



REC: NO_2/NO_x from retrofitted DPF

ETC-WHTC correlation

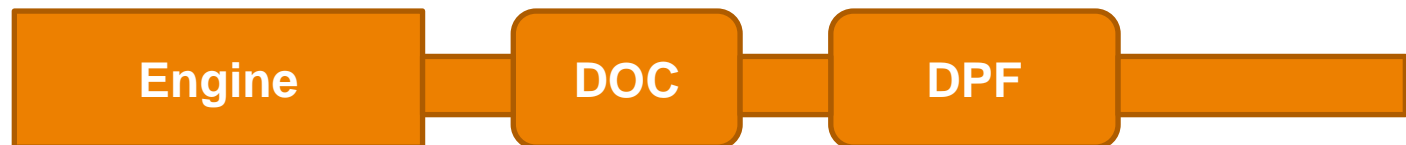
Norbert E. Ligterink





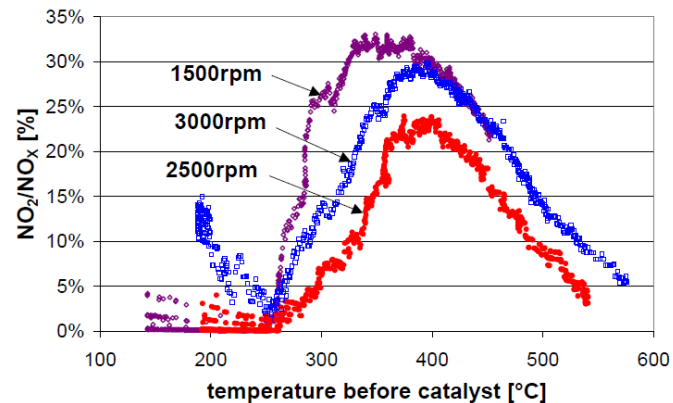
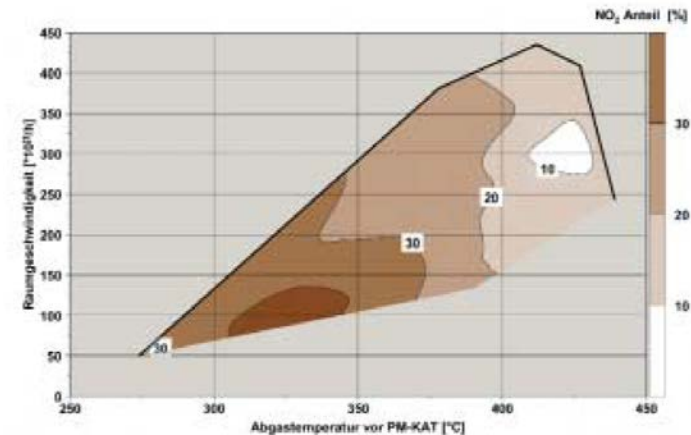
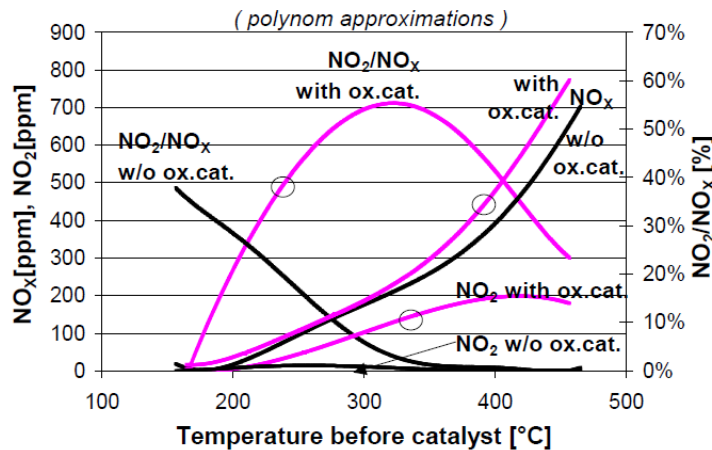
NO₂ from the DOC before DPF

- › not a consistent picture for NO₂ (e.g. from the VERT data)
- › NO₂ produced in DOC upstream from wall-flow DPF
- › NO₂ used to oxidize particulate matter, HC, and CO
- › Typical peak in NO₂ between 300° and 340° C
- › light-off at ~ 200° C
- › dependent of reaction kinetic (space velocity and temperature)
- › balance NO/NO₂: low temperature 50% NO₂, decrease with temperature





Some literature on DOC (diesel oxidation catalysts): Czerwinski et al. (SAE-2007-01-0321) and EMITECH (MTZ 6/2005 Jahrgang 66)

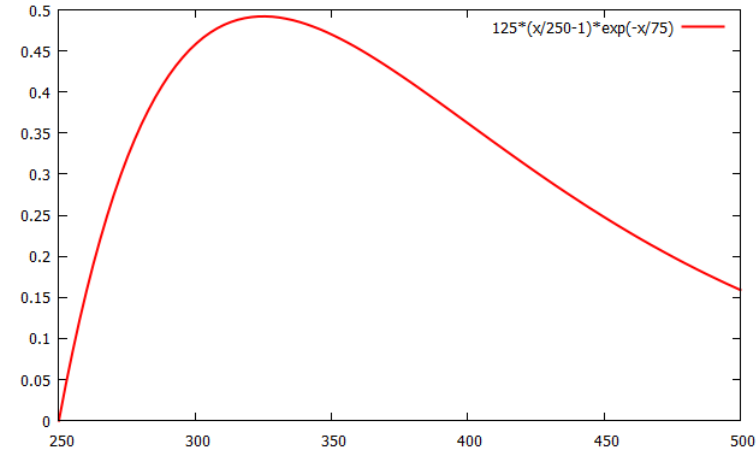
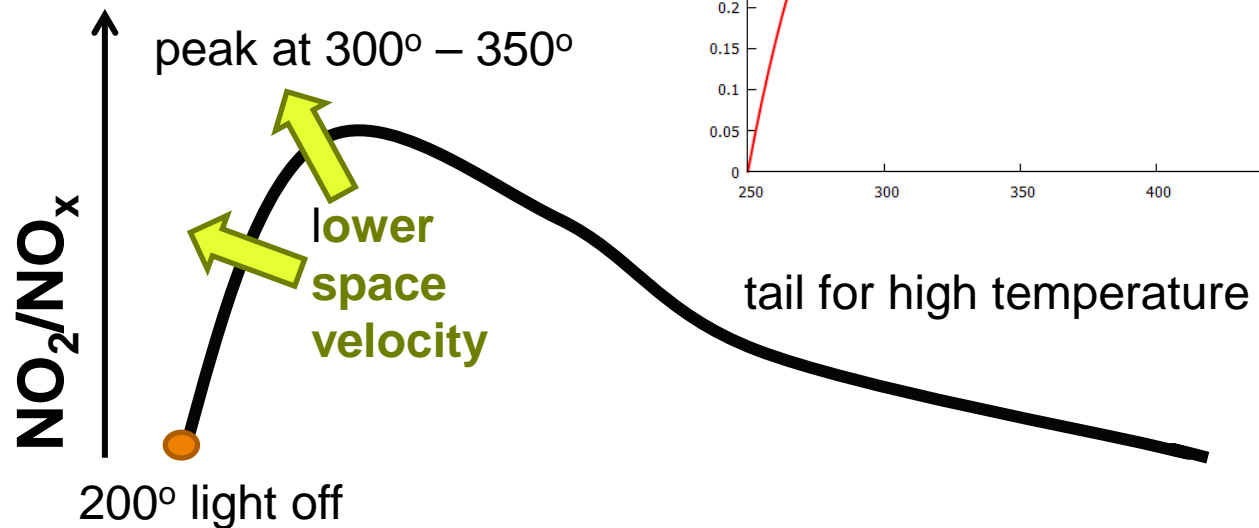


max. 45%-70% NO₂/NO_x
peak between 300° and 350°
some space velocity dependence



Typical characteristic of DOC *fitted function*

$$\text{NO}_2/\text{NO}_x(T) = Q * (T/T_{\text{min}} - 1) * \exp[-T/(T_{\text{peak}} - T_{\text{min}})]$$



*small space velocity effect within the bandwidth,
but would bring WHTC slightly closer to ETC values for NO₂/NO_x*

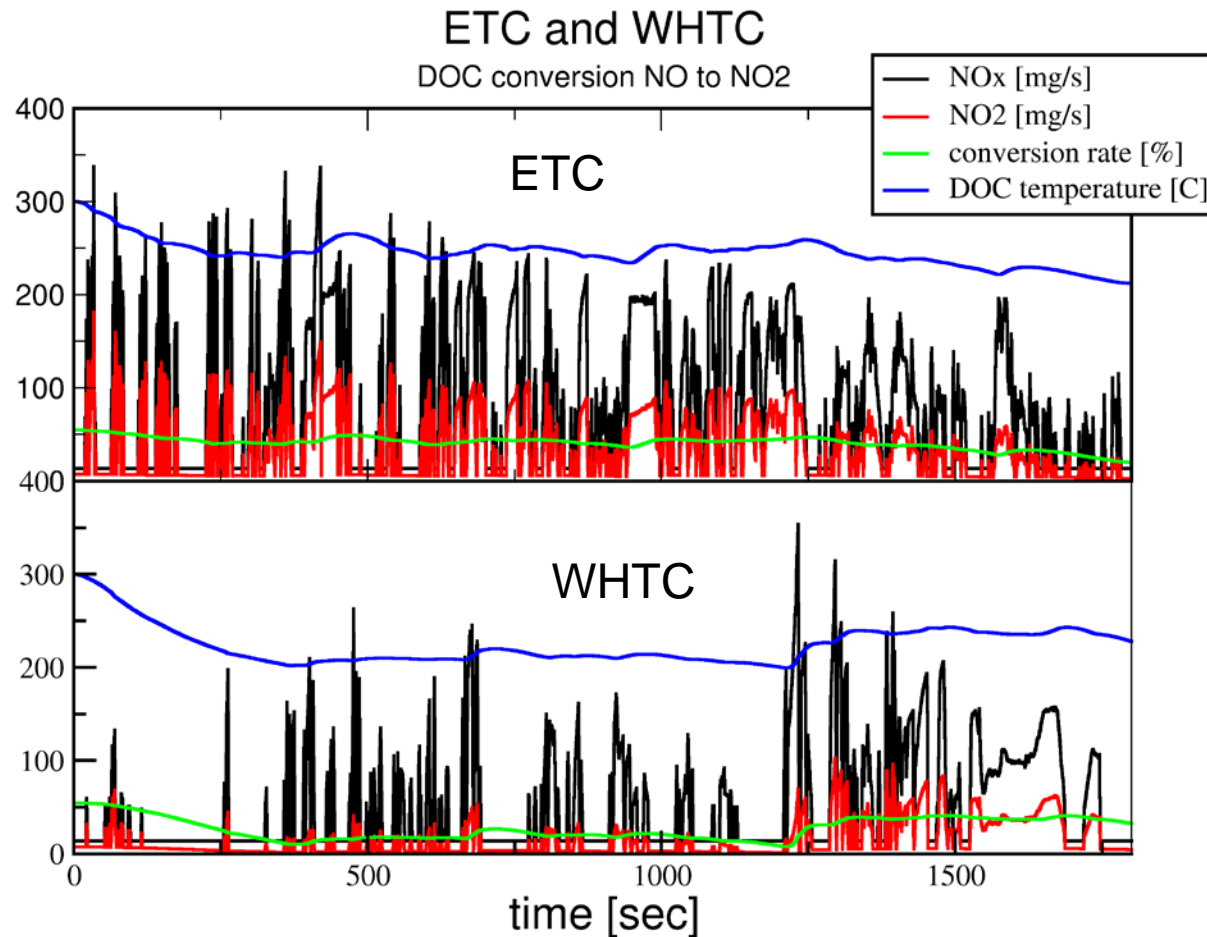


Relevant parameters, values and ranges *based on Euro-III engine out*

- › light-off temperature: 200° C (180° → 250°)
- › conversion peak value NO₂/NO_x: 55% [45% → 70%]
- › conversion peak location: 315° [300° → 340°]
- › space velocity dependence is covered by light-off range and peak location
- › engine-out NO₂ fixed at 8%
- › Not included: reduction of NO₂ through oxidation reactions



baseline simulation (*hot start case*)





large range in NO₂ fractions

WHTC cold: [8%-33%] hot: [9%-37%], ETC: [12%-53%]

NO ₂ /NO _x fraction		WHTC urban	WHTC total	ETC
cold 20° C	base	14%	26%	36%
	light-off 180° C	23%	33%	41%
	light-off 250° C	8%	8%	10%
	peak at 300° C	15%	27%	39%
	peak at 340° C	13%	23%	33%
	efficiency 70%	16%	31%	45%
	efficiency 45%	13%	22%	30%
hot 300° C	base	21%	29%	42%
	light-off 180° C	32%	37%	46%
	light-off 250° C	10%	9%	12%
	peak at 300° C	22%	31%	44%
	peak at 340° C	19%	26%	38%
	efficiency 70%	25%	35%	53%
	efficiency 45%	11%	18%	31%

*urban: first 1200 sec



Average ratios WHTC / ETC for different conditions

NO ₂ /NO _x fraction		WHTC urban	WHTC total	ETC	tot/etc	urb/etc
cold	base	14%	26%	36%	0,72	0,39
	20° C light-off 180° C	23%	33%	41%	0,80	0,56
	light-off 250° C	8%	8%	10%	0,80	0,80
	peak at 300° C	15%	27%	39%	0,69	0,38
	peak at 340° C	13%	23%	33%	0,70	0,39
	efficiency 70%	16%	31%	45%	0,69	0,36
	efficiency 45%	13%	22%	30%	0,73	0,43
hot	base	21%	29%	42%	0,69	0,50
	300° C light-off 180° C	32%	37%	46%	0,80	0,70
	light-off 250° C	10%	9%	12%	0,75	0,83
	peak at 300° C	22%	31%	44%	0,70	0,50
	peak at 340° C	19%	26%	38%	0,68	0,50
	efficiency 70%	25%	35%	53%	0,66	0,47
	efficiency 45%	11%	18%	31%	0,58	0,35
AVG					0,72	0,51

30% NO₂ in ETC matches

21,5% in WHTC total

15,4% in WHTC urban

on average over all conditions/assumptions