Dimensional characterization of airborne particles by means of alternative techniques

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INTRODUCTION

Suspended particulate matter (PM) is recognized as a key element in many atmospheric environmental issues ranging from adverse health effects to global climate change [1,2].

It is now acknowledged that number concentration and numerical size distribution are fundamental indicators [3] for dealing with the impact of PM (and in particular of the PM ultrafine fraction) on the environment and the human health.

There is a variety of measurement methods available for monitoring PM in ambient air [4,5]. These include both direct reading instruments, providing continuous detection, and filter-based samplers, collecting the particles onto a filter which must be analyzed subsequently in a laboratory.

The aim of this work is the comparison of two measurement techniques specifically focused on the investigation of airborne particles in the nanometric range:

- an on-line technique, based on a scanning mobility particle sizer (SMPS),
- an off-line technique, based on a field emission scanning electron microscope (FESEM).

EXPERIMENTAL

SAMPLING

✓ **SMPS** (Grimm Technik GmbH & Co. KG, Ainring, Germany) equipped with an ultrafine particle classifier (M-DMA, size range from 5 to 350 nm) and a condensation particle counter capable of measuring concentrations up to 10^{10} particles/L.

✓ **Gilian AIRCON-2** sampler on polycarbonate filters (pore size 0.2 µm, Ø 25 mm, Merck KGaA, Darmstadt, Germany).

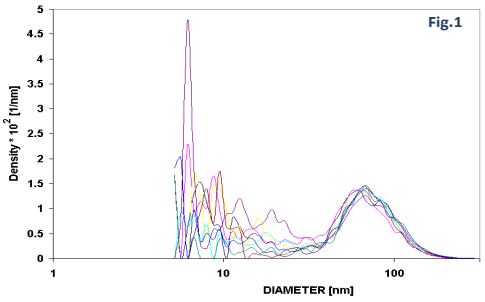
Sampling was carried out on the roof of the Chemistry and Industrial Chemistry Department of the University of Genoa.

CHARACTERIZATION

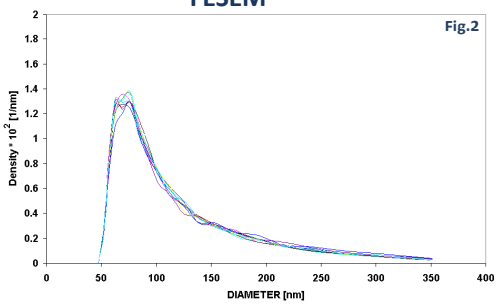
A **FESEM** Supra 40 VP Carl Zeiss (SMT Ltd., Cambridge, England) equipped with electron probe microanalysis (X-EDS) managed by INCA software (Oxford Instruments, Analytical Ltd., Bucks, U.K.) was used in order to analyse (in automated mode, lower detection limit = 50 nm) the particles collected on polycarbonate filters.

RESULTS AND DISCUSSION

SMPS



FESEM



❖ All the results refer to the same day of observation.

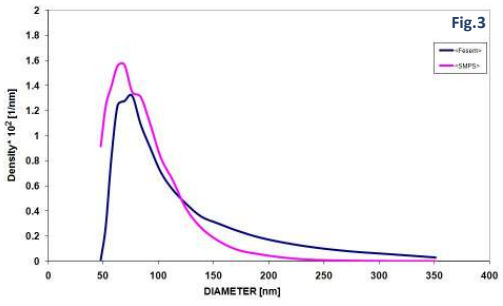
❖ SMPS exhibits a higher sensitivity in detecting the distribution of the PM ultrafine fraction, as shown in Figure 1, where the density size distributions at various times (sampling time = 6 min) are reported.

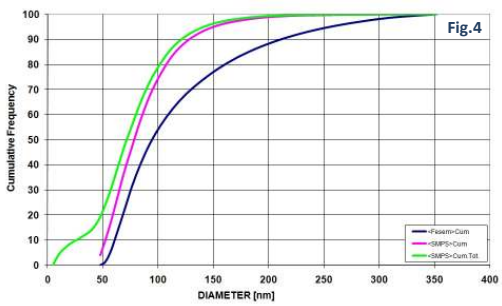
❖ The area scanned by the FESEM beam (A_F) is representative of the whole sample area (A_S, with $A_S/A_F \cong 10^5$), as verified by constructing several distributions, each related to a different A_F and belonging to the same sample (Figure 2).

❖ In Figure 3 the comparison between the two techniques, in the dimensional range 50–350 nm, is illustrated in terms of the daily average distributions (density).

❖ Figure 4 shows the cumulative frequencies for the distributions of Figure 3. The green line refers to the SMPS analysis over the full observable size range (5-350 nm); the fraction 5-50 nm accounts for about 20% of the total.

SMPS vs FESEM





CONCLUSIONS

✓ The results show the potential of SMPS as on-line monitoring technique capable of probing particles down to 5 nm. The instrument is rather easy and fast to be used.

✓ The FESEM technique is more time consuming and requires an expert operator to optimize the sample loading and the data processing.

On the other hand, the samples can be (off-line) analyzed several times and further subjected to different kinds of assessment (e.g. EDX microanalysis).

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