Supplementary Information

Evaluation of Portable Dilution System for Aerosol Measurement from Combustion Sources

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TABLE S1

Description of Measuring Instruments

Monitoring Instruments	Measurement	Measurement Range	Time interval	Accuracy
NDIR CO ₂ Analyzer (Polltech Inst. Pvt. Ltd)	Undiluted CO ₂	0-10%	2 sec	0.01 %
Velocity vane probe (Model 0560 4450) Polltech Inst. Pvt. Ltd.	Velocity and temp.	0.6-20 m/s and temp. - 40°C-350°C	2 sec	±0.2 m/s
Emission Analyzer; Model 350 XL (Testo Inc., Sparta, NJ)	Moisture	-	-	-
	O ₂	0-25%	1 sec	≤ 0.2%
	CO ₂	0-50%		±0.3%
	CO	0-10000 ppm		≤ 2 ppm
	SO _x	0-5000 ppm		≤ 5 ppm
	NO _x	0-500 ppm		≤ 5 ppm
	HC	100-40000 ppm		≤ 5 ppm
Ambient CO ₂ Analyzer (Testo make)	Diluted CO ₂	0-10000 ppm	2 sec	±100 ppm of CO ₂ ± 3 % value
Temperature and RH Zero Air Assembly (Polltech Inst. Pvt. Ltd)	At Dilution tunnel	70°C and 100% RH	2 sec	±4% and ±0.4°C
Multi-stream PM _{2.5} Cyclone (URG Based)	Dilution Air	20-80 LPM	-	-
	PM _{2.5} Particle			
Battery and Invertor (FINMAC)	Power Supply	24 V (100 Amph) and 3 KW	-	-
Data-logger (ATOMBERG)	Measuring parameters	8-channel	2 sec	-

Figure S1 Schematic diagram of experimental set up used for measuring number based particle loss in Portable Dilution System (PDS)

Figure S2 Experimental set-up for evaluation of dilution system in laboratory with downdraft gasifier cook stove for biofuel emission

Figure S3 (a) Points of measurement in longitudinal (b) radial cross section in dilution tunnel (c, d) variation of CO₂, (e, f) variation of temperature, relative humidity and pressure drop in longitudinal direction at different dilution ratio for gasifier cook stove and diesel vehicle. Error bars are one standard deviation around average of 4 measurements at each point.

Figure S4 Multi-stream Cyclone Sampler consist of AIHL cyclone, equilibrium chamber and four filter holder

Figure S5 Experimental set-up for evaluation of dilution system in chassis dynamometer study for light duty diesel vehicle

Figure S6 Comparison of flow based and CO₂ based dilution ratios

S.1 OC-EC Analysis

Collected samples were analyzed for OC-EC using a Thermal/Optical Carbon Analyzer (DRI Model 2001A, DRI USA). The IMPROVE-A thermal optical reflectance (TOR) protocol was adopted for carbon analysis. The analysis involves two stages. In the first stage, OC was volatilized from the sample as the temperature gradually rose to 120 °C (OC1), 250 °C (OC2), 450 °C (OC3), and 550 °C (OC4) in a non-oxidizing helium atmosphere. In the second stage, 2 % oxygen in a balance of helium atmosphere was introduced and then the analyzer oven temperature was gradually ramped to 550 °C (EC1), 700 °C (EC2), and 800 °C (EC3). The optical pyrolyzed carbon (OP) was also formed in this process. OC1, OC2, OC3, OC4, EC1, EC2, EC3, and OP represent different volatile components corresponding to different temperatures. Carbon in these volatile components was converted into CO₂ by oxidant (MnO₂), then converted into CH₄ through a converter, and was finally quantified with a flame ionization detector (FID). According to the IMPROVE protocol (Chow et al. 2004a), OC was defined as OC1+OC2+OC3+OC4+ OP and EC was considered as EC1+EC2+EC3–OP. All the experimental procedures were conducted under

quality control. The analyzer was calibrated with known quantities of CH₄ every day. Replicate analyses were performed for one per 10 samples, and the difference between replicate analyses was less than 10 % for OC and EC. The blank filters were analyzed using the same methods described above, and the sample analysis results were then corrected by the average blank concentrations of OC and EC, respectively (Feng et al. 2009).

S.2 Ions Analysis:

For Ion analysis, half of the Teflon filter and quartz filters were cut into several small pieces and poured into test tube with 20ml of Milli-Q water and then the solution was ultrasonicated for 20 min (Chakraborty and Gupta, 2010; Gupta et al. 2011) for the extraction of ions. The residue was filtered and transferred into 50 ml centrifuge tube and then analyzed by Ion Chromatography (DIONEX ICS-1000). Chloride, nitrate and sulfate were eluted with 30 mM NaOH. Anions samples were analyzed on an anion-exchange columns (AS11-HC, AG11-HC), with an ASRS Ultra-2mm auto-regenerating suppressor, and a model CD10 conductivity cell detector. Similarly, Sodium, potassium, ammonium, magnesium and calcium were eluted with 6 mM methane sulphonic acid. Cation sample were analyzed on cation exchange column (CS-12), with CSRS - 2mm auto regenerating suppressor, and same conductivity detector. Blank filters were also analyzed using same procedure. Utmost care was taken to follow the standard procedure during handling and analysis (Chakraborty and Gupta, 2010; Gupta et al. 2011) of filter to avoid the contamination.

References

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