21st ETH-Conference ON COMBUSTION GENERATED NANOPARTICLES
June 19th-22nd, 2017 ETH Zurich, Switzerland

Universidad de los Andes

TEMPERATURE EFFECTS ON THE SIZE DISTRIBUTION OF PARTICLES PRODUCED BY A TWO-STROKE ENGINE IN A HIGH ALTITUDE CITY

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INTRODUCTION

- The considerable increase in traffic and travel times has caused a corresponding increase in the use of two stroke mopeds (Figure 1)
- The use of these non-regulated engines might have serious implications for emissions of particulate pollutants, as well as higher total emission of organic gases [1][6] .
- Emissions from two stroke engine was studied in a emissions laboratory at the local conditions of a high altitude city such as Bogotá (Colombia), with the focus on the dilution temperature dependence of particle number
- A data inversion algorithm was developed and applied for the Dekati DMM-230 instrument data

FIGURE 1. Two-stroke engine coupled to a bicycle (48 cc)

METHODOLOGY - II

DATA-INVERSION ALGORITHM

In order to get number distributions without the need to assume a particular shape for the number particle size distribution, a revised inversion algorithm was applied to the raw instrument data. The scheme applied here follows closely that developed in other work (Mamakos, ETH conference 2007)

The currents generated by the particles in the 6 impaction stages and the mobility channel are used as input for the calculation of number distribution and total number concentration.

$$d_a^2 \cdot C_c(d_a) = d_B^2 \cdot C_c(d_B) \cdot \rho_{eff}(d_B) \Rightarrow F_{\min} = \sum_{i=1}^{12} \left[\left(\frac{I_i}{\sum_{j=1}^{12} I_j} \right)_{SIMULATED} - \left(\frac{I_i}{\sum_{j=1} I_j} \right)_{MEASURED} \right]^2$$

METHODOLOGY - I

Experimental Set-up

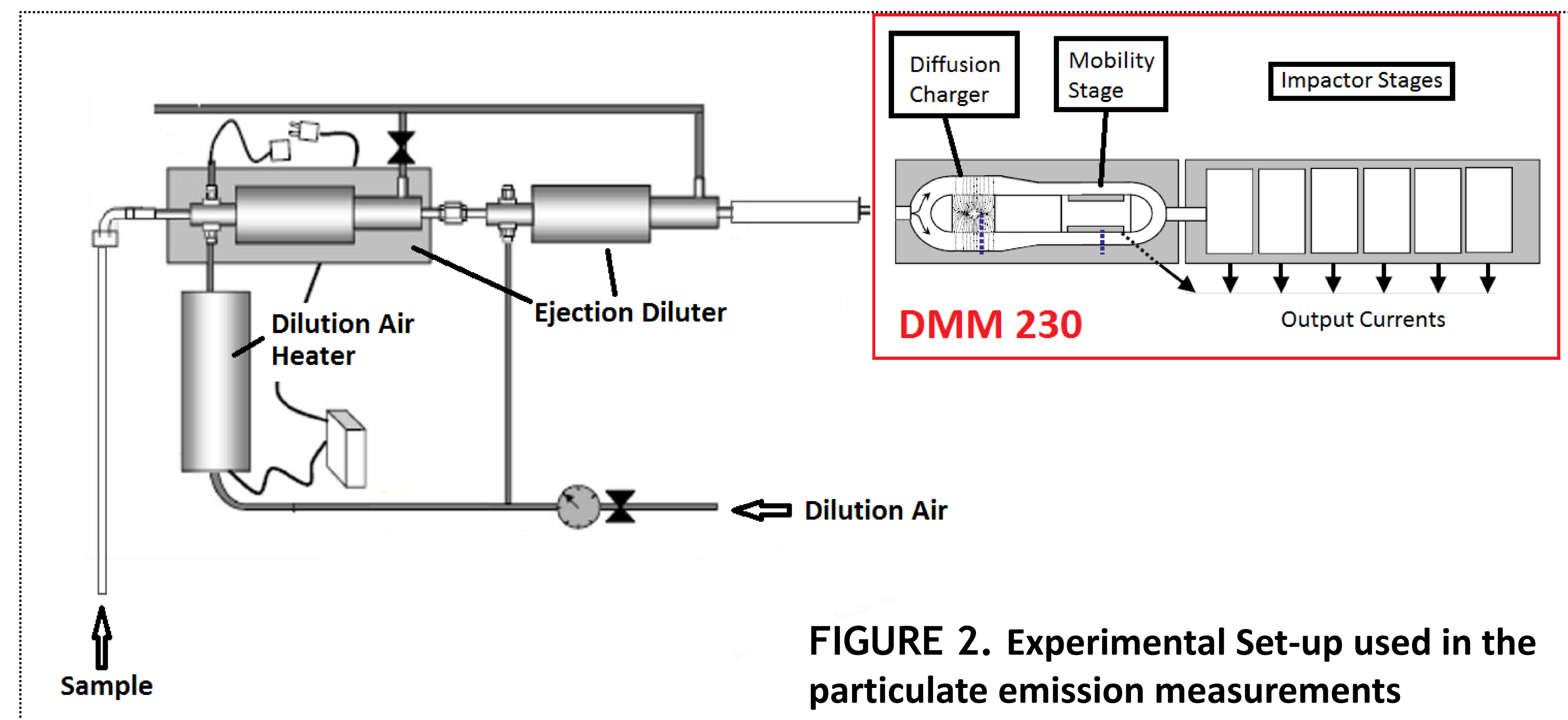

FIGURE 2. Experimental Set-up used in the particulate emission measurements

- A two-stage ejection dilution system was used (Fig. 2) to treat the sample aerosol
- The diluted sample was then measured with an electric, low-pressure impactor (Dekati, DMM-230), following the measurement schedule shown in Figure 3.
- In order to explore the impact of sampling temperature on the distribution of PM, several experiments were performed without heating the dilution air

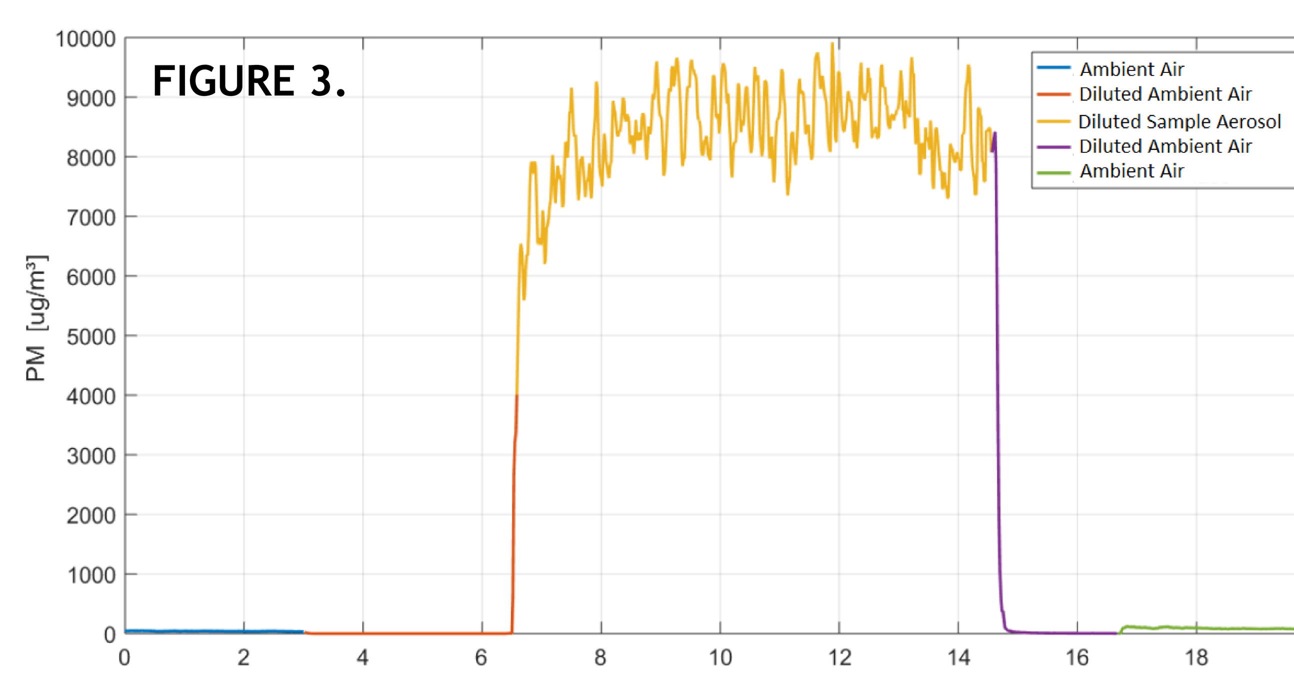

FIGURE 3. Typical measurement schedule used during measurements.

Diluted and undiluted ambient air was measured to directly estimate dilution factor.

RESULTS

Mass and Number Emission Factors

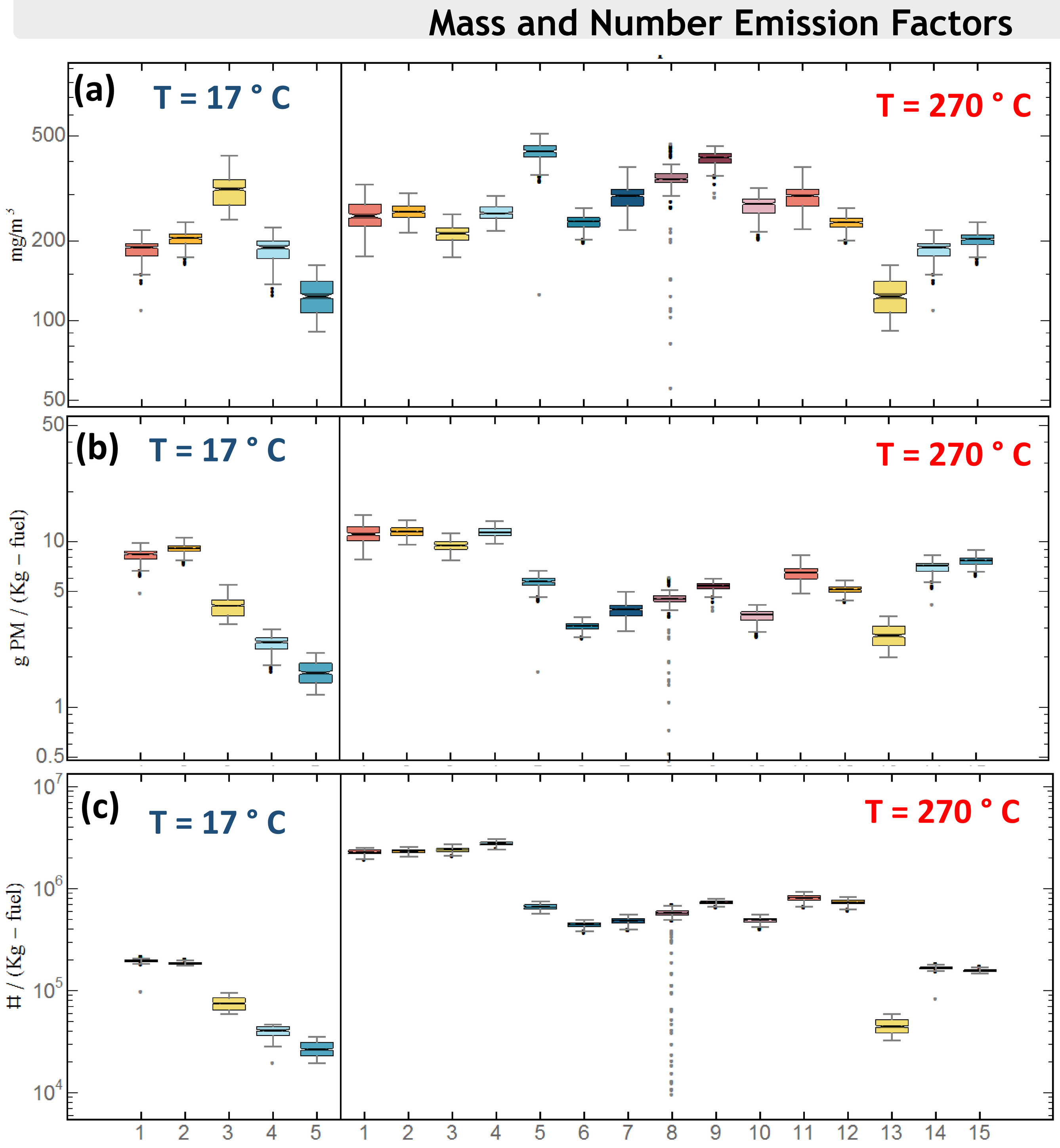

FIGURE 4. **Observations for a set of 20 experiments performed during the measurement campaign. The left side is for ambient temperature, and the left side is for measuremnts with heated dilution air.**

(a) Mass concentration measured from the tail-pipe of the 48 cc. engine.

(b) Fuel-based mass emission factors for the same set of experiments

(c) Fuel-based number emission factors for the same set of experiments

Number Size Distribution

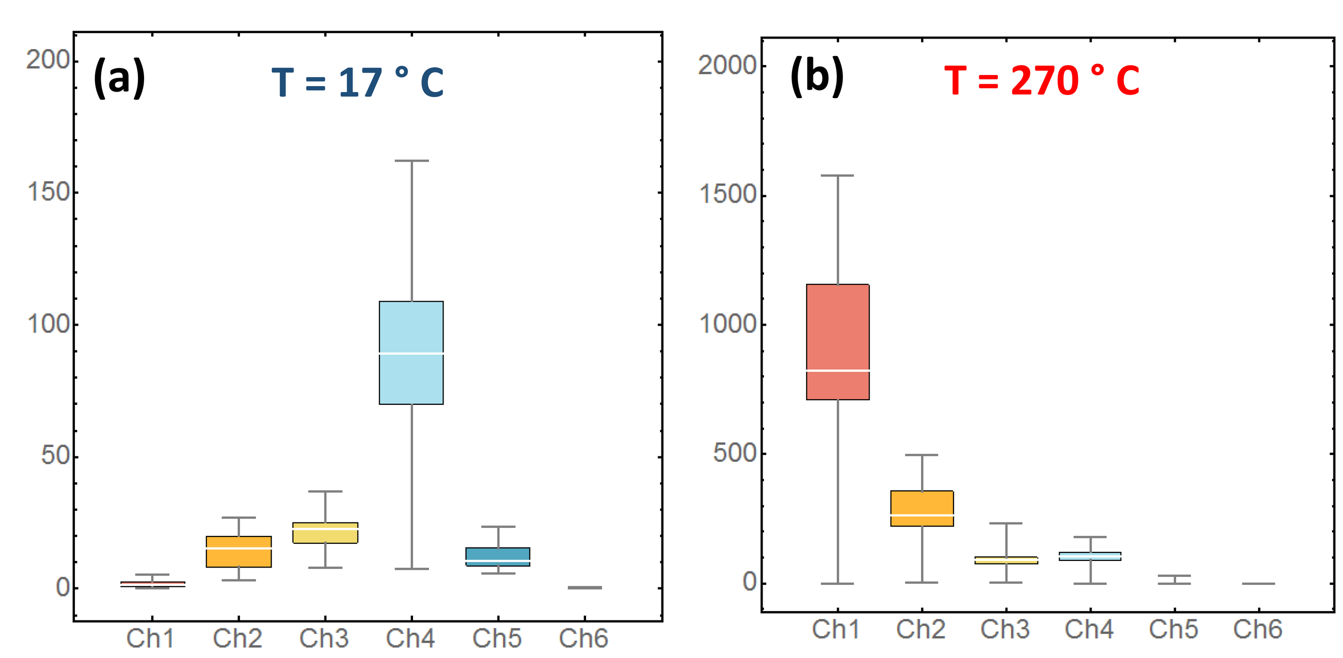

FIGURE 5. Particle size distributions observed for experiments performed at (a.) ambient temperature, and (b.) using heated dilution air

- A clear shift towards smaller sizes (Ch-1 and Ch-2) is clearly visible in the average size distributions observed in Fig. 5b. (heated dilution air), compared to those in Fig. 5a (ambient temperature)
- Fuel-based mass emission rates between 1 and 10 grams of PM1 per kilogram of fuel burned were observed for the engine under testing.
- Increased total number concentration is observed fo measurements performed using heated dilution air.

CONCLUDING REMARKS

- Mass and number emission rates were measured for a two-stroke, 48cc., oil-gas mixed fuel engine
- Particle number emission rates ranging from 3×10^4 #/kg-fuel to 3×10^7 #/kg-fuel were found in this study. Particle emission rate estimates were one order of magnitude higher when heated dilution air was used.
- The size distribution was shifted towards 30 to 50 nm sized particles. The increase in particle number emissions can only be partially explained due to this shift in the size distribution
- Unlike number emission rate estimates, mass emission rates were not strongly impacted by diluted air temperature

ACKNOWLEDGEMENTS

This work is supported by the Research Initiatives Fund of the Department of Civil and Environmental Engineering at Universidad de los Andes. Centro de Investigaciones en Ingeniería Ambiental (Environmental Engineering Research Center) CIIA.Civil and Environmental Engineering Department, Universidad de los Andes.

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