

(6) We recommend that you neutralize PM sample media (e.g. filter) to within ±2.0 V of neutral. Measure static voltages as follows:
(i) Measure static voltage of PM sample media (e.g. filter) according to the electrostatic voltmeter manufacturer's instructions.
(ii) Measure static voltage of PM sample media (e.g. filter) while the media is at least 15 cm away from any grounded surfaces to avoid mirror image charge interference.

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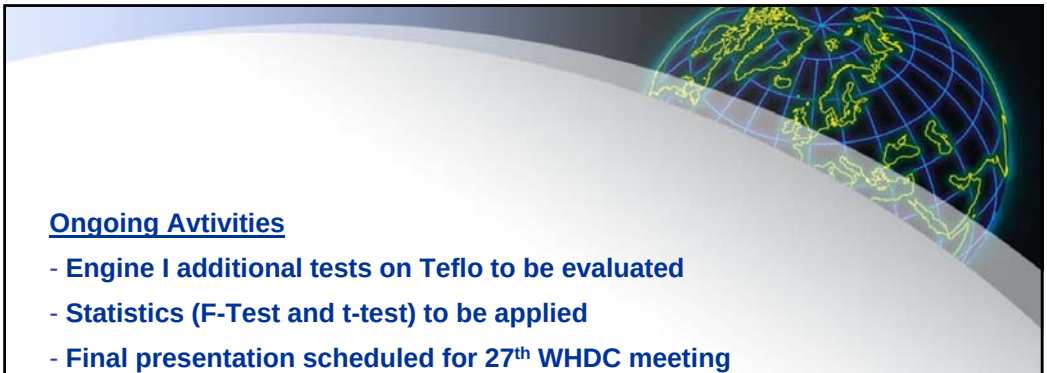

Ongoing Avtivities

- **Engine I additional tests on Teflo to be evaluated**
- **Statistics (F-Test and t-test) to be applied**
- **Final presentation scheduled for 27th WHDC meeting**

TÜV Nord Mobilität – IFM
Motoren / Nutzfahrzeuge
Essen

lschulte@tuev-nord.de

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