

Paper/Poster-Abstract Form

Name of Author: Jan Czerwinski, P. Comte, AFHB.....
Co-Authors: F. Reutimann, BAFU; A. Mayer, TTM.....
Affiliation: Abgasprüfstelle AFHB der BFH-TI, Biel
Mailing address: Gwerdtstrasse 5, CH-2560 Nidau.....
Phone / Fax: 032 321 66 80..... E-mail:jan.czerwinski@bfh.ch.....

Title:Changes of Nanoparticles Size Distributions of 2-Stroke Scooters
in the Exhaust and in CVS-Installation

Abstract: (min. 300 – max. 500 words)

The abstracts for papers and posters must contain unpublished information on your research subject: background, investigation methods, results and conclusions. Graphs and references are very welcome. Acronyms should be avoided. Abstracts with < 300 words can not be considered. General information on products which are already commercially available can not be accepted as presentations for the conference but are very welcome at the exhibition of particle filter systems and nanoparticle measurement instruments.

Nanoparticle emissions of two 2-stroke scooters were investigated along the exhaust- and CVS-system (Constant Volume Sampling) with closed and with open line (cone). Due to their technology the scooters produce different kind of aerosol (state of oxidation & SOF-content) and in addition to that they were operated with and without oxidation catalyst.

The scooters represent a modern technology with direct injection TSDI (two stroke direct injection) and with carburettor.

The tests were performed at two constant speeds of the vehicles (20 km/h & 40 km/h) according to the measuring procedures, which were established in the previous research in the Swiss Scooter Network.

The nanoparticulate emissions were measured by means of SMPS (CPC) and NanoMet.

The most important results are:

- The changes of the PSD's of the aerosol along the exhaust and CVS-system are connected to the average gas temperature and PC-concentration, which result after the different dilution steps and cooling down in the connecting pipe.
- In the "open" variant of exhaust gas extraction there is a dilution step with unfiltered ambient air directly after tailpipe. This causes a stop of agglomeration, reduction of diffusion losses and increased background NP-concentration. There is also lower postoxidation of CO & HC. In some cases spontaneous condensates due to the temperature drop are supposed.
- With the "closed" variant there is a stronger reduction of SMPS PC's along the gas way, than with the open variant. This is to explain with the higher temperatures and concentrations in the closed system, which enable more intense thermophoresis – and diffusion losses.
- The NP-concentrations measured with "open" variant are always higher.
- Most intense oxidation is observed with Peugeot Carb: due to the SAS, rich tuning and a relatively high temperature level there are oxidation effects already without catalyst (temp. approx. 350°C). With catalyst the temperature is in the range of 400°C and the oxidation is so intense, that the particles are nearly eliminated.

The type of sampling: "open", or "closed" as well as the sampling position in the exhaust installation have significant influence on the measured nanoparticles emission results.

Short CV:

- Study of Mechanical Engineering in Austria
- Assistant on the Technical University, Vienna, Ph.D. about combustion in SI-engines
- R & D diesel injection systems, diesel combustion, Voest Alpine Friedmann, Austria
- R & D turbocharging systems, Asea Brown Boveri, Switzerland
- Since 1989, professor for thermodynamics and IC-engines, head of the laboratory for emission gas control, University of Applied Sciences, Biel-Bienne, Switzerland
- Member of Societies of Automotive Engineering, SAE: USA, Switzerland, Austria, Poland
- Swiss Delegate to the IEA Implementing Agreement Advanced Motor Fuels.
- Nominated for SAE Fellow 2009
- Author & Coauthor of more than 170 technical publications: engine technology, emissions & environment.

**Return by e-mail latest 14th of April 2012 to
ttm.a.mayer@bluewin.ch**

Changes of Nanoparticles Size Distributions of 2-Stroke Scooters in the Exhaust and in CVS-Installation

J.Czerwinski, P.Comte, C.Chiesura
AFHB, University of Applied Sciences,
Biel-Bienne, CH

A. Mayer
TTM, CH

F. Reutimann
BAFU, Technology, CH

Passage of exhaust gas from tailpipe to CVS:
closed (left), open (right)

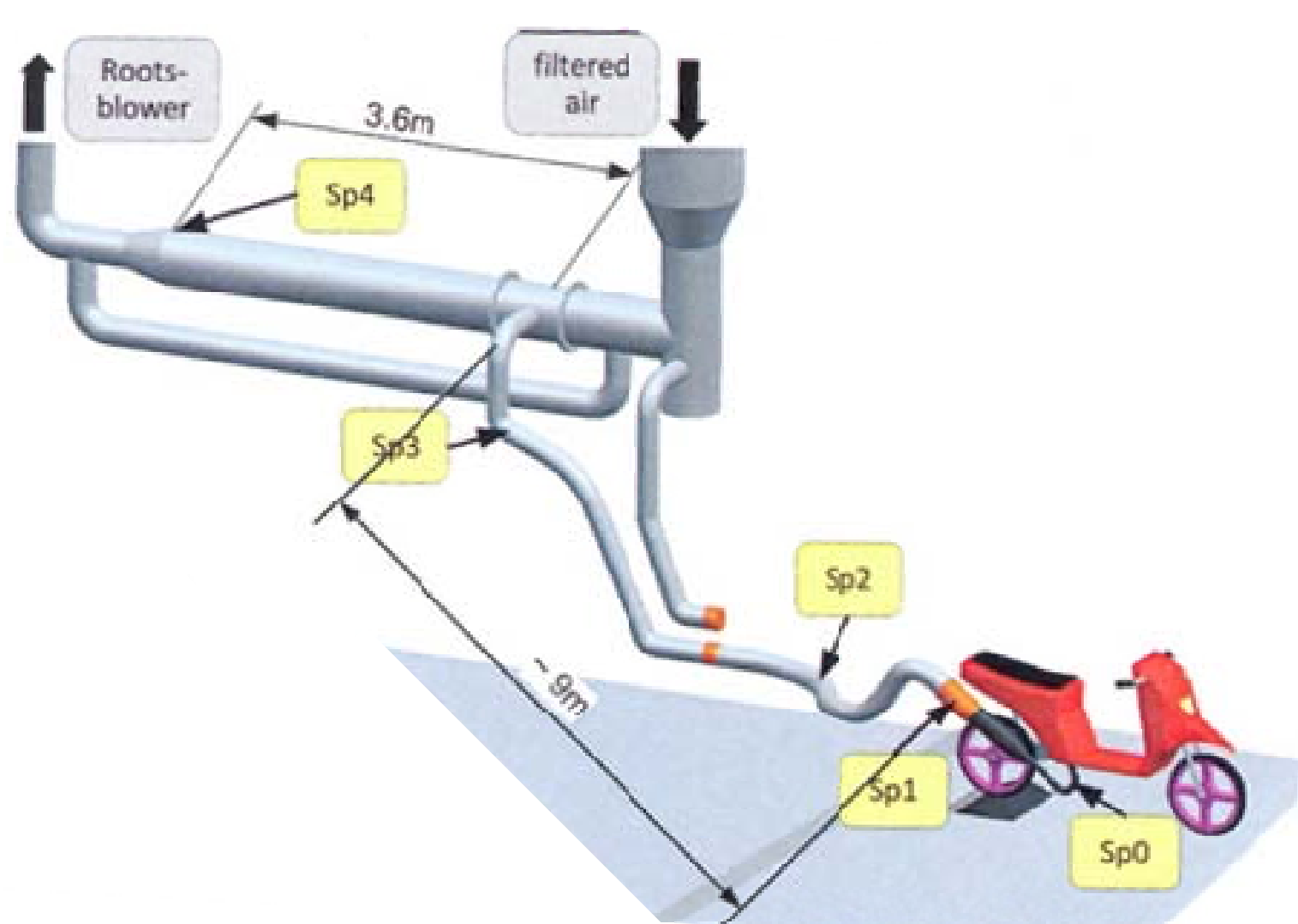


Peugeot scooters:
left TSDI, right "carburetor"

Data of the investigated Peugeot scooters

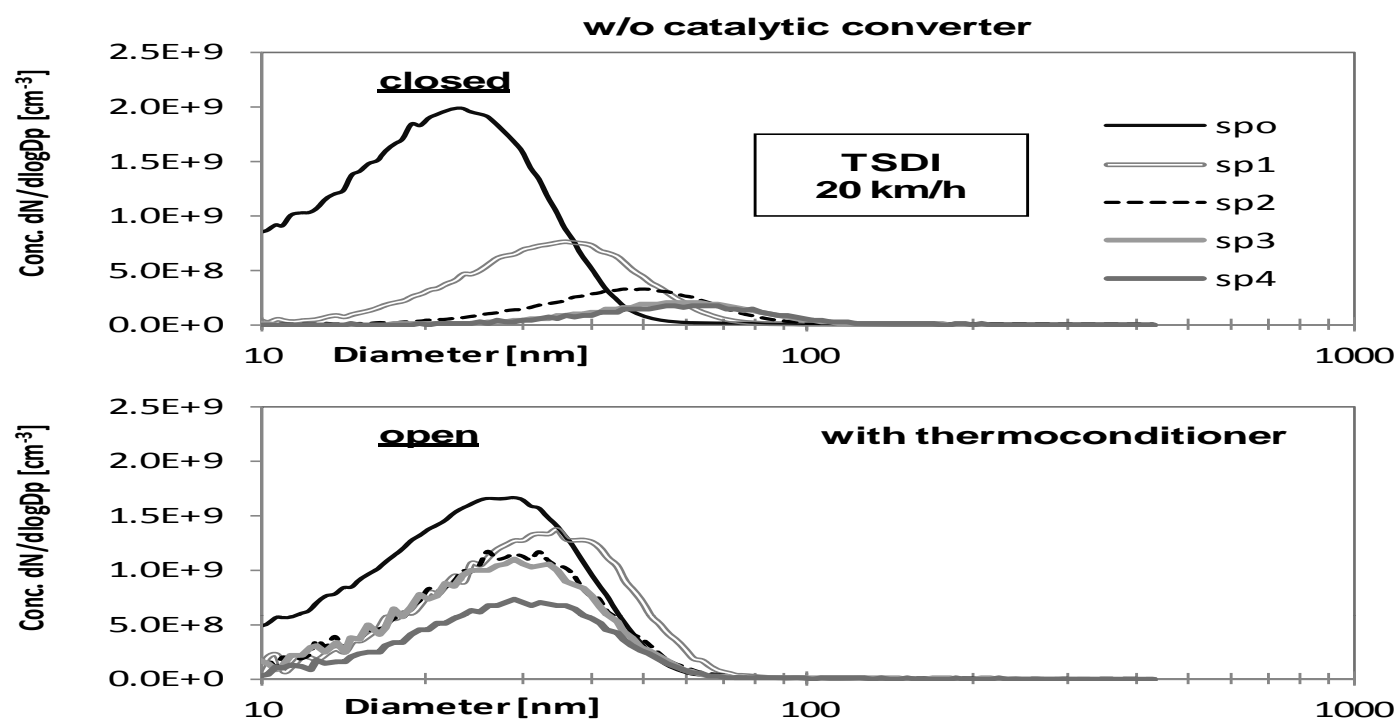
	Peugeot	Peugeot
vehicle identification	Looxor TSDI	Looxor
model year	2002	2004
transmission no. of gears	variomat	variomat
km at beginning	1400	0
engine:		
type	2 stroke	2 stroke
displacement cm ³	49.1	49.1
number of cylinders	1	1
cooling	Air forced	Air forced
rated power	3.6 kW	3.72 kW
rated speed	7800 rpm	8100 rpm
idling speed	1700 rpm	1800 rpm
max vehicle speed	45 km/h	45 km/h
weight empty	94 kg	94 kg
mixture preparation	direct injection with automatic oil pump	carburetor with automatic oil pump
catalyst	yes	yes + SAS (secondary air system)
catalyst data	Pt/Rh 5/1 50 g/ft ³ 200 cpsi metal support Ø 60,5 / L 25	PtPd/Rh 1/28/1 50 g/ft ³ 100 cpsi metal support Ø 60,5 / L 40

Sampling positions (Sp) used in the tests

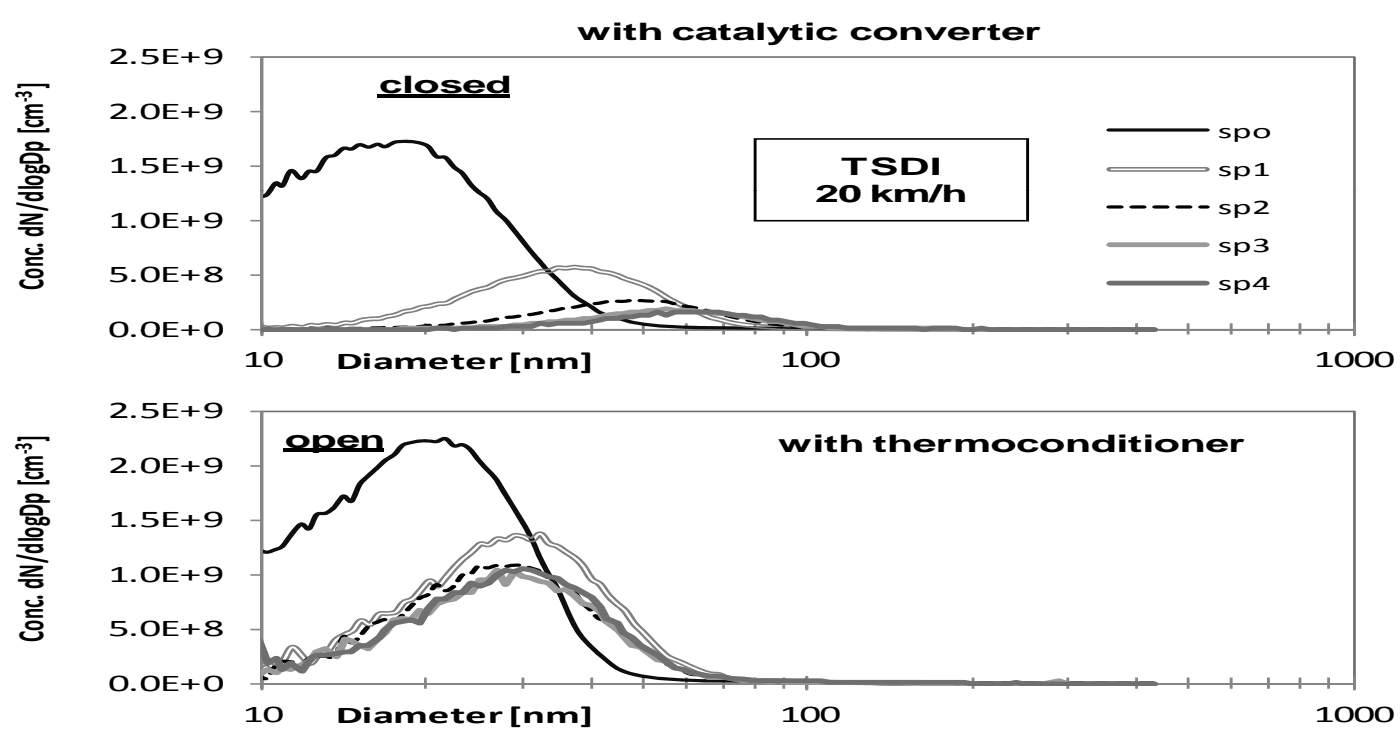


Peugeot TSDI

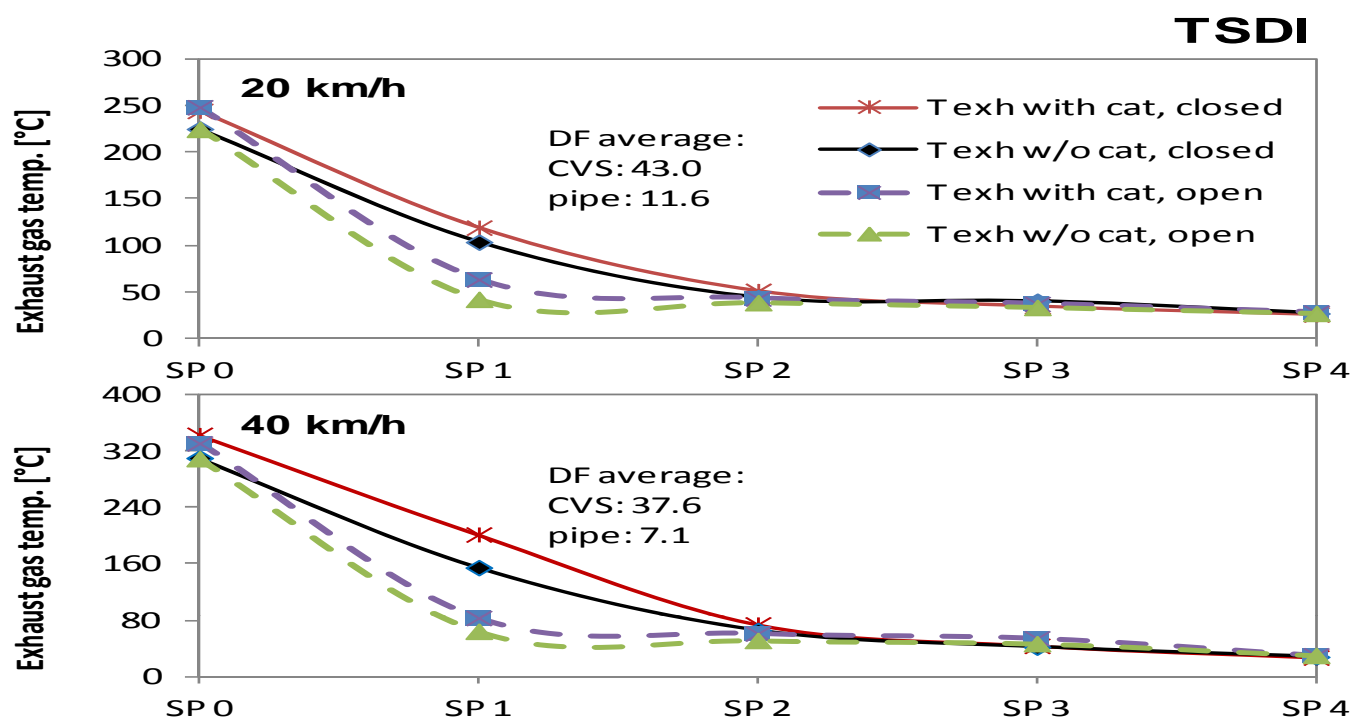
This vehicle has: leaner tuning, no SAS, TP exhaust temperatures at 40km/h approximately 300°C.



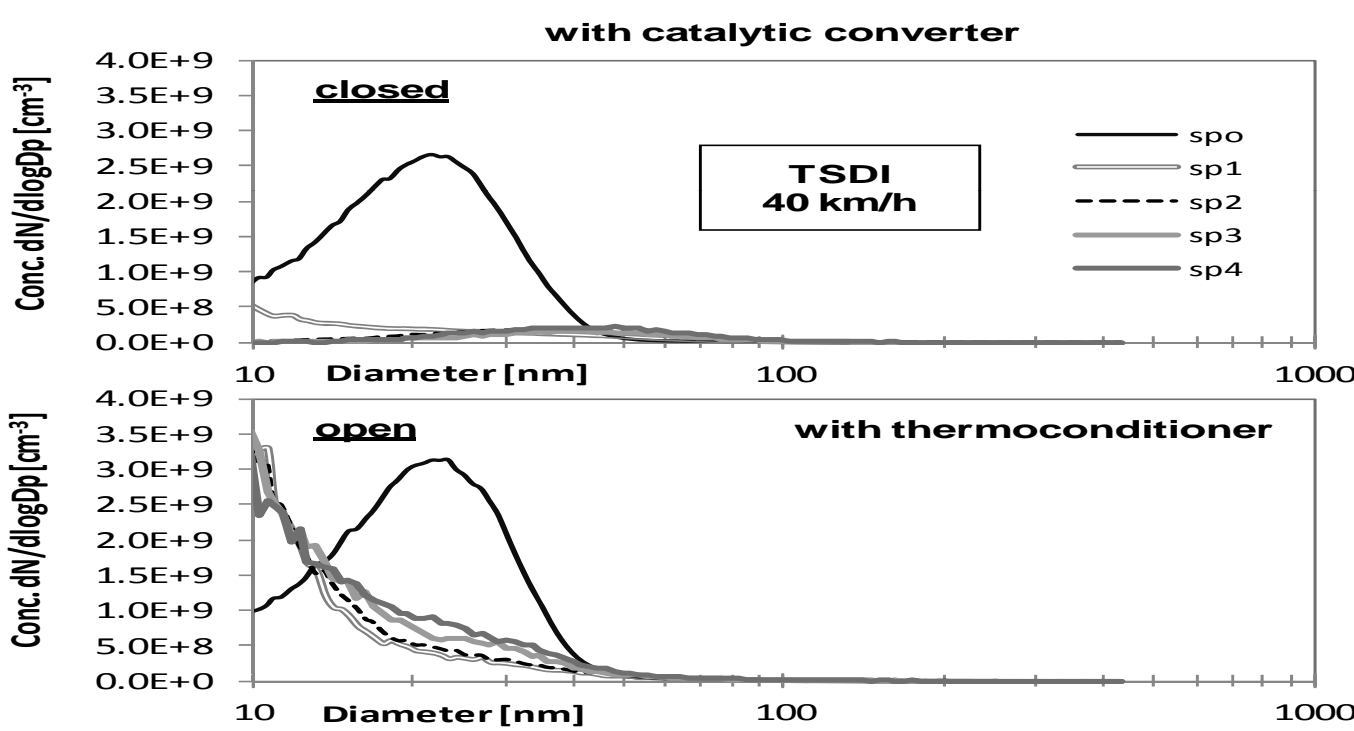
SMPS - size spectra at constant speed 20 km/h and different sampling points of the exhaust pipe and CVS tunnel without catalyst.



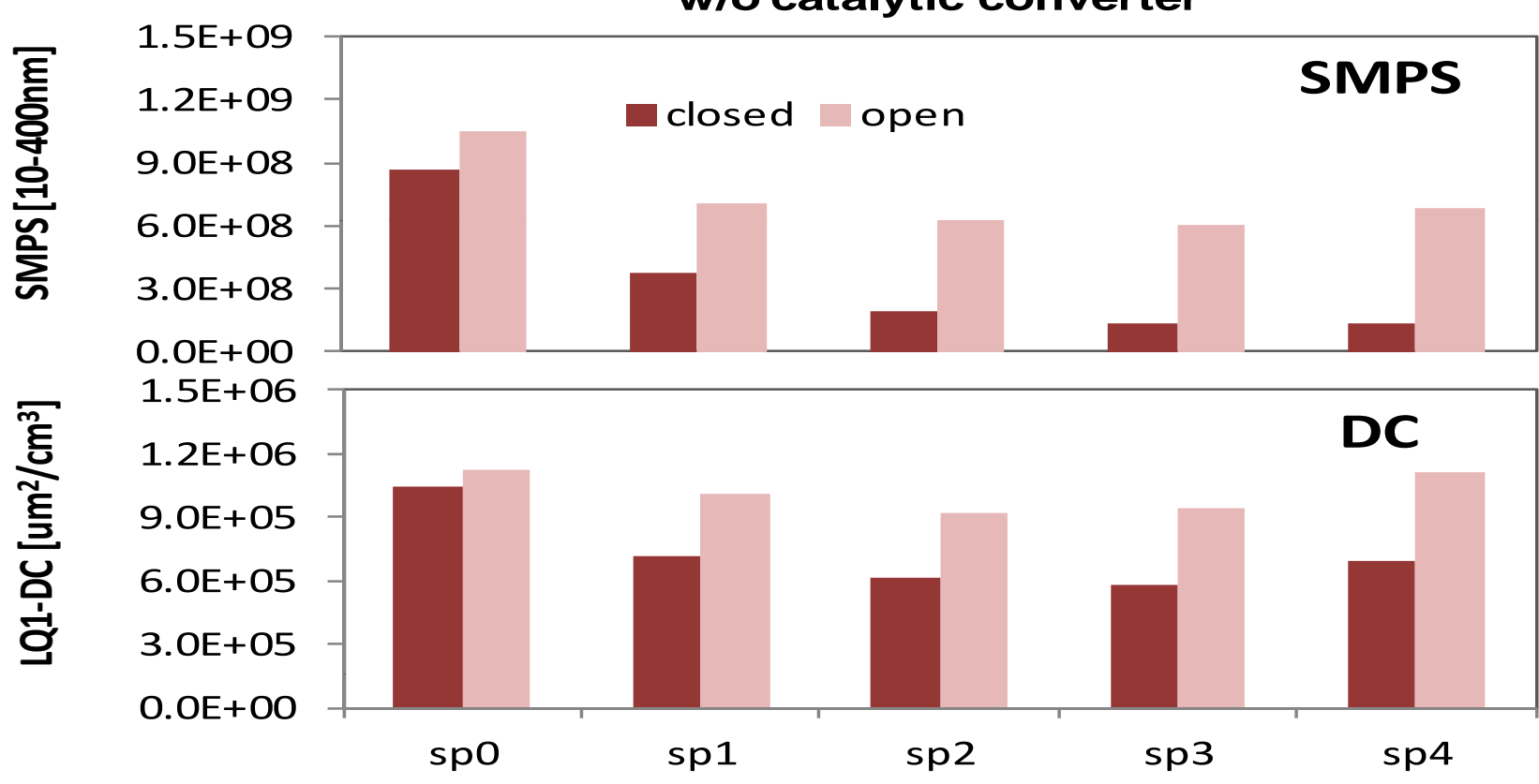
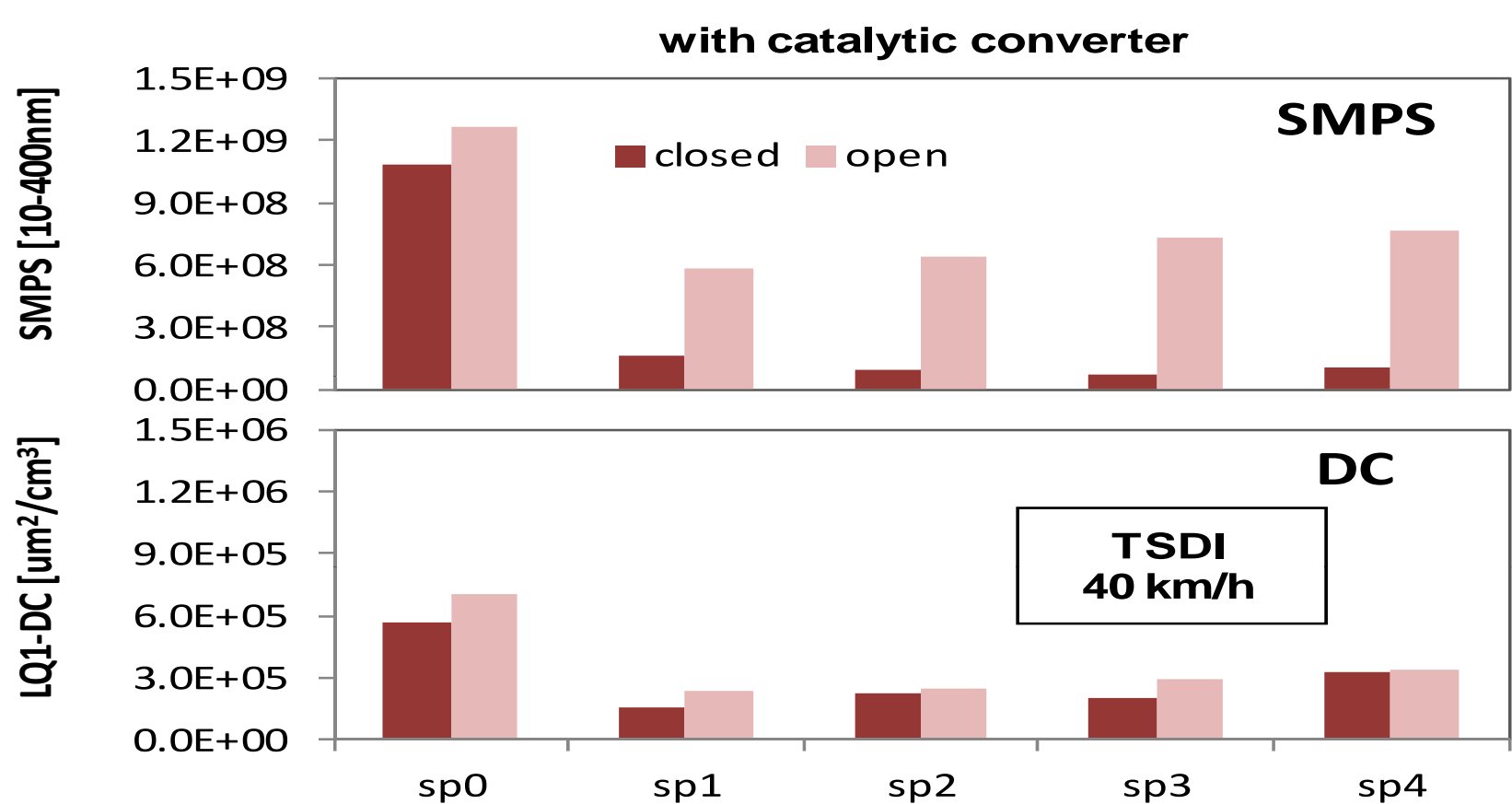
SMPS - size spectra at constant speed 20 km/h and different sampling points of the exhaust pipe and CVS tunnel with catalyst.



Gas temperatures and dilution factors in the exhaust system at constant speeds 20 & 40 km/h, with TSDI.



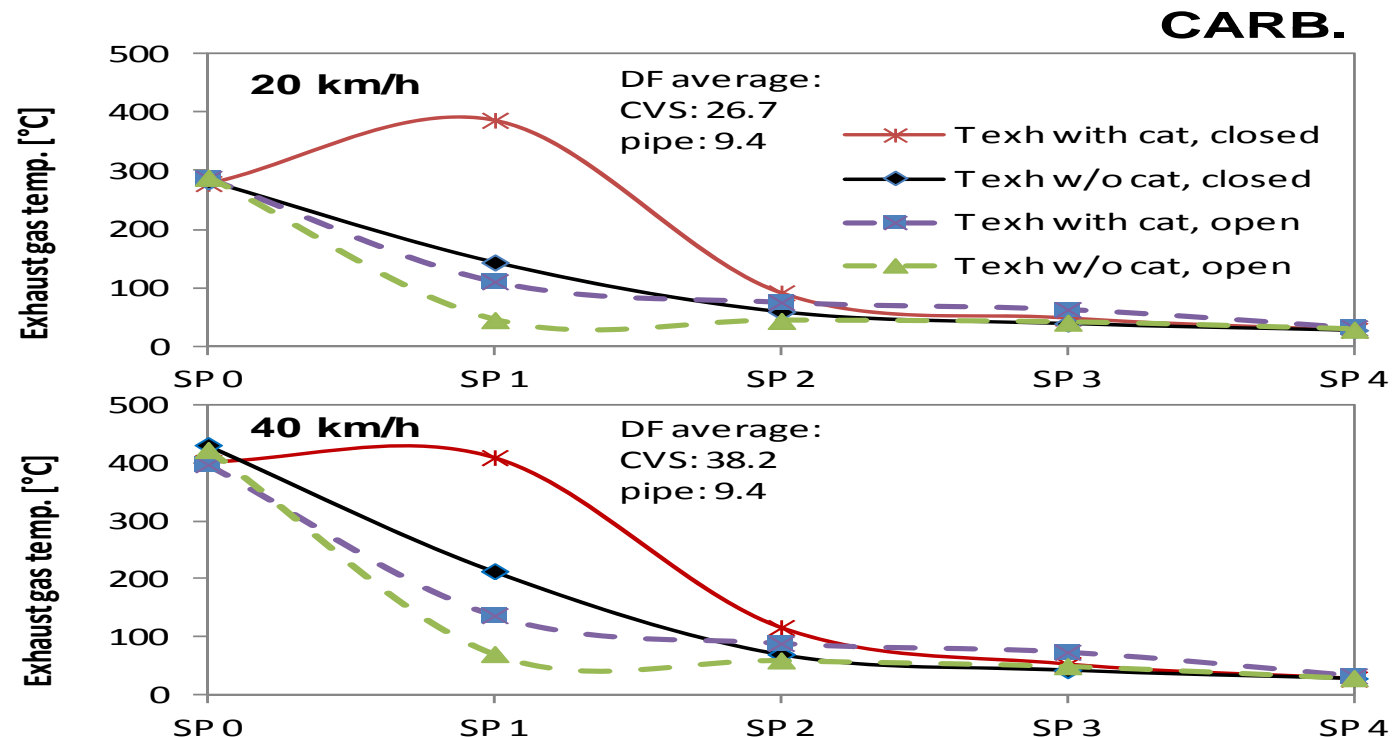
SMPS - size spectra at constant speed 40 km/h and different sampling points of the exhaust pipe and CVS tunnel with catalyst.



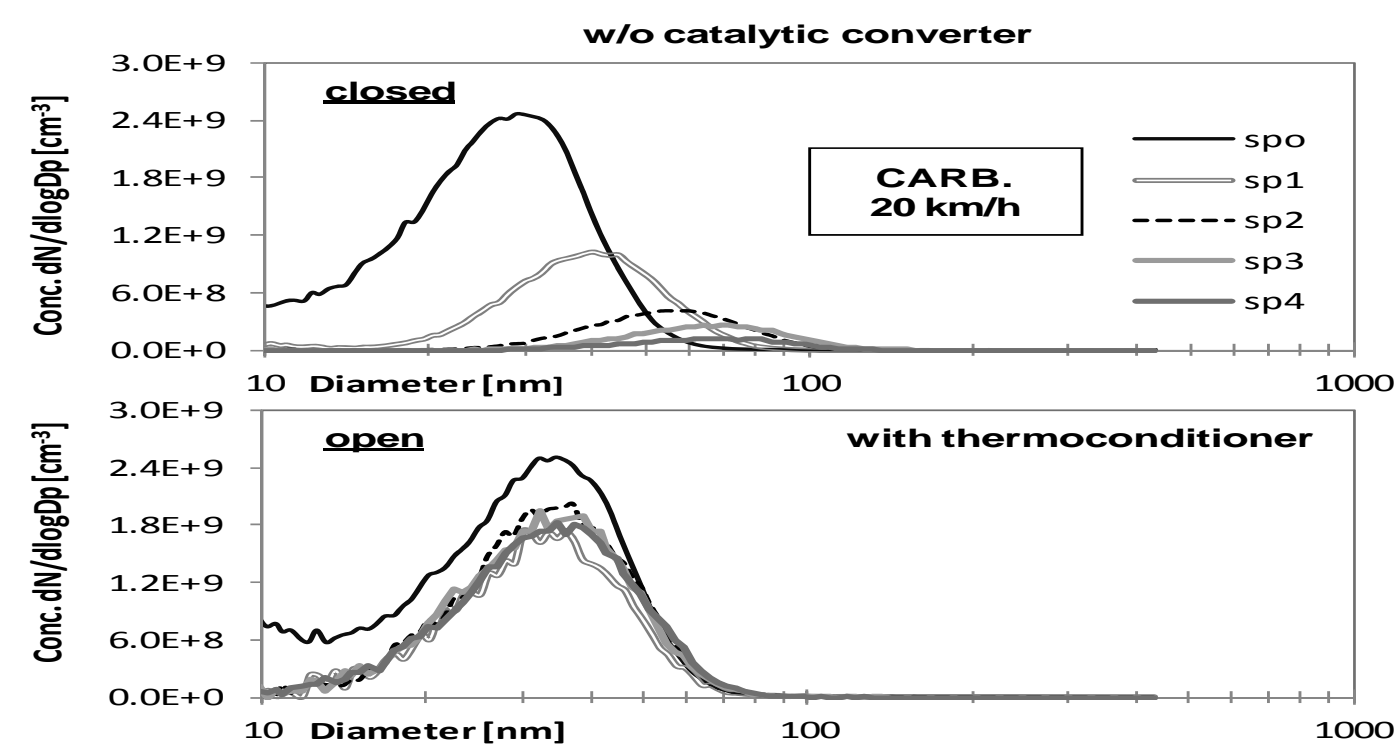
Comparison of the DC signal & SMPS integral concentration at constant speed 40 km/h with open and closed exhaust sampling.

Peugeot Carburettor

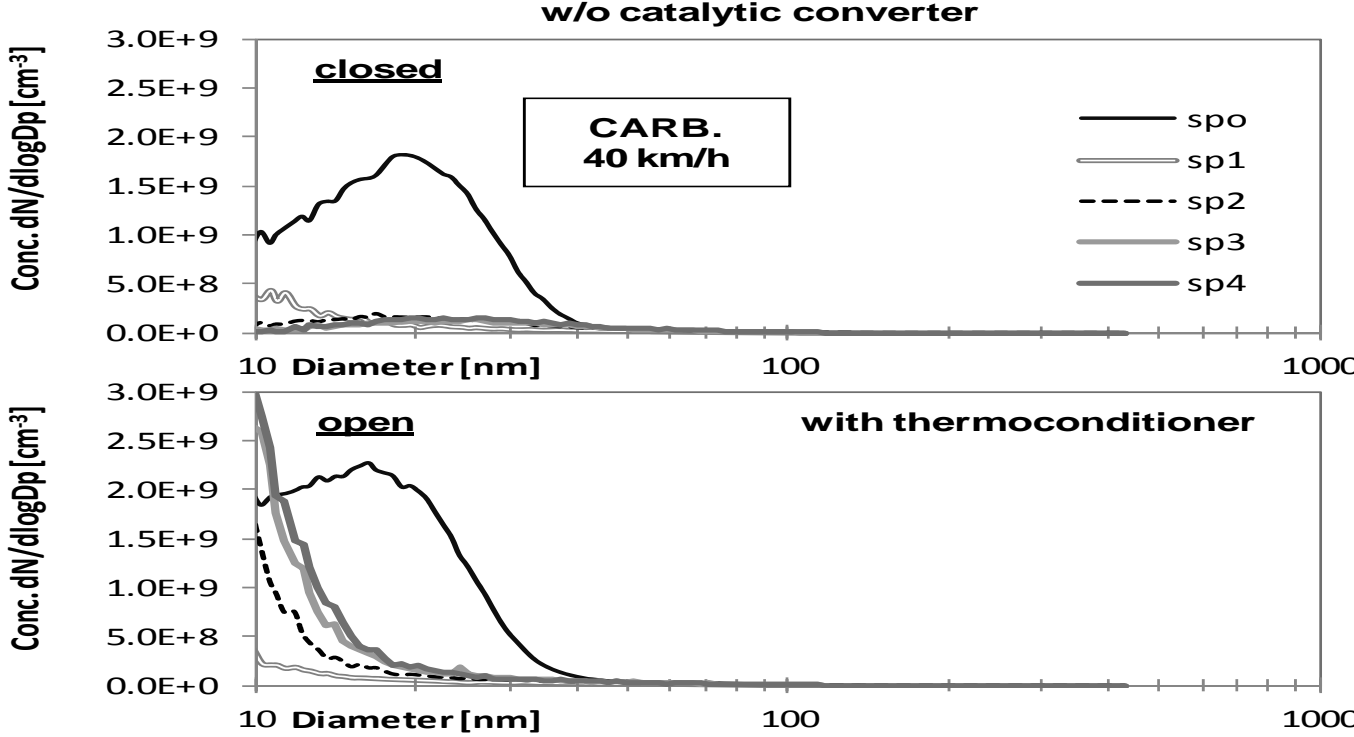
This vehicle has: richer tuning, active SAS, TP exhaust temperatures at Sp1 are approximately 400°C.



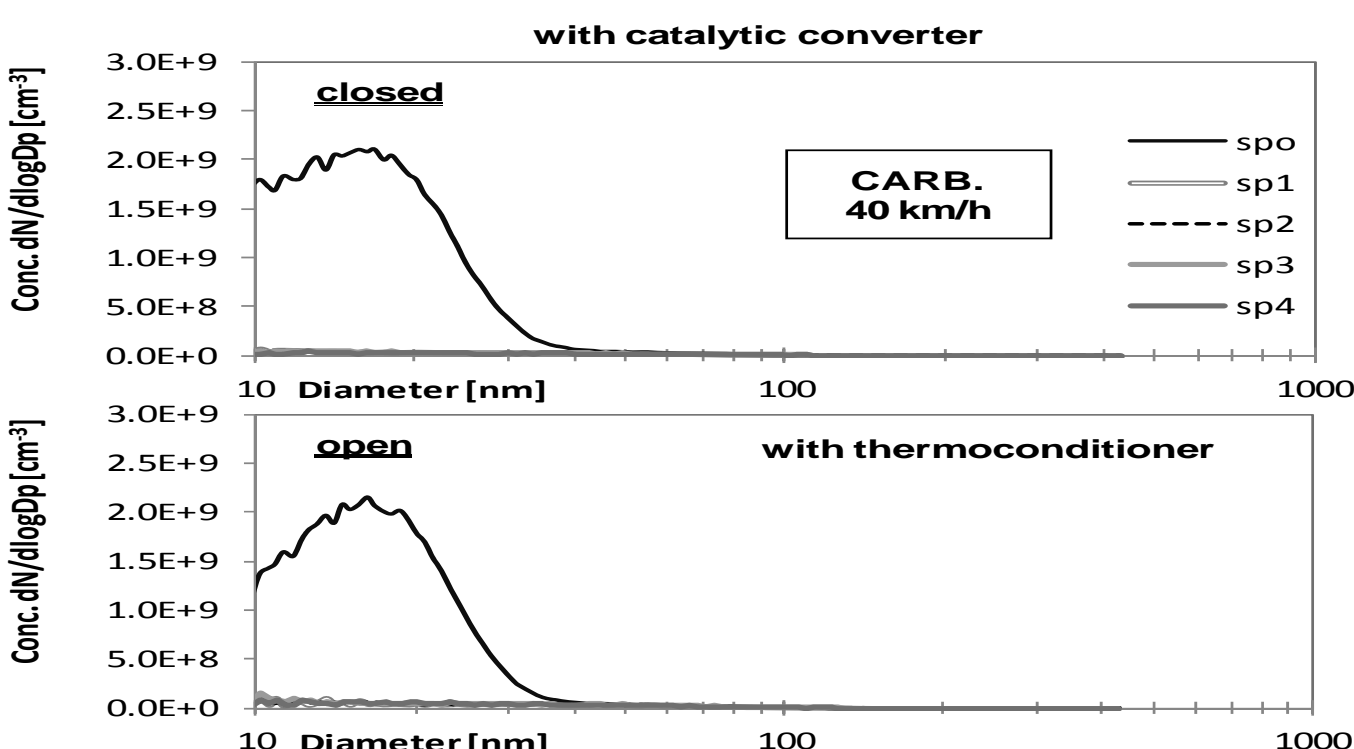
Gas temperatures and dilution factors in the exhaust system at constant speeds 20 & 40 km/h, with Carb.



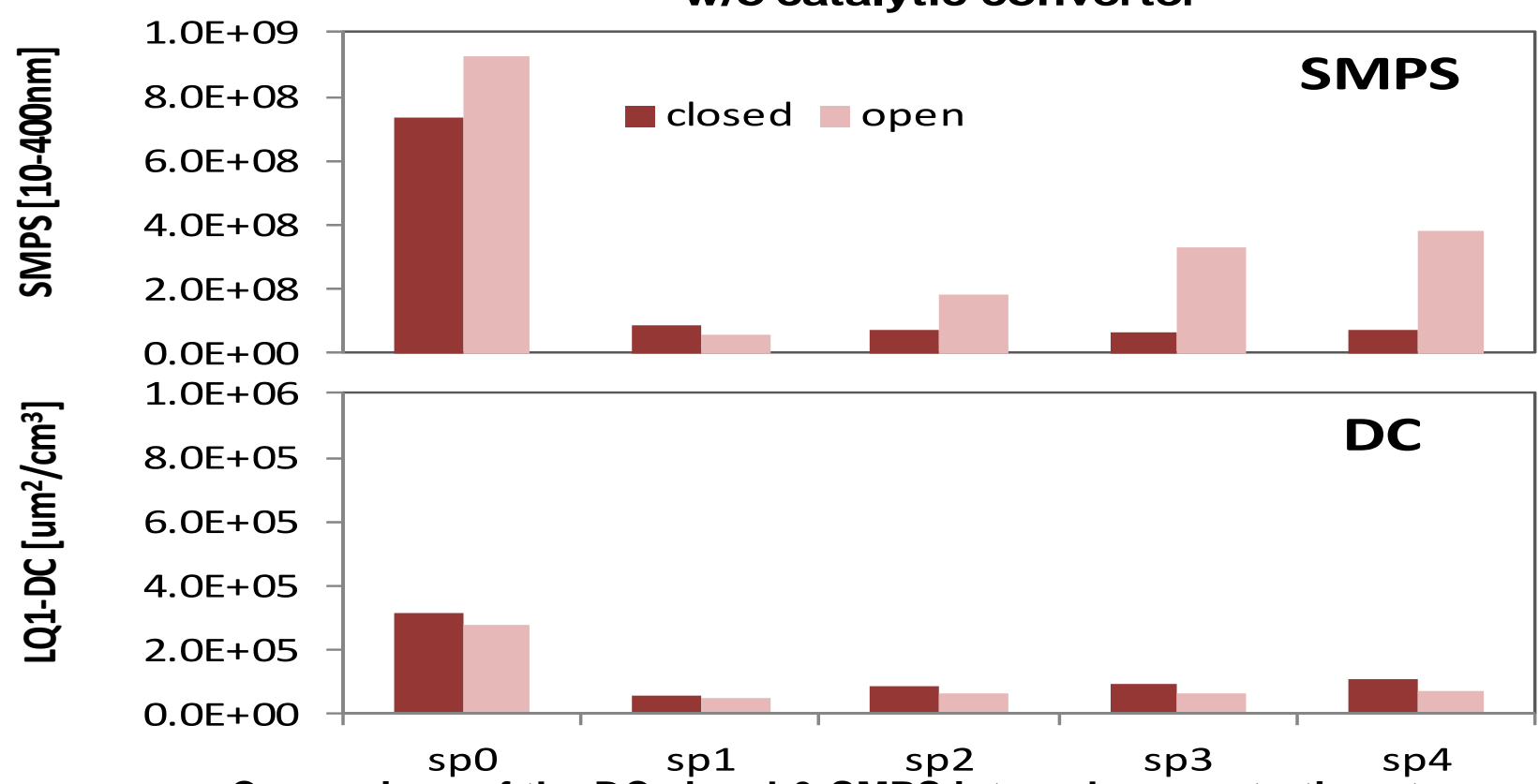
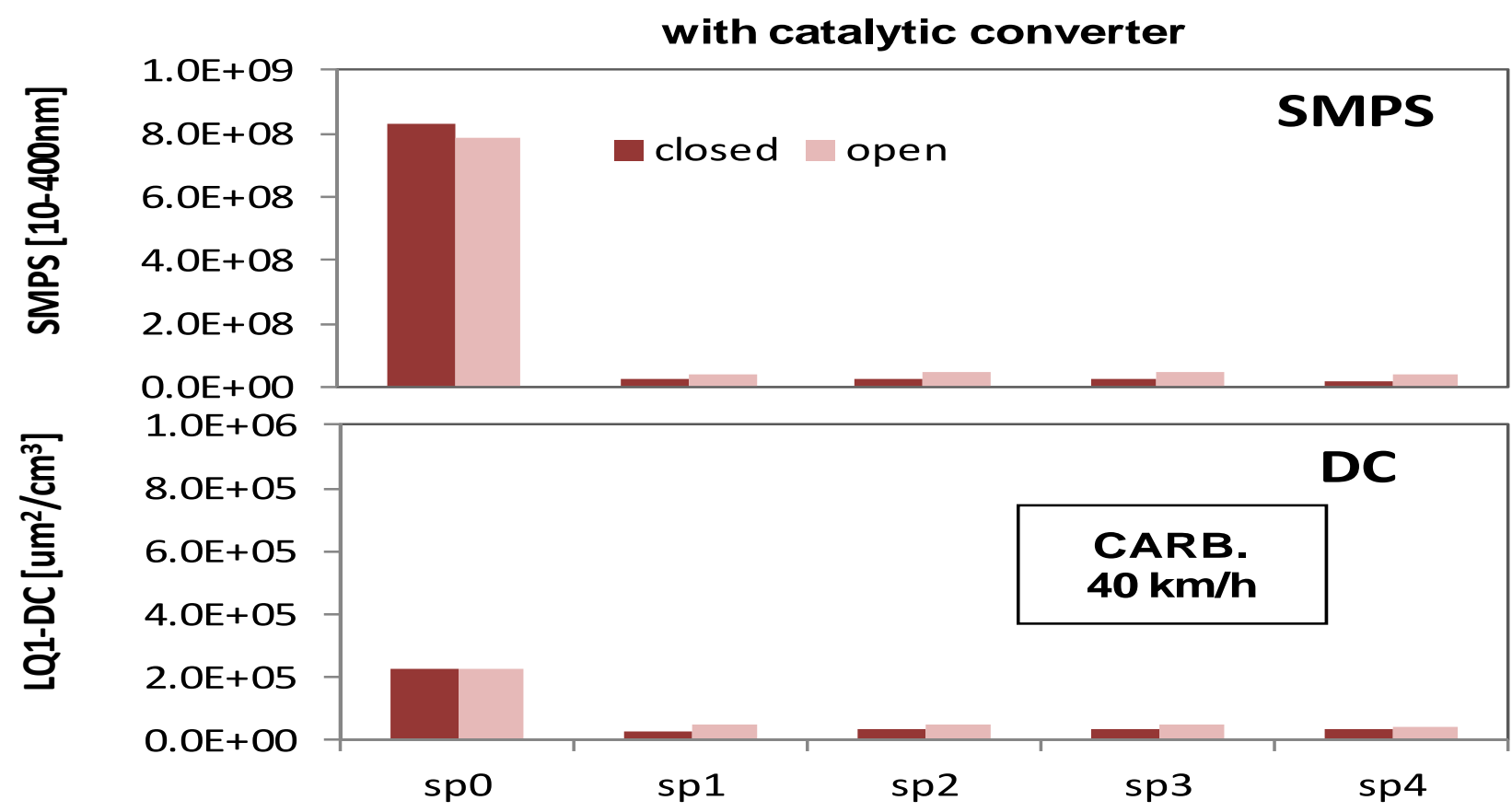
SMPS - size spectra at constant speed 20 km/h and different sampling points of the exhaust pipe and CVS tunnel without catalyst.



SMPS - size spectra at constant speed 40 km/h and different sampling points of the exhaust pipe and CVS tunnel without catalyst.



SMPS - size spectra at constant speed 40 km/h and different sampling points of the exhaust pipe and CVS tunnel with catalyst.



Comparison of the DC signal & SMPS integral concentration at constant speed 40 km/h with open and closed exhaust sampling.

Conclusions

- The changes of the PSD's of the aerosol along the exhaust and CVS-system are connected to the average gas temperature and PC-concentration, which result after the different dilution steps and cooling down in the connecting pipe.
- The effects influencing the aerosol at different sampling positions are: agglomeration, condensation, diffusion losses and thermophoresis.
- In the "open" variant of exhaust gas extraction there is a dilution step with unfiltered ambient air directly after tailpipe. This causes a stop of agglomeration, reduction of diffusion losses and increased back-ground NP-concentration. There is also lower postoxidation of CO & HC. In some cases spontaneous condensates due to the temperature drop are supposed.

- With the "closed" variant there is a stronger reduction of SMPS PC's along the gas way, than with the open variant. This is to explain with the higher temperatures and concentrations in the closed system, which enable more intense thermophoresis – and diffusion losses.
- The NP-concentrations measured with "open" variant are always higher.
- The oxidation catalyst principally lowers the NP count concentrations and moves the PSD-maximum to the lowest sizes. The intensity of oxidation depends on the exhaust gas temperature.
- Most intense oxidation is observed with Peugeot Carb: due to the SAS, rich tuning and a relatively high temperature level there are oxidation effects already without catalyst (temp. approx. 350°C). With catalyst the temperature is in the range of 400°C and the oxidation is so intense, that the particles are nearly eliminated.