HIGH CAPACITY FILTERING STATION: ASSESSMENT OF PM ABATEMENT PERFORMANCE

Study presented at PM2008 III National conference on atmospheric particulate **Bari 6th-8th October** ***"Atmospheric particulate: knowledge for information and action strategies"***

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Introduction

Systemlife filtering stations [1] have been designed to intake non-negligible volumes of air polluted by airborne powders and harmful gases, carry out a multistage filtering process, treat gas effluents, and return purified air to the atmosphere.

The volumes of treated air vary according to the model in question (currently 7,000 m^3/h, 10,000 m^3/h and 15,000 m^3/h).

Previous studies [2,3,4,5,6] have given encouraging performance results for the SL filtering station:

- forcing the air entering and leaving the SL filtering station through ducts and measuring the particulate conveyed in the inlet and outlet flows
- using continuous-operation optical particle spectrometers to measure powder concentrations (approximating PM10, PM2.5 and PM1 values) at outdoor stations located at various distances from the SL filtering station

In the outdoor studies performed up till now, the control of experimental conditions can be perfected by improving the quality of the available meteorological information (including site-specific data and simultaneous with particulate measurement, by wind speed, humidity and height of the mixing layer) and information on active sources (traffic, heating).

To measure station performance in controlled conditions, an experiment was planned inside an industrial building set aside for this purpose, in order to assess:

- the intake and delivery effectiveness of the SL filtering station;
- particulate removal efficiency with different typologies (dimensional distribution).

Materials and methods

An experiment was also performed in an industrial building (approx. 50m x 60m x 8m) with the doors and windows closed.

A system of uniform particulate concentrations was developed using forced ventilation systems (Fig.1) and control of powder concentrations in various points of the building (Fig. 3) performed with five GRIMM laser scattering Dust Monitors series 1.108 spectrometers, in the “environmental” and the “count” acquisition modes.

Fig.1: Ventilation system

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Fig. 2: System Life Filter Station, Città model

Fig.3: Grimm 1.108 positioned for measuring performance

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The following were used as airborne particulate sources:

- in experiment 1, two smoke candles (Mr. SMOKE 1 produced by F.D.F. srl, dimensional distribution of smoke less than 0.3 micrometers), reaching uniform environmental concentrations in the treated area of 670 micrograms per cubic metre.

- in experiment 2, PM filtered by SL filtering stations was resuspended, with a large prevalence of PM10 with respect to PM2.5 and PM1, reaching uniform environmental concentrations in the treated area of 490 (380) micrograms per cubic metre.

The speed of the air masses to the active filtering station was controlled using an LT Lutron YK80AP anemometer.

Results and discussion

The visual inspection of the extension of the delivery air flow, marked using smoke candles at the mouths of the filtering station, and the verification performed by observing concentration variations in the various positions with Grimm spectrometers, indicates that the delivery air travels well over 50 metres from the SL filtering station in a few seconds.

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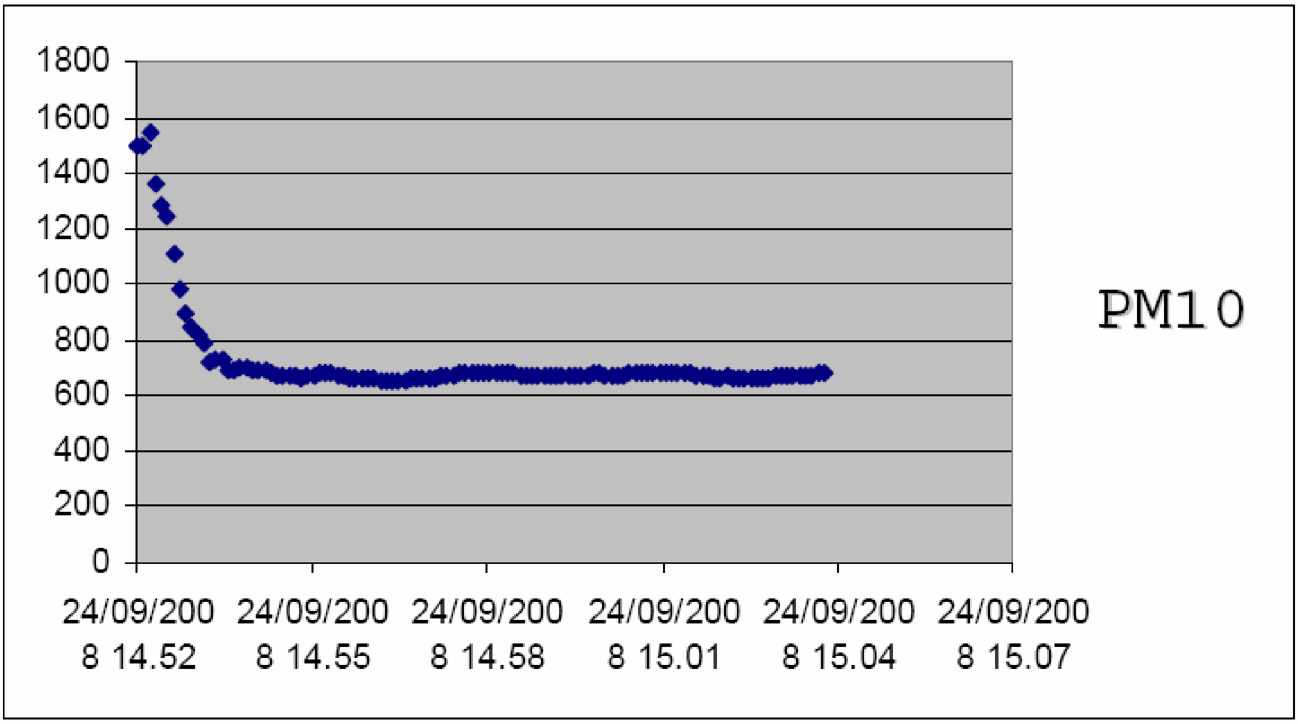

Fig.4: Assessment of the stability of particulate concentrations in the environmental prior to filtration

After checking the uniformity of the concentrations following the generation of particulate inside the building (Fig.4), the filtering station was activated (figs. 2, 5 and 6), both for the particulate generated by the smoke candles (experiment 1) and for the filtered and resuspended particulate (experiment 2). The PM abatement kinetics caused by the action of the filtering station were analysed and found to follow an exponential curve (Fig.7).

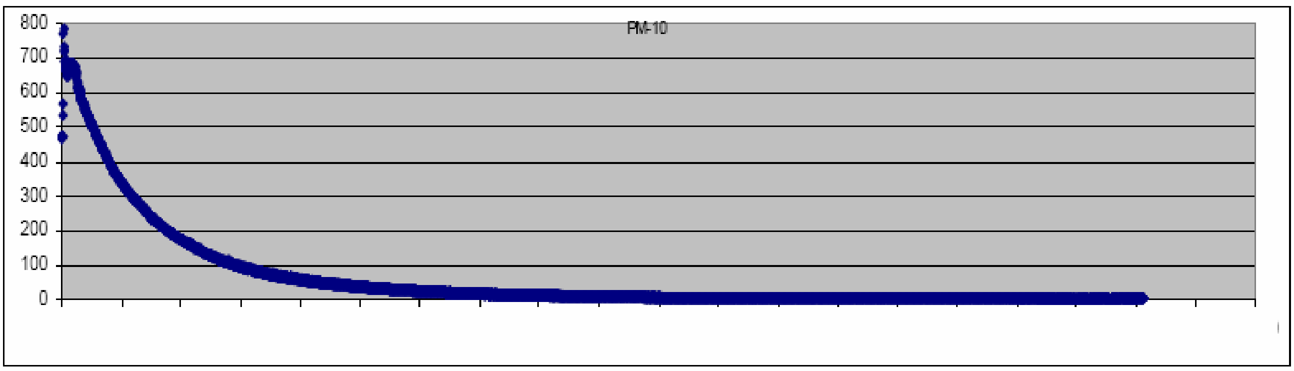

Fig. 5: PM10 concentrations plotted by the GRIMM1.108 analyser during experiment 1

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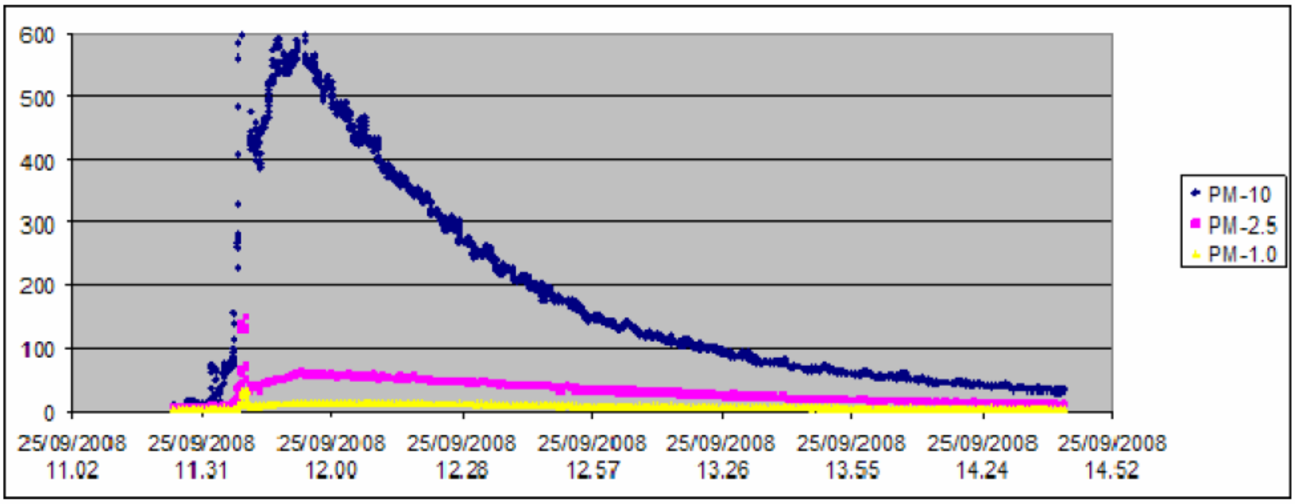

Fig. 6: PM10, PM2.5 and PM1 concentrations plotted by the GRIMM1.108 analyser (experiment 2)

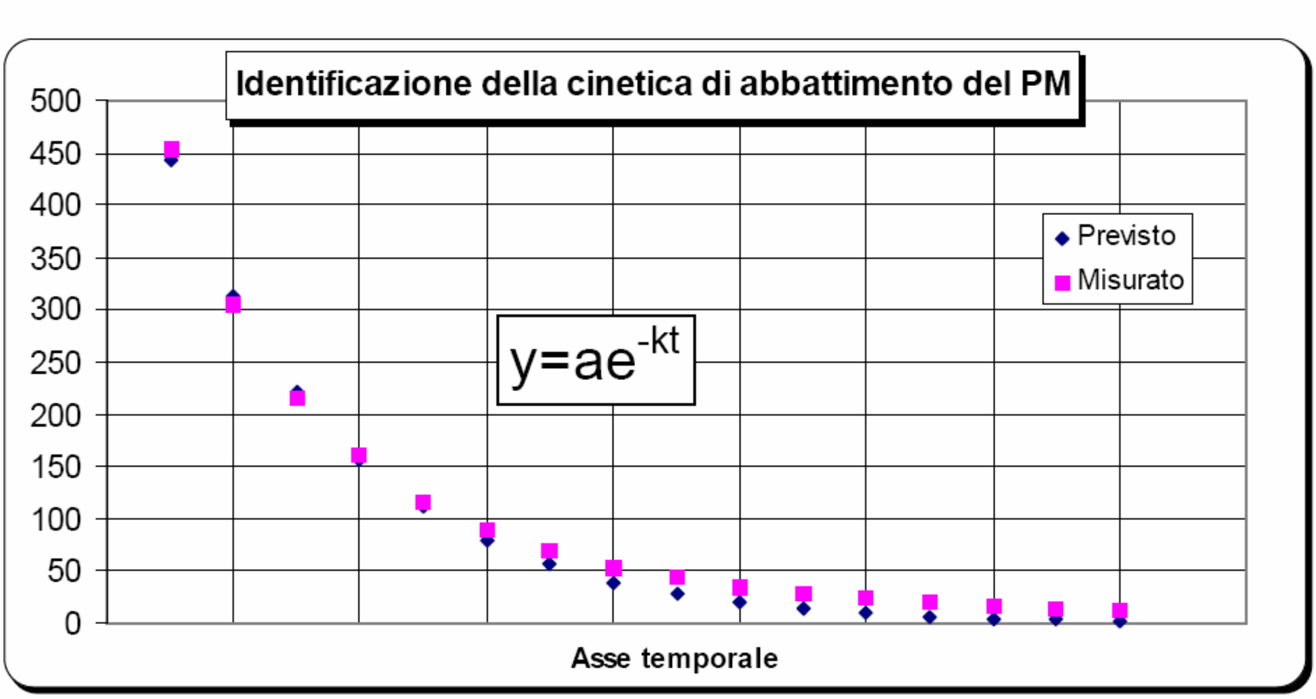

Fig. 7: Particulate abatement kinetics

Conclusions

The abatement performance of very fine particulate (experiment 1, mode < 0.3 μm) and PM10 (experiment 2) was tested:

- in experiment 1, filtration abated concentrations from 670 μg/m^3 to 15 μg/m^3
- in experiment 2, during the first hour's operation of the filtering station, PM10 concentrations decreased by 70%, from 380μg/m^3 to 115μg/m^3
- during the entire operating period of the filtering station (2.5 hours), the entire volume of available air was statistically treated (25000 m^3). Following continual monitoring of environmental concentrations, the PM10 fraction abatement percentage stood at 92%, showing of concentration values of 31μg/m^3 at the end of the test.

Factors, such as:

- excellent filtration performance,
- the consideration that the meteorological conditions promoting the onset of very elevated environmental particulate concentrations often correspond to situations with weak movements of air masses (that is, the advection of masses of polluted air in the zone benefiting from SL filtration – which would nullify the abatement performance of the filtering station – it is not very significant) and
- the consideration that the morphological conditions promoting the onset of very elevated environmental particulate concentrations often correspond to situations of partial confinement (e.g.: urban "rooms" and "canyons" which, in the absence of filtration, stagnate the pollutants, while in the presence of effective filtering stations and characterised by relatively limited volumes of contaminated air, make it possible to mitigate peak situations);

make it necessary to continue experimentation in semi-confined *indoor* [7] and *outdoor* situations, for the site-specific assessment of the abatement effectiveness of atmospheric pollution, also in relation to the proximity and intensity of sources (vehicular traffic, heating, industries).

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