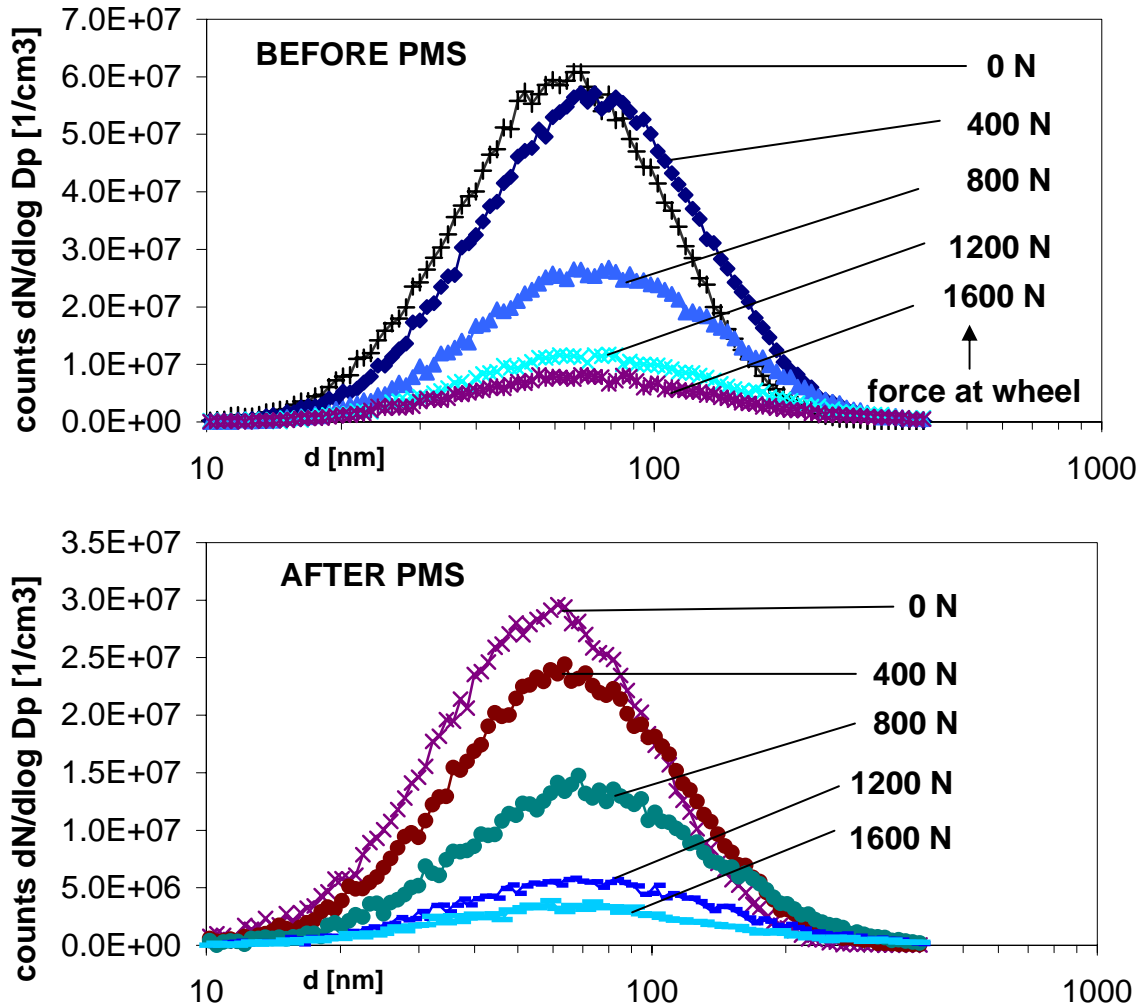


SMPS : nanoparticle filtration efficiency at 85 km/h with engine warm and engine load variations.

Measured before and after HJS2-PMS; VW Passat 1.9 TDI; low sulfur diesel

SMPS PSD - spectra



Configuration	BEFORE	AFTER
	SMPS [10-400 nm]	SMPS [10-400 nm]
0 N	35019501	17581167
400 N	34631726	15135626
800 N	17565346	9257139
1200 N	8031399	4080254
1600 N	5484759	2478642

Configuration	PZAG
	SMPS [10-400 nm] [%]
0 N	49.80
400 N	56.30
800 N	47.30
1200 N	49.20
1600 N	54.81

Configuration	w/o	AFTER
	PM [g/km]	PM [g/km]
0 N	0.0074	0.0025
400 N	0.0189	0.0076
800 N	0.0383	0.0103
1200 N	0.0461	0.0099
1600 N	0.0545	0.0114

Configuration	PMAG
	PM [%]
0 N	66.22
400 N	59.79
800 N	73.11
1200 N	78.52
1600 N	79.08

Procedure :
 10 min stabilization
 10 min measurements before PMS
 10 min measurements after PMS

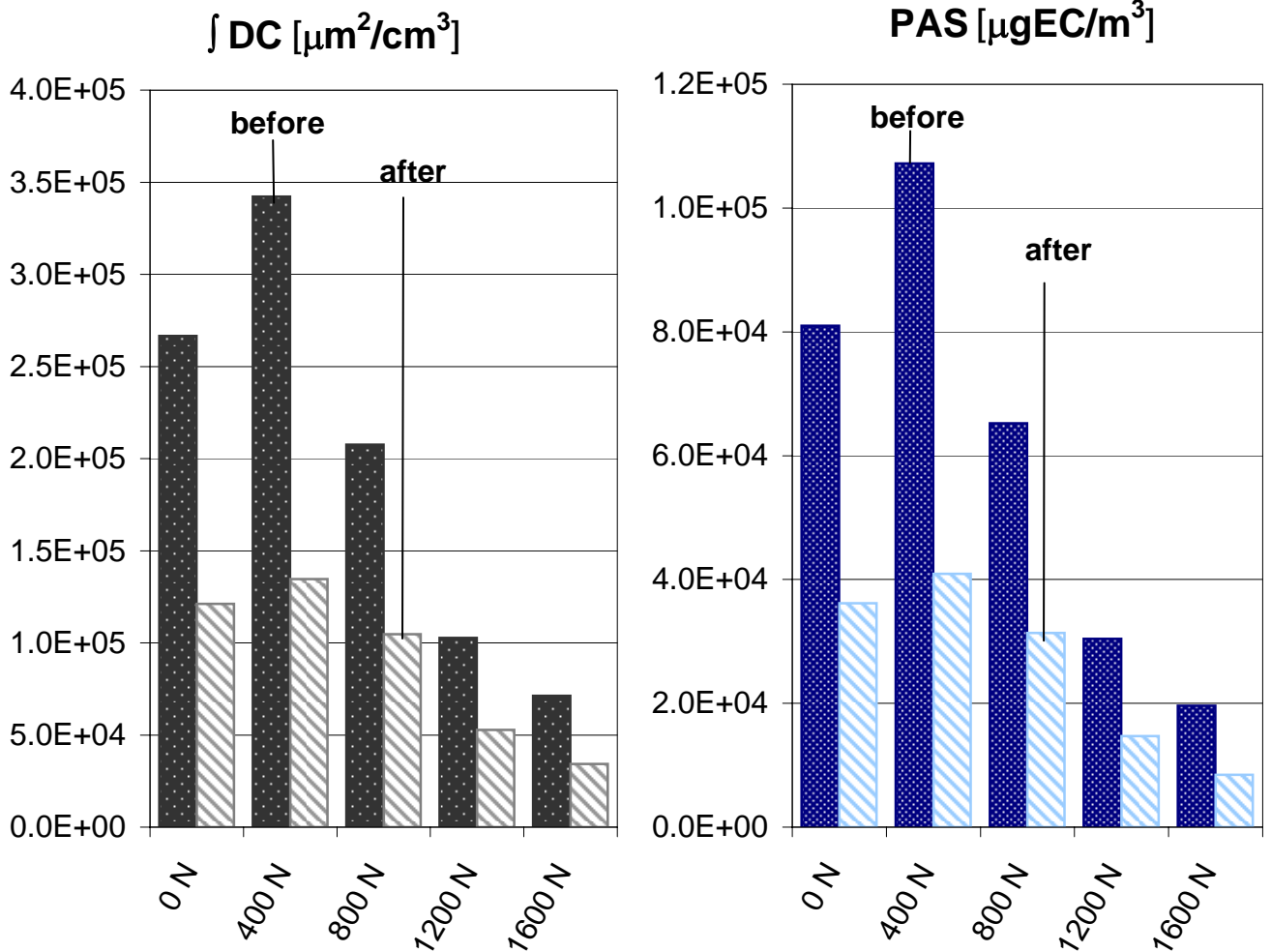
NanoMet : nanoparticle filtration efficiency at 85 km/h with engine warm and engine load variations.

Before and after HJS2-PMS; VW Passat 1.9 TDI; low sulfur diesel

Driving cycle : 85 km/h const.

Configuration	BEFORE		AFTER		PZAG	
	∫ DC *)	∫ PAS *)	∫ DC *)	∫ PAS *)	DC	PAS
	[$\mu\text{m}^2/\text{cm}^3$]	[$\mu\text{gEC}/\text{m}^3$]	[$\mu\text{m}^2/\text{cm}^3$]	[$\mu\text{gEC}/\text{m}^3$]	[%]	[%]
0 N	266533	81006	121191	36145	54.53	55.38
400 N	342237	107179	134703	40914	60.64	61.83
800 N	207587	65218	104778	31377	49.53	51.89
1200 N	102695	30437	52696	14687	48.69	51.75
1600 N	71199	19591	34244	8456	51.90	56.84

*) ... integral average value of 7.5 min.



Procedure :
 10 min stabilization
 10 min measurements before PMS
 10 min measurements after PMS

NO_x emissions by constant speed 85 km/h with different wheel loads, before and after PMS.

HJS2-PMS; 6th gear; n=1710 rpm; low sulfur diesel; hot NO_x-measurement.

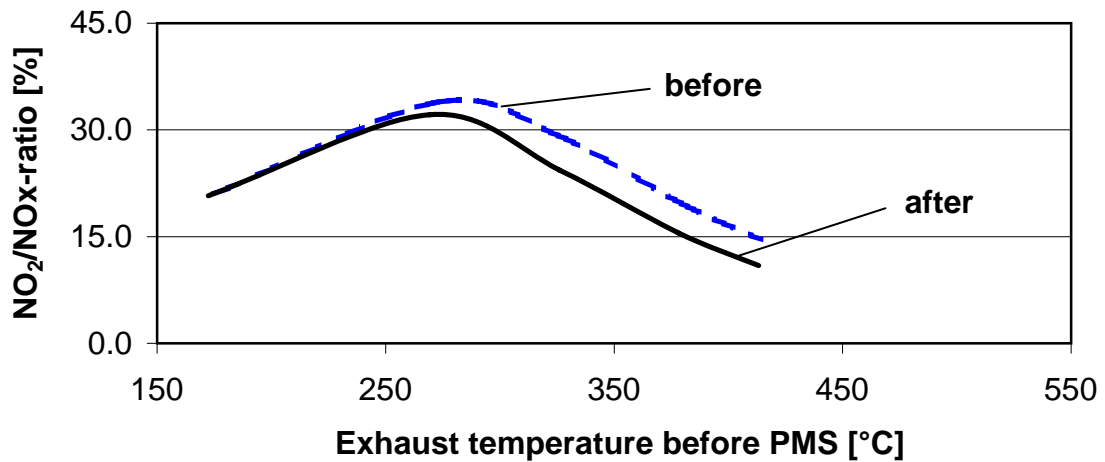
BEFORE PMS

Fwheel	V	T b. PMS	T a. PMS	NO ₂	NO _x	NO ₂ /NO _x -ratio
[N]	[km/h]	[°C]	[°C]	[ppm]	[ppm]	[%]
3	84.5	174.8	171.1	9.3	44.5	21.0
400	84.3	273.3	270.8	69.3	204.3	33.9
798	84.1	325.5	324.3	144.8	495.5	29.2
1198	83.9	379.5	376.5	194.2	988.0	19.7
1598	83.7	414.2	408.9	189.7	1301.1	14.6

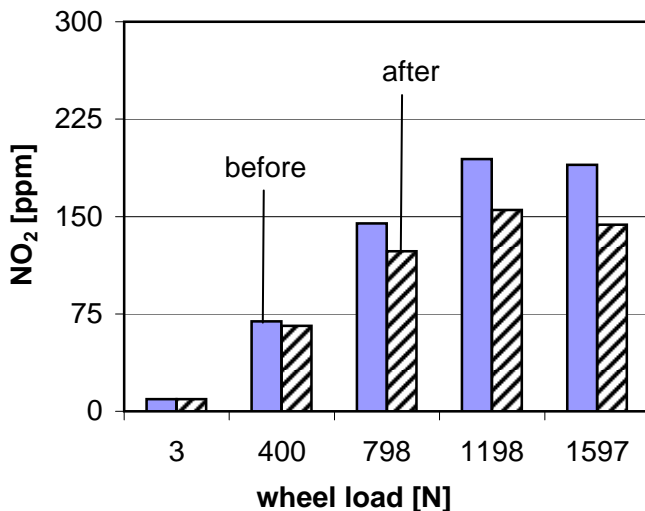
AFTER PMS

Fwheel	V	T b. PMS	T a. PMS	NO ₂	NO _x	NO ₂ /NO _x -ratio
[N]	[km/h]	[°C]	[°C]	[ppm]	[ppm]	[%]
3	84.5	172.4	168.9	9.4	45.2	20.8
400	84.3	269.2	268.3	65.9	205.1	32.1
798	84.1	326.1	325.4	123.2	505.8	24.4
1198	83.9	378.0	375.4	155.1	999.6	15.5
1597	83.7	413.3	407.7	143.7	1314.9	10.9

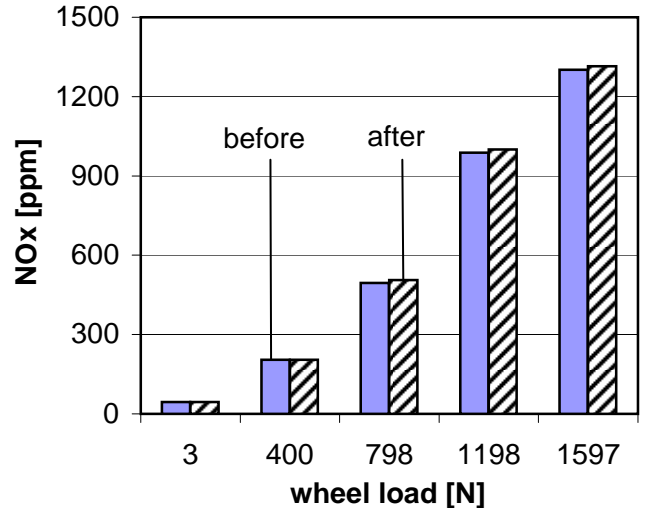
NO₂/NO_x-ratio before and after HJS2-PMS



NO₂ before and after HJS2-PMS



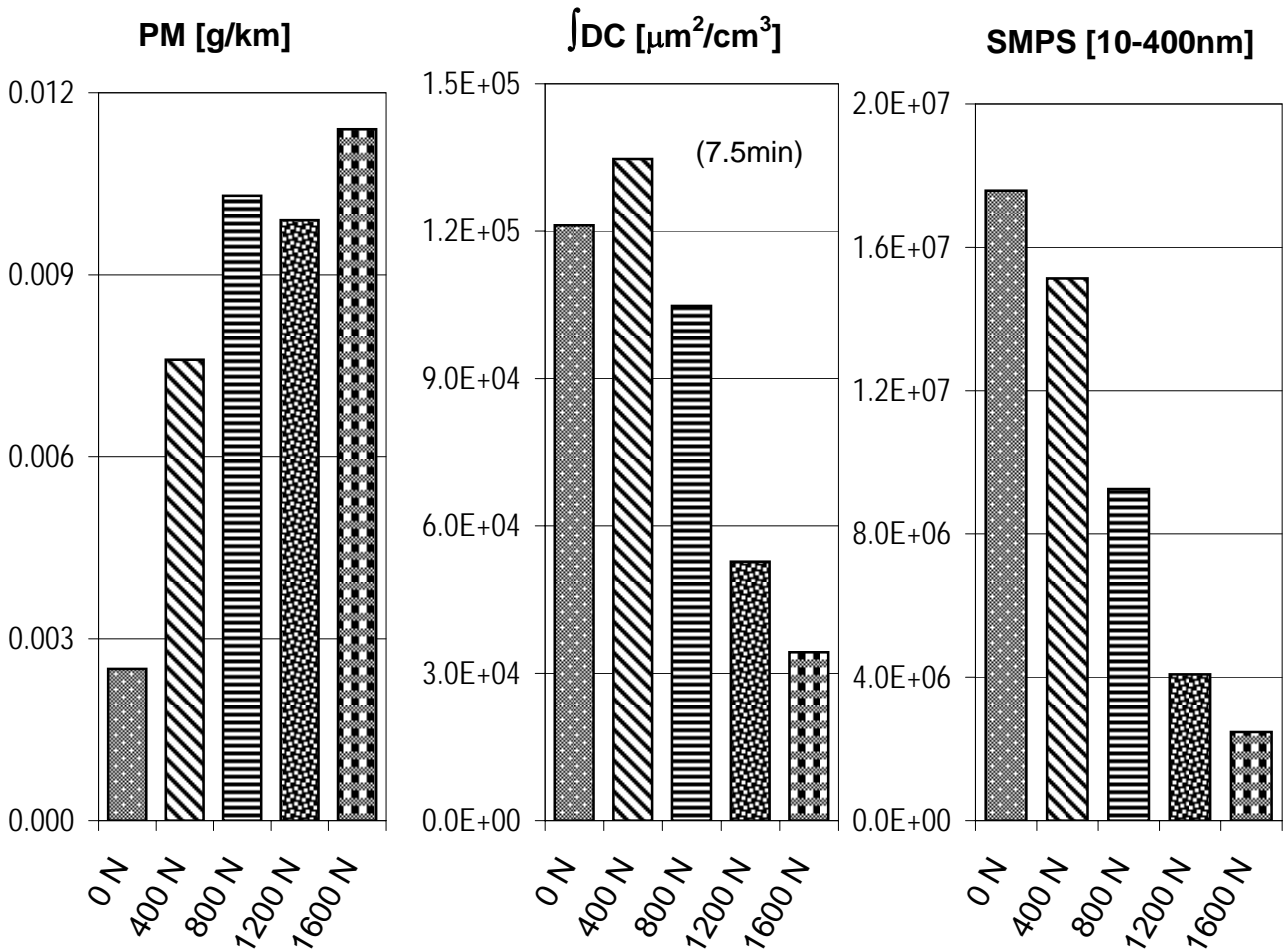
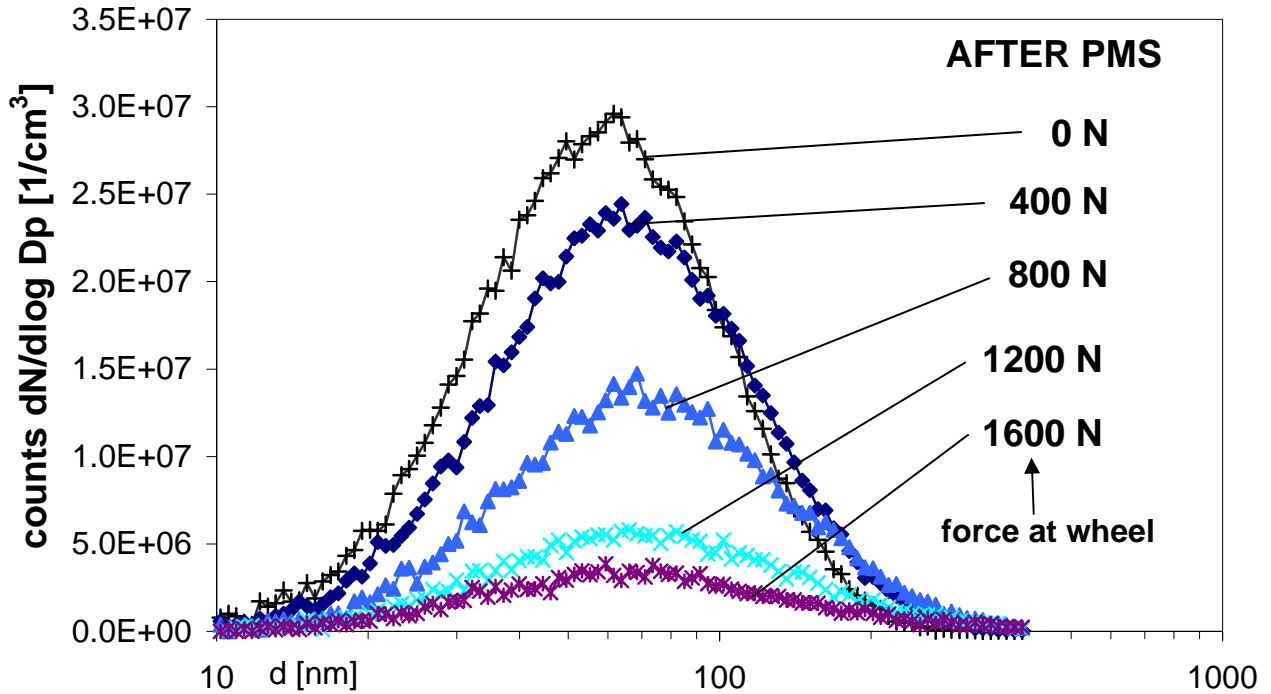
NO_x before and after HJS2-PMS



Particle mass and nanoparticles at const. speed 85 km/h, warm, with engine load variations.

with HJS2-PMS; VW Passat 1.9 TDI; low sulfur diesel

SMPS PSD - spectra



Comparison of emissions during the measurements of nanoparticles by engine load variations

Low sulfur diesel; CO, HC, NOx, NOx bag values

VW Passat 1.9 TDI

w/o PMS

Driving cycle : 85 km/h const., warm

Configuration	CO [g/km]	HC [g/km]	NOx [g/km]	PM [g/km]	∫ DC *) [μm ² /cm ³]	∫ PAS *) [μgEC/m ³]	SMPS [10-400 nm]
0 N	0.004	0.008	0.041	0.0074	288881	105098	3.57E+07
400 N	0.010	0.008	0.331	0.0189	212401	76953	2.11E+07
800 N	0.017	0.014	1.030	0.0383	126780	44778	1.06E+07
1200 N	0.033	0.013	2.402	0.0461	59223	18689	4.45E+06
1600 N	0.053	0.007	3.242	0.0545	65968	20492	4.48E+06

*) ... integral average value of 7.5 min.

HJS2-PMS

Driving cycle : 85 km/h const., warm, after PMS

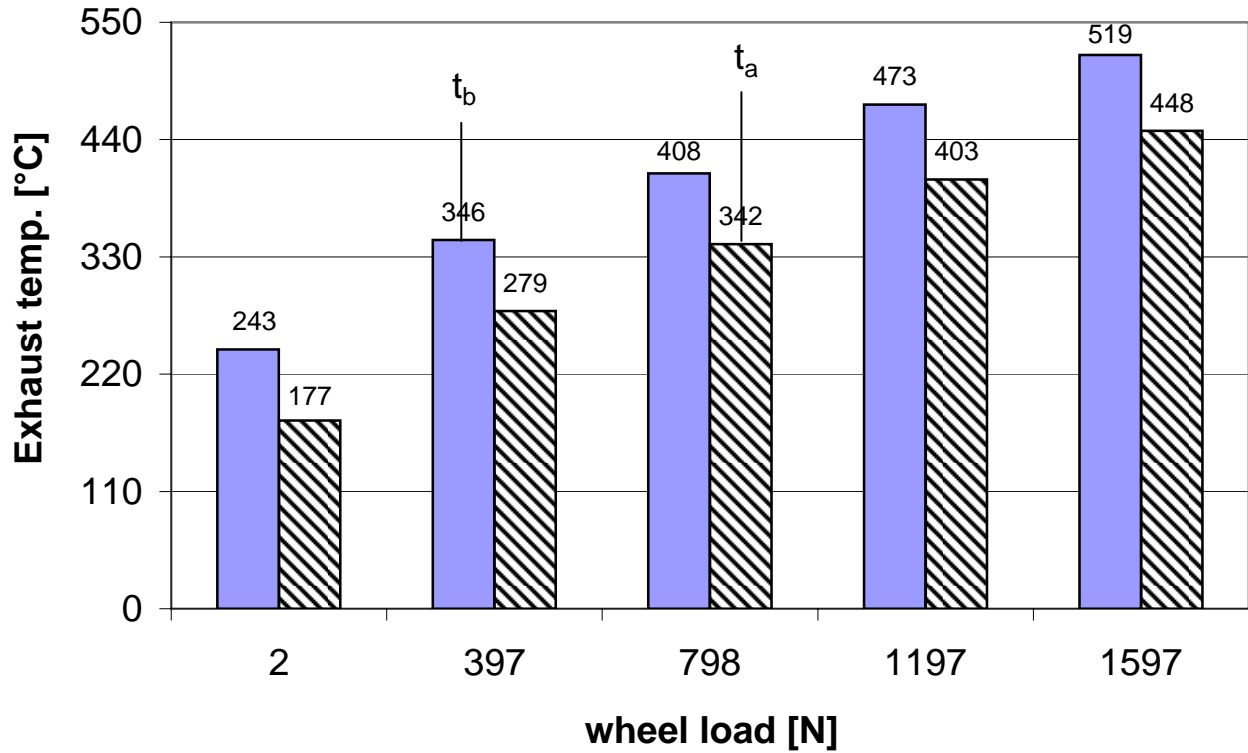
Configuration	CO [g/km]	HC [g/km]	NOx [g/km]	PM [g/km]	∫ DC *) [μm ² /cm ³]	∫ PAS *) [μgEC/m ³]	SMPS [10-400 nm]
0 N	0.005	0.005	0.030	0.0025	121191	36145	1.76E+07
400 N	0.007	0.007	0.287	0.0076	134703	40914	1.51E+07
800 N	0.013	0.009	0.949	0.0103	104778	31377	9.26E+06
1200 N	0.026	0.007	2.311	0.0099	52696	14687	4.08E+06
1600 N	0.038	0.005	3.448	0.0114	34244	8456	2.48E+06

*) ... integral average value of 7.5 min.

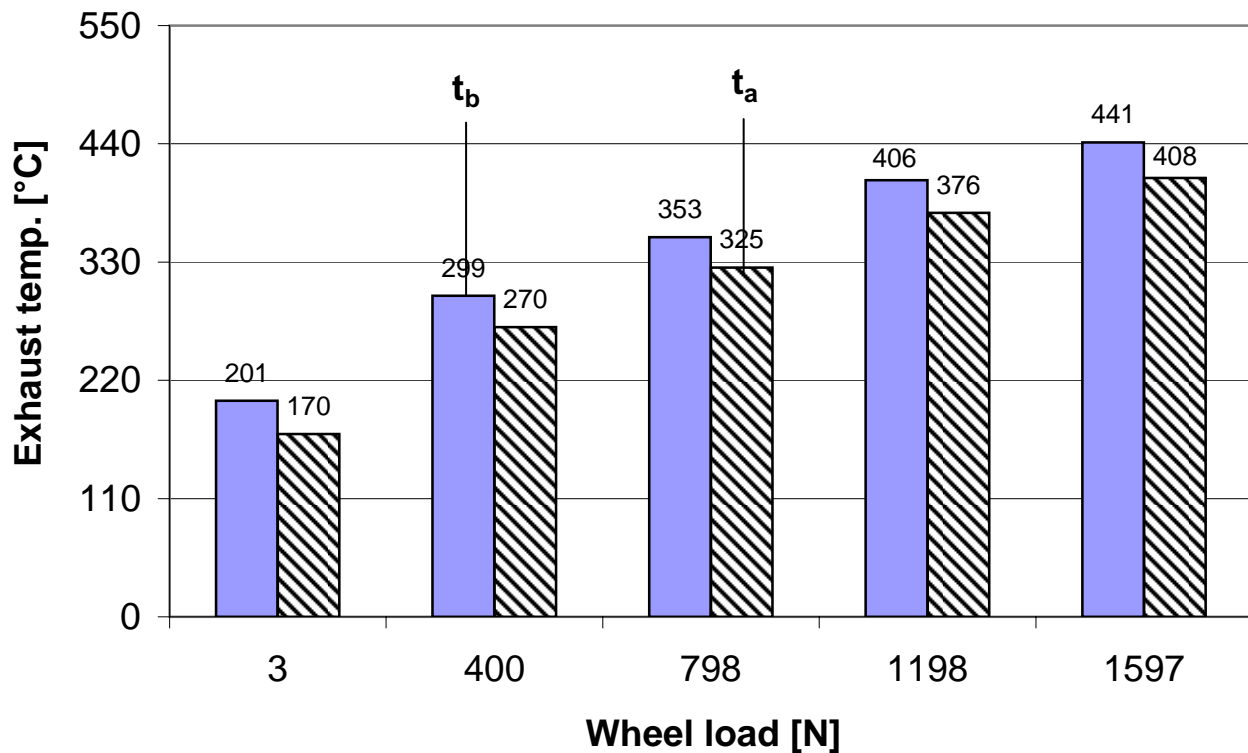
Temperatures before / after HJS PMS.

VW Passat 1.9 TDI; low sulfur diesel

Load steps HJS 1



Load steps HJS 2



Comparison of limited and non limited emissions during different driving cycles

w/o and with HJS2-PMS; low sulfur diesel; CO, HC, NOx bag values

VW Passat 1.9 TDI

1st day, w/o

Total cycle values

Cycle	CO	HC	NOx	PM	∫ DC *)	CPC	∫ PAS *)
	[g/km]	[g/km]	[g/km]	[g/km]	[$\mu\text{m}^2/\text{cm}^3$]	[TPN]	[$\mu\text{gEC}/\text{m}^3$]
NEFZ c.	0.209	0.054	0.331	0.032	47354	5.27E+13	13813
NEFZ w.	0.043	0.018	0.325	0.027	42166	4.81E+13	11477

*) ... integral average value

1st day, with HJS2 PMS

Cycle	CO	HC	NOx	PM	∫ DC *)	CPC	∫ PAS *)
	[g/km]	[g/km]	[g/km]	[g/km]	[$\mu\text{m}^2/\text{cm}^3$]	[TPN]	[$\mu\text{gEC}/\text{m}^3$]
NEFZ c.	0.132	0.041	0.367	0.022	16277	2.15E+13	4009
NEFZ w.	0.016	0.012	0.325	0.011	17173	2.12E+13	4256

*) ... integral average value

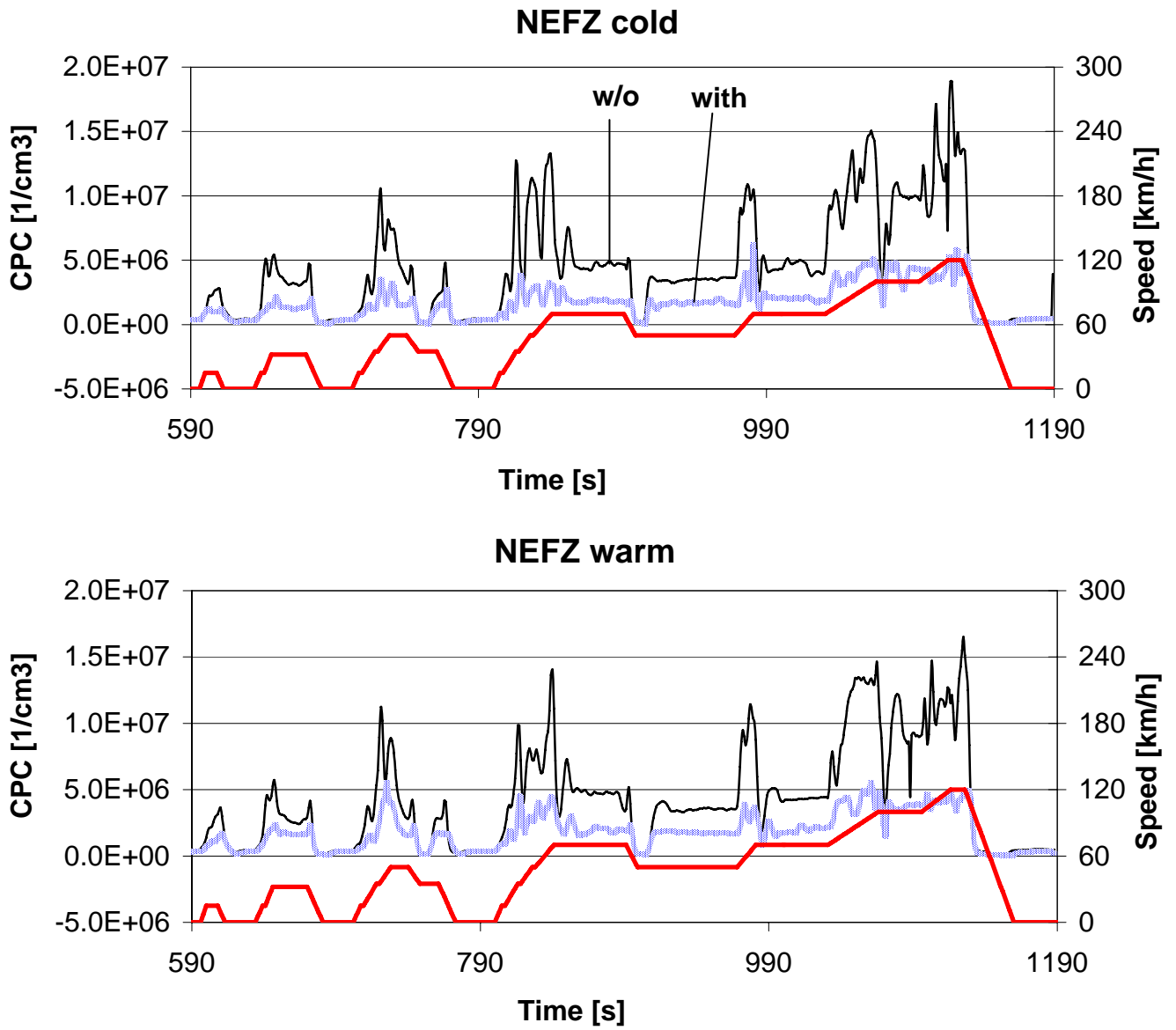
Exhaust emissions conversion rate and filtration efficiency

Cycle	K _{CO}	K _{HC}	K _{NOx}	PMFE	DCFE	CPCFE	PASFE
	[%]	[%]	[%]	[%]	[%]	[%]	[%]
NEFZ c.	36.8	24.1	-10.9	32.8	65.6	59.1	71.0
NEFZ w.	62.8	33.3	0.0	58.1	59.3	55.9	62.9
AVERAGE	49.8	28.7	-5.4	45.5	62.5	57.5	66.9

FE... Filtration efficiency (HJS2)

CPC nanoparticle count concentrations in NEFZ driving cycles

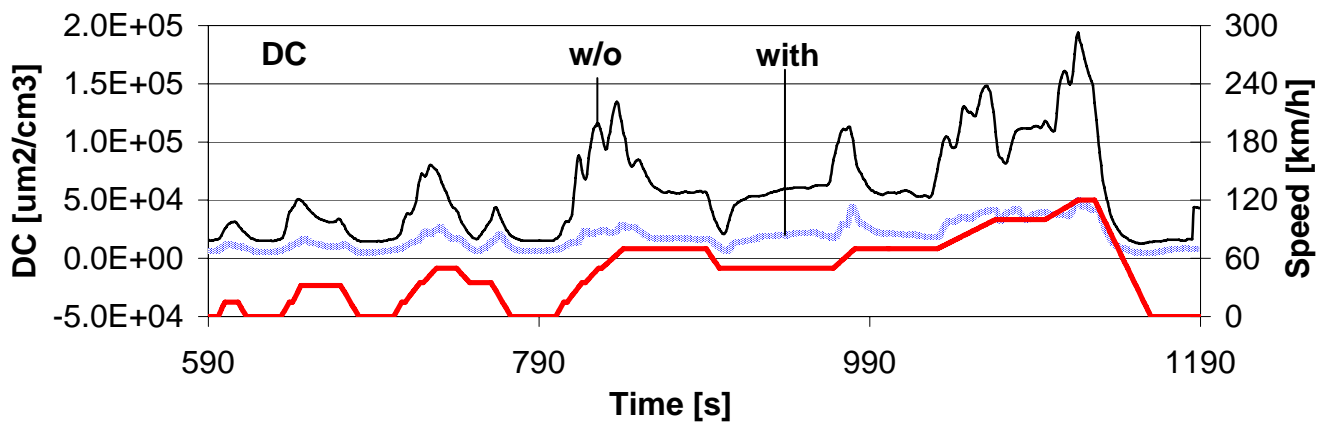
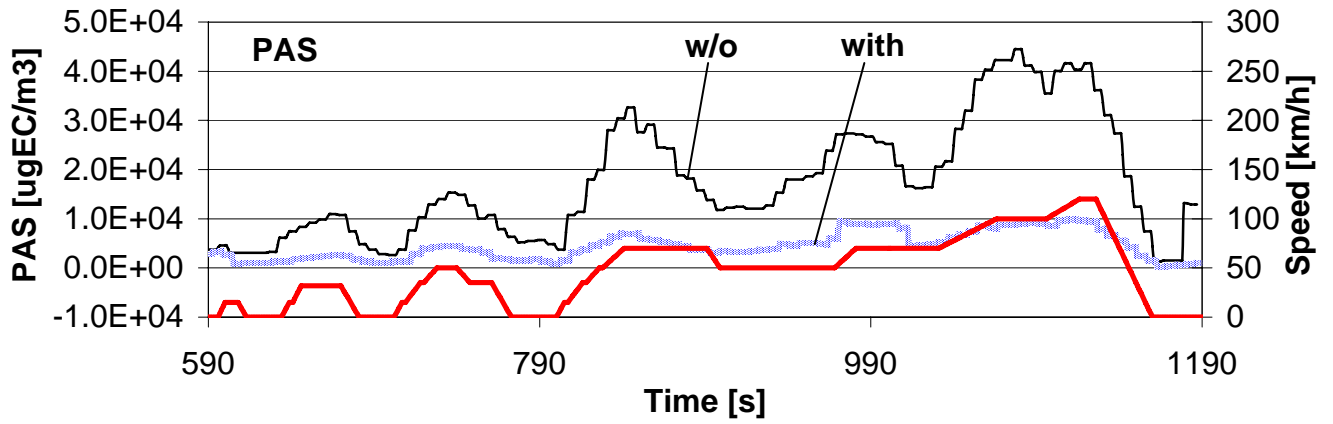
w/o and with HJS2-PMS; VW Passat 1.9 TDI; low sulfur diesel



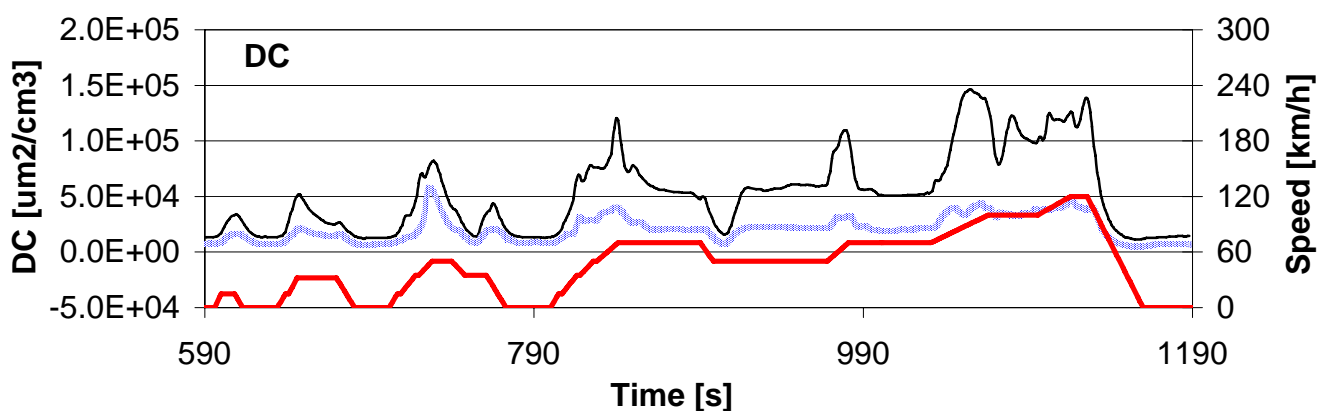
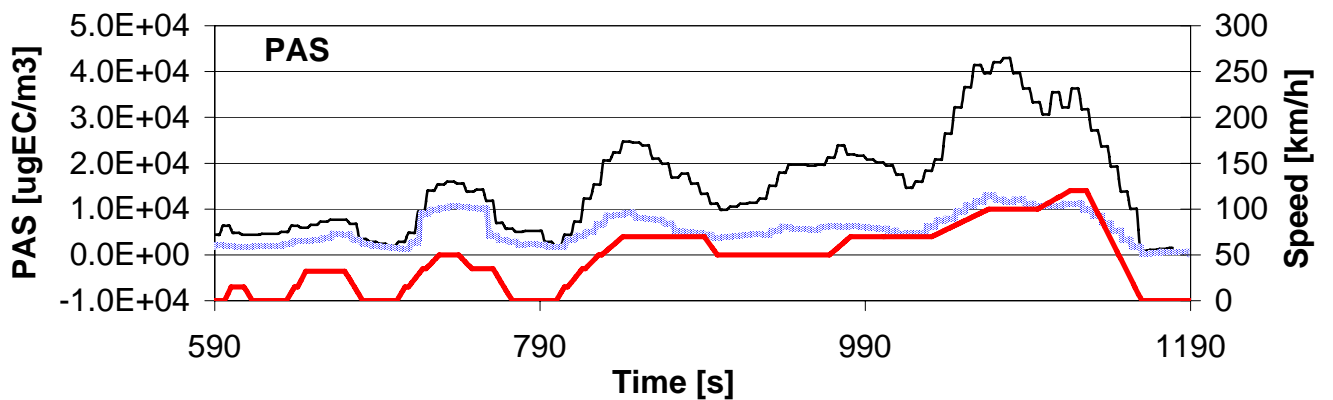
NanoMet signals PAS / DC in NEFZ driving cycles

w/o and with HJS2-PMS; VW Passat 1.9 TDI; low sulfur diesel

NEFZ cold



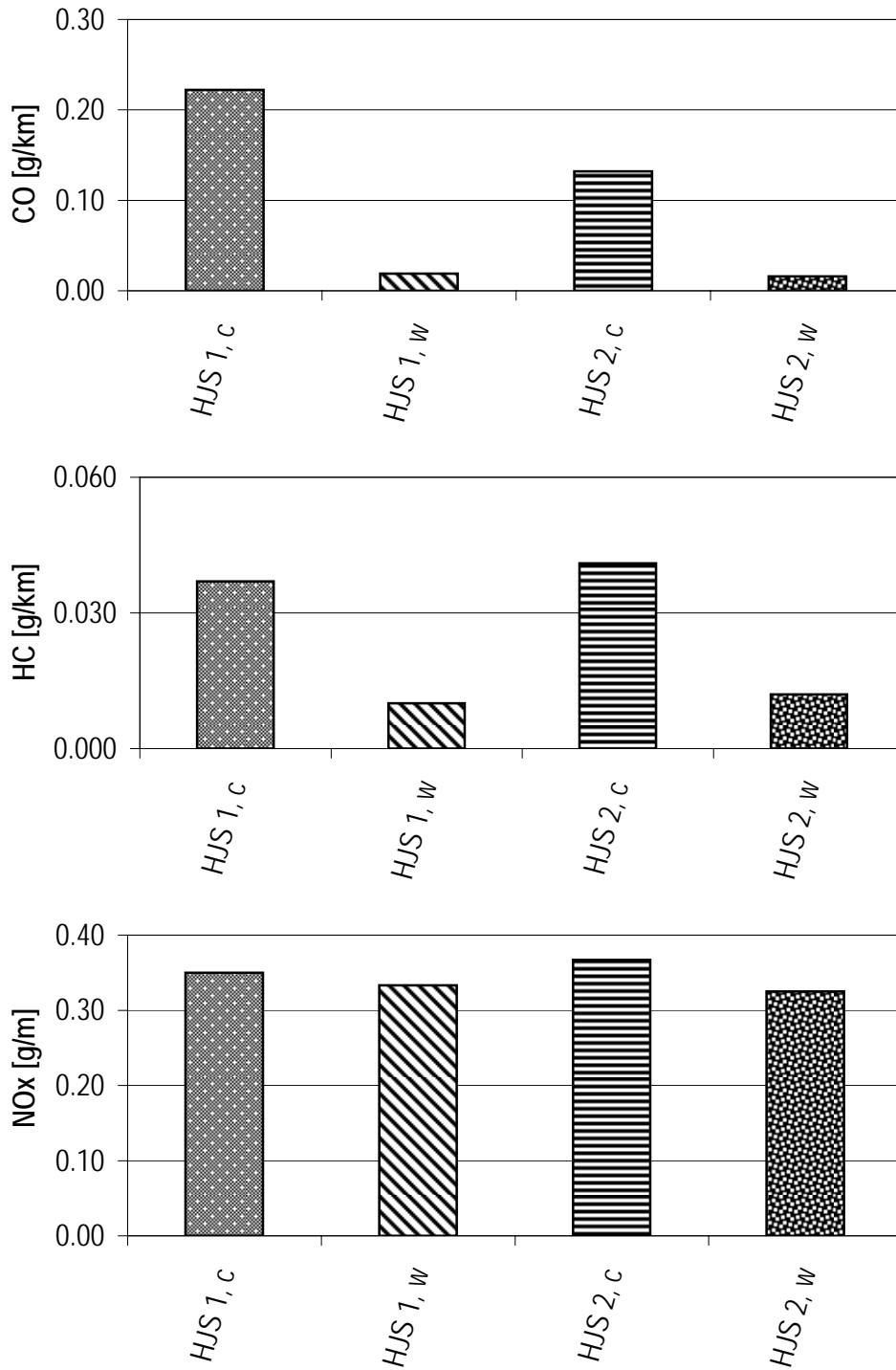
NEFZ warm



Comparison of limited and non limited emissions during the NEFZ driving cycle with engine cold and warm.

with HJS-PMS; VW Passat 1.9 TDI; low sulfur diesel

1st day

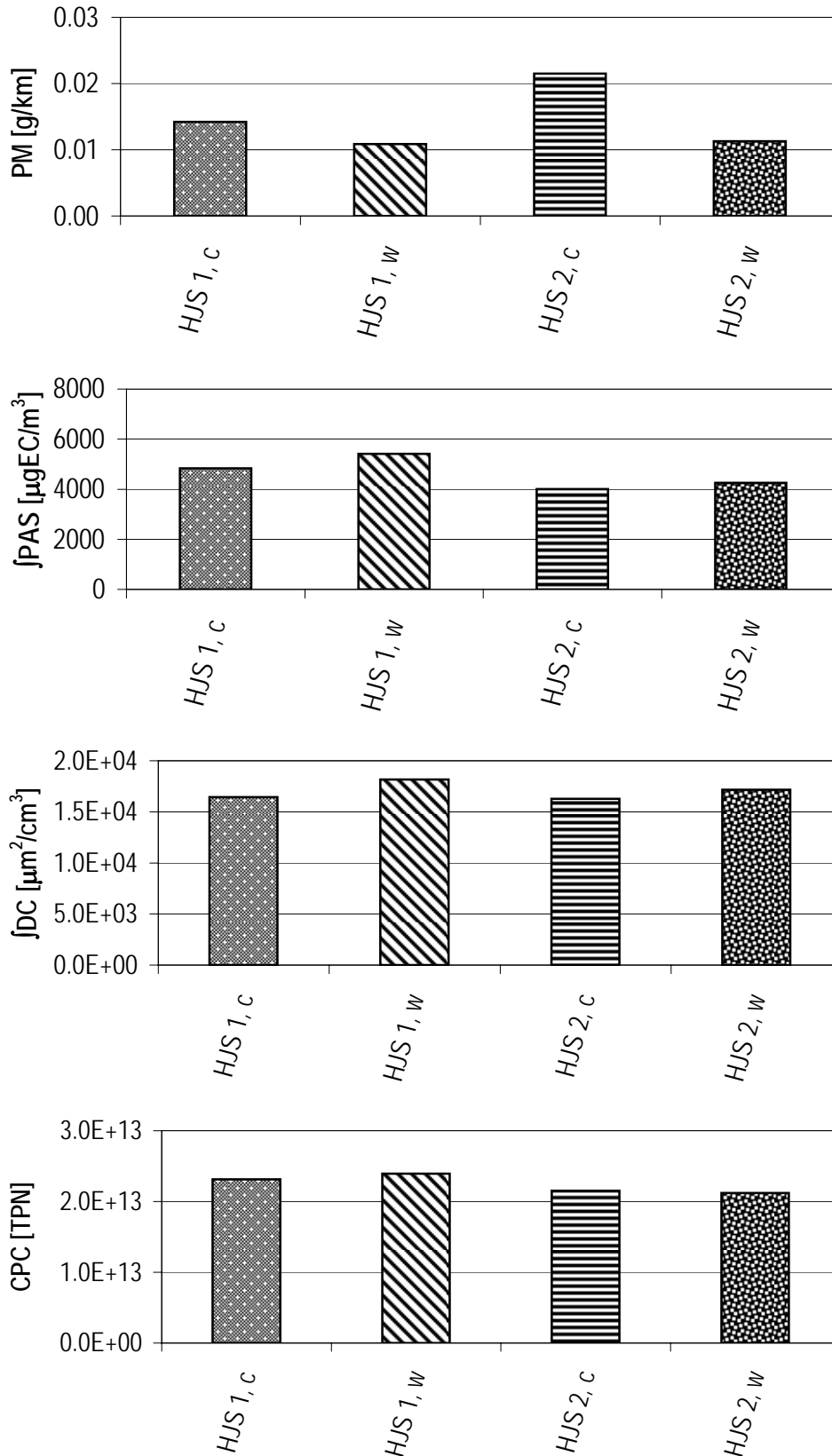


HJS 1, c... HJS-PMS from manufacturer, with cold start
 HJS 1, w... HJS-PMS from manufacturer, with engine warm
 HJS 2, c... HJS-PMS from market, with cold start
 HJS 2, w... HJS-PMS from market, with engine warm
 TPN... Total Particle Number [particle/km]

Comparison of limited and non limited emissions during the NEFZ driving cycle with engine cold and warm.

with HJS-PMS; VW Passat 1.9 TDI; low sulfur diesel

1st day



Comparison of limited and non limited emissions during different driving cycles

with HJS2-PMS; low sulfur diesel; CO, HC, NOx bag values

VW Passat 1.9 TDI

Total cycle values

Cycle	CO [g/km]	HC [g/km]	NOx [g/km]	PM [g/km]	∫ DC *) [μm ² /cm ³]	CPC [TPN]	∫ PAS *) [μgEC/m ³]
NEFZ c.	0.132	0.041	0.367	0.022	16277	2.15E+13	4009
NEFZ w.	0.016	0.012	0.325	0.011	17173	2.12E+13	4256

*) ... integral average value

Values "phase per phase"

Configuration	Meas- 21										
	CO [g/km]	CO ₂ [g/km]	HC [g/km]	NOx [g/km]	PM [g/km]	Conso [l/100km]	Distance [m]	Vol (CVS) [m ³]	∫ DC *) [μm ² /cm ³]	CPC [TPN]	∫ PAS *) [μgEC/m ³]
NEFZ c.	0.132	177.880	0.041	0.367	0.0215	6.68	11041		16277	2.15E+13	4009
NEFZ, 1st phase	0.343	251.660	0.086	0.401	0.0336	9.46	4064	106.910	13254	3.00E+13	3215
NEFZ, 2nd phase	0.009	134.905	0.014	0.347	0.0144	5.06	6977	54.857	22157	1.66E+13	5554
NEFZ w.	0.016	155.212	0.012	0.325	0.0113	5.82	11083		17173	2.12E+13	4256
NEFZ, 1st phase	0.029	205.232	0.018	0.356	0.0150	7.69	4101	106.670	13838	2.82E+13	3179
NEFZ, 2nd phase	0.007	125.831	0.009	0.306	0.0092	4.72	6982	54.726	23661	1.71E+13	6351

Backpressure with HJS1 / HJS2 - PMS

VW Passat 1.9 TDI; low sulfur diesel

Load steps HJS 1 / HJS 2

