Supplementary information

Development and evaluation of a catalytic stripper for the measurement of solid ultrafine particle emissions from internal combustion engines.

A.D. Melas[1,*], V. Koidi[1,2], D. Deloglou[1], E. Daskalos[1], D. Zarvalis[1], E. Papaioannou[1,2], A.G. Konstandopoulos[1,2]

[1]Aerosol & Particle Technology Laboratory, CERTH/CPERI, P.O. Box 60361, Thessaloniki, Greece

[2]Department of Chemical Engineering, Aristotle University, Greece

* Author to whom inquiries should be addressed:

tel: +30 2310498193, email: amelas@certh.cperi.gr

S1. Tetracontane particle removal setups and tetracontane particle size distribution characteristics

Figure S1 presents the tetracontane particle removal setup that was used for testing the stand-alone CS (SA-CS). The polydisperse tetracontane aerosol that was generated by the volatile particle generator was either measured directly by the SMPS or driven to the CS, cooled in an ejector diluter and then measured by the SMPS and a CPC.

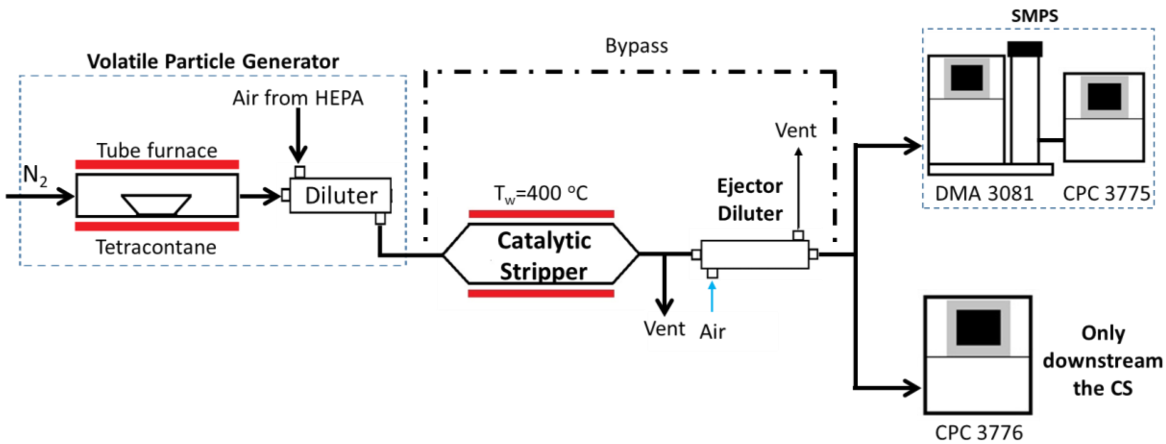

Figure S1. The experimental setup of tetracontane particle removal with the catalytic stripper as a stand-alone device.

Figure S2 plots the tetracontane removal setup that was used to evaluate the VPR-CS and the VPR-ET. The main difference with Figure S1 is that whilst in the SA-CS setup all the aerosol flow from the volatile particle generator is driven to the conditioning system, the VPRs sample from the dilution tunnel and the rest of the aerosol flow is driven to the vent.

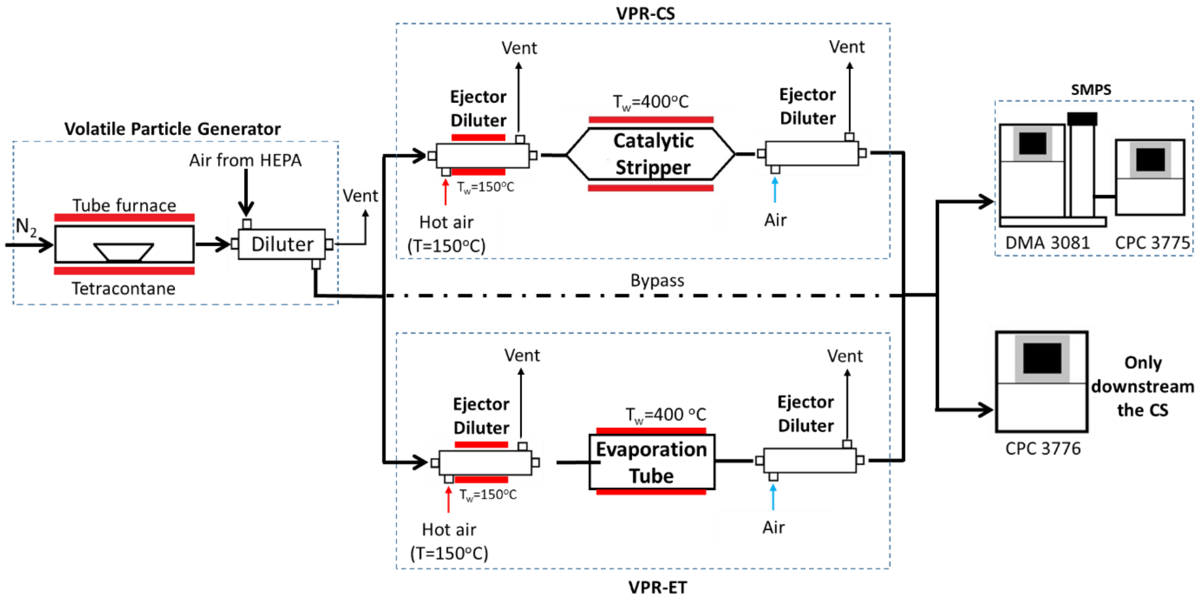

Figure S2. The experimental setup used to evaluate the C$0 removal efficiency of the VPR-CS and VPR-ET.

Tables S1 and S2 list the tetracontane number concentration, the mass concentration, the mean size, and the σ_g for the SA-CS tests. Table S1 refers to the experiments performed with mean tetracontane size ~30 nm (see also Figure 3b) while Table S2 refers to a mean size >50 nm (see also Figure 3a).

Table S1. Tetracontane particle size distribution data at different stand-alone catalytic stripper testing conditions when the mean size is ~30 nm.

Flow (l/min)	Number concentration (#/cm^3)	Number concentration (#/cm^3), $D_m \geq 30$ nm	Mass concentration (mg/m^3)	$\tilde{D}_m$ (nm)	σ_g

10	$3.2 \cdot 10^7$	$1.4 \cdot 10^7$	0.62	27.9	1.50
10 (Saturated)	$4.5 \cdot 10^6$	$2.8 \cdot 10^6$	0.10	34.3	1.31
15	$3.1 \cdot 10^7$	$2.4\ 10^7$	1.19	40.1	1.46
15 (Saturated)	$3.2 \cdot 10^6$	$1.9 \cdot 10^6$	0.0.7	33.8	1.29
20	$2.8 \cdot 10^7$	$1.9 \cdot 10^7$	0.76	35.9	1.51
22.5	$1.6 \cdot 10^6$	$1.1 \cdot 10^6$	0.03	33.2	1.30
30	$6.5 \cdot 10^5$	$4.9 \cdot 10^5$	0.02	35.3	1.31

Table S2. Tetracontane particle size distribution data at different stand-alone catalytic stripper testing conditions when the mean size is >50 nm

Flow (l/min)	Number concentration (#/cm^3)	Mass concentration (mg/m^3)	$\tilde{\boldsymbol{D}}_m$ (nm)	σ_g
5	$2.3 \cdot 10^7$	2.19	50.3	1.45
10	$1.3 \cdot 10^7$	1.45	50.8	1.55
15	$1.4 \cdot 10^7$	1.02	50.1	1.29

Tables S3 and S4 list the tetracontane particle size distribution data used for testing the VPR-CS and the VPR-ET with mean sizes ~30 nm and >50 nm, respectively.

Table S3. Tetracontane particle size distribution data used for testing VPR-CS and VPR-ET with tetracontane mean size is ~30 nm.

Flow (l/min)	Number concentration (#/cm^3)	Number concentration (#/cm^3), $D_m \geq 30$ nm	Mass concentration (mg/m^3)	$\tilde{\boldsymbol{D}}_m$ (nm)	σ_g
8 (VPR-CS)	$3 \cdot 10^6$	$1.6 \cdot 10^6$	0.13	31.4	1.61
5 (VPR-ET)	$4.5 \cdot 10^6$	$2.7 \cdot 10^6$	0.24	33.9	1.61

Table S4. Tetracontane particle size distribution data used for testing VPR-CS and VPR-ET with tetracontane mean size is >50 nm.

Flow (l/min)	Number concentration (#/cm^3)	Mass concentration (mg/m^3)	$\tilde{\boldsymbol{D}}_m$ (nm)	σ_g
8 (VPR-CS)	$2 \cdot 10^7$	1.57	51.4	1.30
5 (VPR-ET)	$1,1 \cdot 10^7$	1.79	50.3	1.49

S2. CAST-generated volatile fraction removal and diesel engine exhaust measurement setups

Figure S3 shows a schematic of the setup used to test the VPR-CS and VPR-ET efficiency to remove CAST-generated volatile particles. The same setup was also used for the diesel exhaust solid particle measurement. A DMA 3085 was used for CAST experiments while a DMA 3081 for Diesel exhaust experiments.

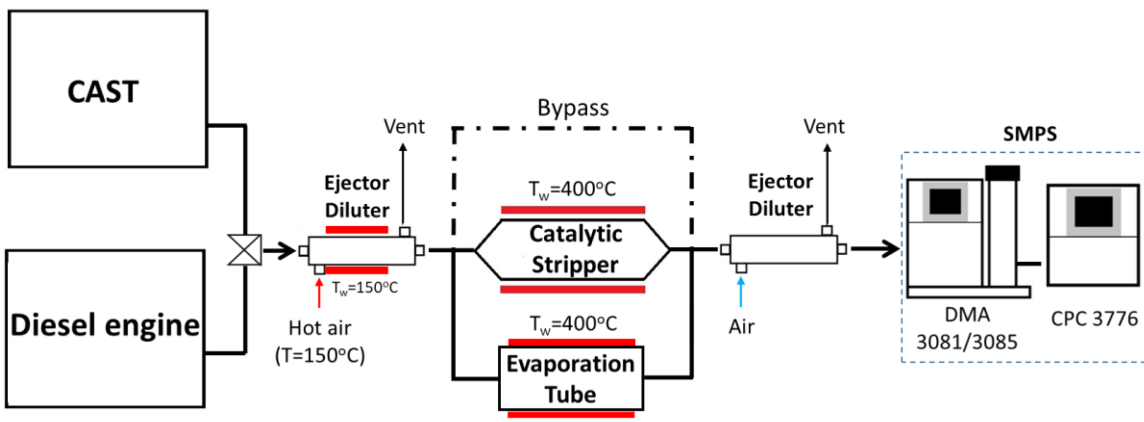

Figure S3. Experimental setup used for comparing the volatile particle removal efficiency (CAST generator) and the particle losses (Diesel engine) of two volatile particle removal (VPR) setups equipped either with a catalytic stripper (VPR-CS) or with an evaporation tube (VPR-ET).

S3. Sulphur adsorption capacity setup

Figure S4 shows the experimental setup that was used to determine the sulphur adsorption capacity.

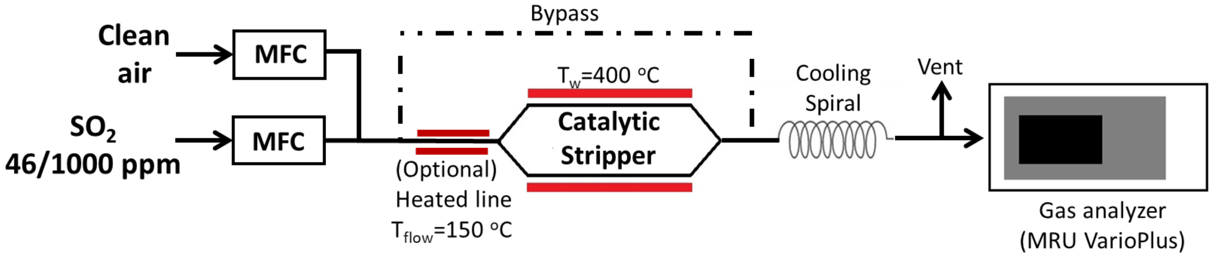

Figure S4. Experimental setup employed for the catalytic stripper's sulphur storage capacity study.

S4. Experimental determination of particle losses

Figure S5 shows the experimental setup used to determine the particle losses of the CS at ambient temperature.

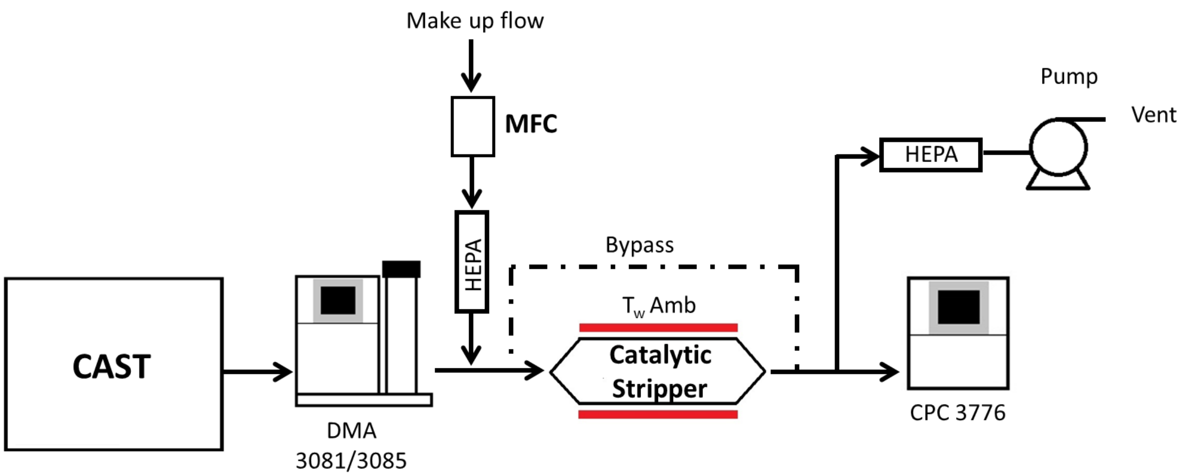

Figure S5. The experimental setup used to determine the particle losses of the CS at ambient T.

Figure S6 shows a schematic of the setup used to evaluate the particle losses in the SA-CS and the PCRF of the VPR-CS and VPR-ET.

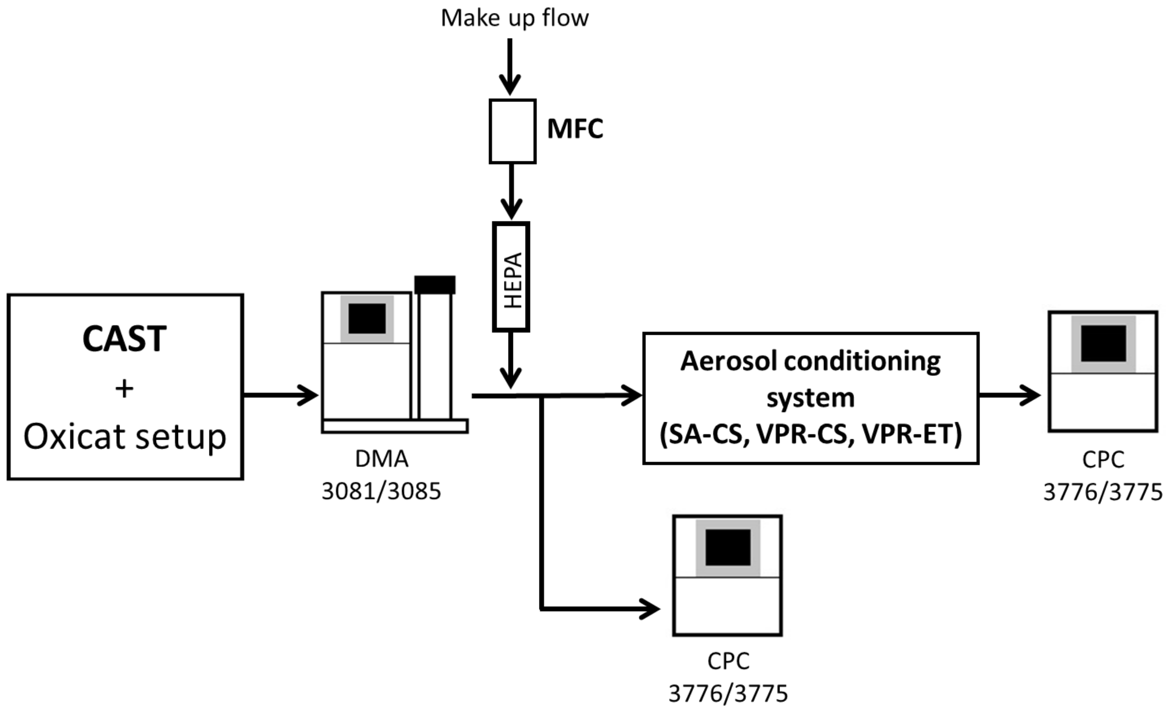

Figure S6. The experimental setup used to determine the particle losses of the SA-CS and the PCRF of the VPR-CS and the VPR-ET.