

Lab Scale Investigation on the Formation of Aerosol Nuclei by a Wet Electrostatic Precipitator in the Presence of SO₂ in a Gas Stream

Introduction

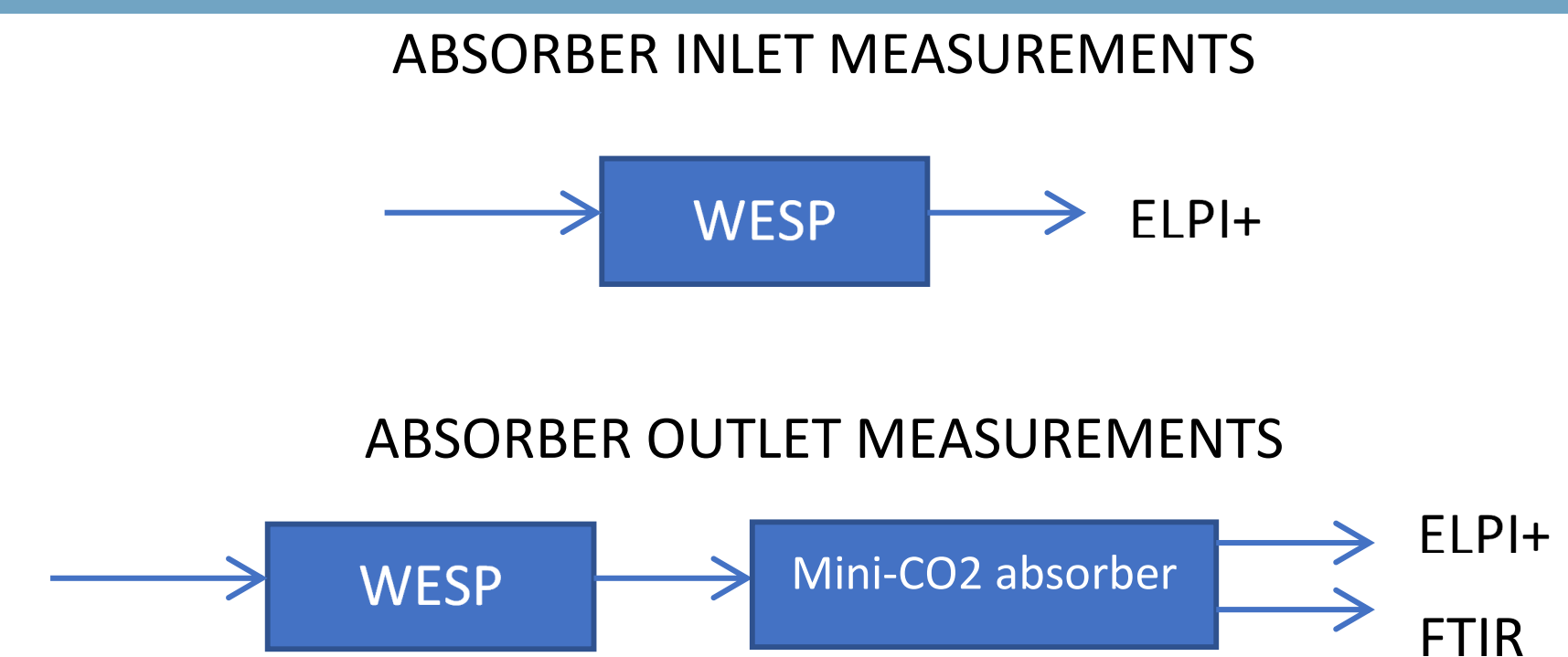
Conventional counter-measures fail to reduce aerosol based emissions [1]. One of the methods to remove ultrafine particles is a Wet Electrostatic Precipitator (WESP) [2]. WESP removes particles by means of charging them at a high power input. However, WESP also has shown to result in formation of ultrafine particles which can further result in aerosol based emissions [3].

[1] P. Khakharia et al., IJGGC, vol. 34, pp. 63–74, Mar. 2015. [2] S.-S. L. S H Jeong et al., Polish J. Environ. Stud., vol. 22, no. 2, pp. 409–415, 2013. [3] J. Mertens et al., IJGGC, vol. 31, pp. 175–181, Dec. 2014.

Equipment and Methods

WESP → single star shaped electrode, power supply
Heinzinger PNC 30000- 5 neg high voltage device
Solvent → 30 wt. % MEA pre-loaded with 1mol CO₂/L
Particle → Dekati ELPI+® with an axial dilutor (DAD-100)
Emissions → FTIR (GASMET DX4000)

Gas	Composition
SO ₂ (ppmv)	9.1, 18.3, 36.7, 61.1, 122.3 183.4
N ₂ (vol. %)	69.6
CO ₂ (vol. %)	12.5
O ₂ (vol. %)	17.9

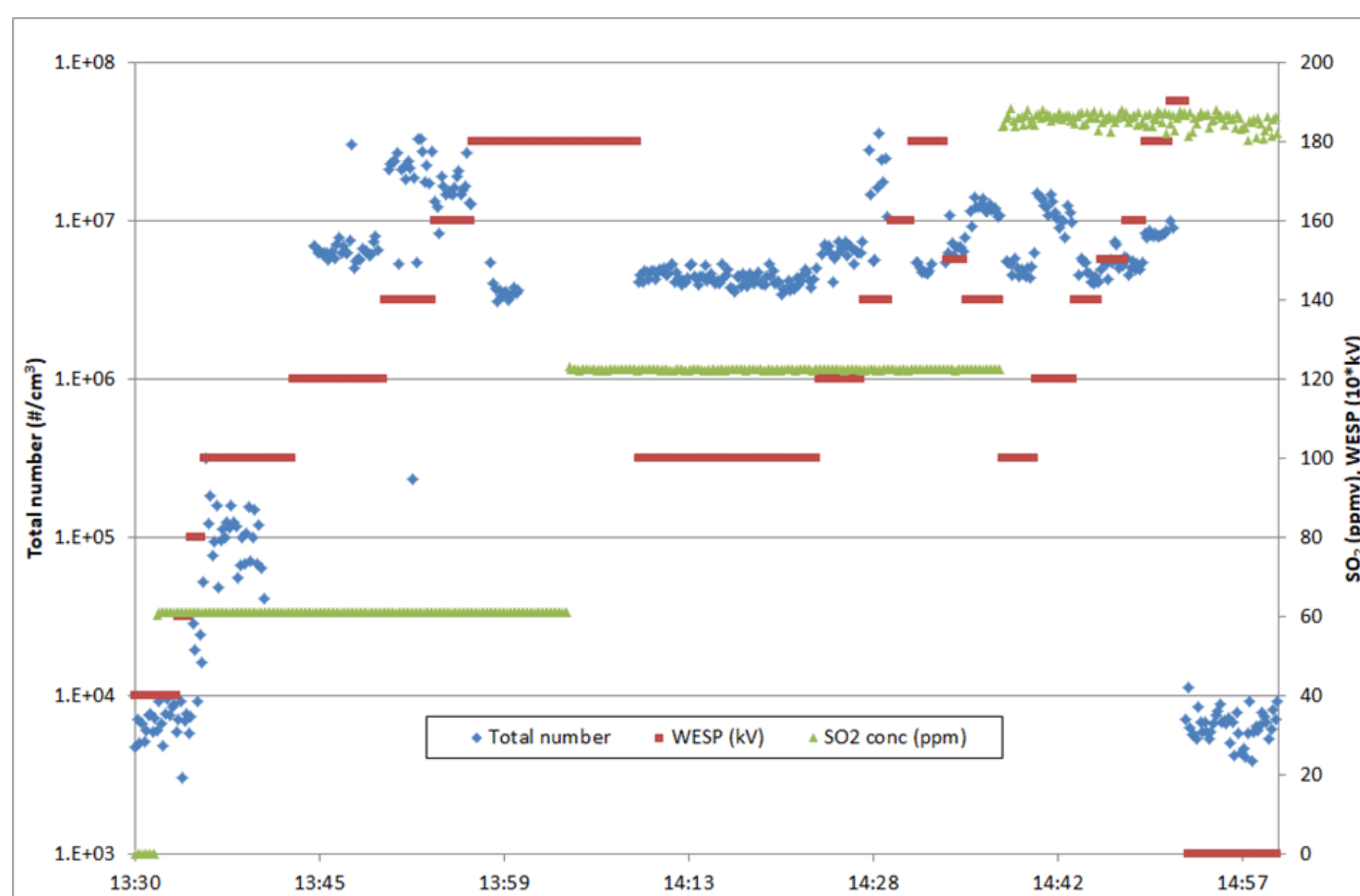


Results

Particle generation by WESP – Absorber inlet

In the absence of SO₂ total number is close to the baseline, 10⁴ per cm³. Below 8 kV the total number remains below 10⁵ /cm³ but significantly increases beyond 10 kV. At the maximum stable voltage of 14 kV the particle number reaches 10⁷ /cm³.

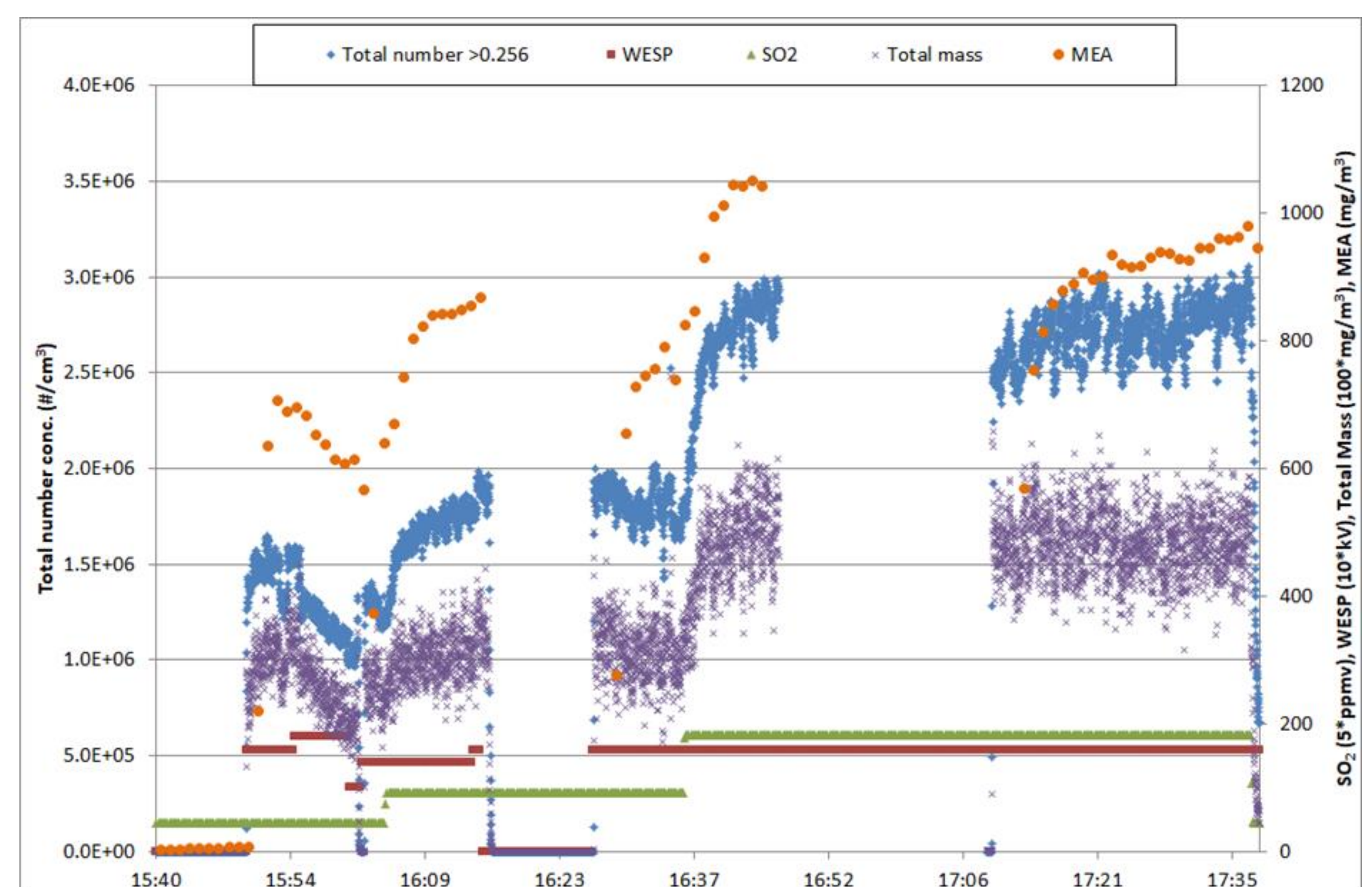
The number distribution is dominated by the smallest 3 size fractions (>99%), with 0.006 μm contributing to more than 80 % of the total number. The total mass of particles is in the range of 10⁻⁴ to 10⁻² mg/Nm³, very close to that without SO₂ in feed gas.



Amine emissions – Absorber outlet

In the presence of SO₂ but absence of WESP voltage, very low emissions of MEA (<10 mg/Nm₃) are observed. MEA increases instantaneously as the WESP is switched on and is in the range of 600-700 mg/Nm³, indicating aerosol based emission.

Most of the particles are of 0.006 μm (>60 %), but particles of sizes 0.0945 to 0.945 μm, contributes with 35% of the total number. The total mass concentration at the outlet of the absorber is 0.2 to 0.5 mg/Nm³, which is significantly more than that at the inlet.



Conclusions

- WESP generates ultrafine particles, of less than 0.0307 μm
- Ultrafine particles can result in aerosol based MEA emission even at a SO₂ concentration of 9ppmv. The range observed was 600-1050 mg/Nm³.
- MEA emissions correlate with the total number at the outlet when particles larger than 0.256 μm are considered.
- Ultrafine particles grown in the absorber column such that the maximum mass is contributed by particles of 0.945 μm for all the test conditions.