UNIVERSITY OF TRIESTE
Department of Chemical Sciences

Trieste, 11th September 2008

REPORT

PROGRESS of the "STUDY ON THE ENVIRONMENTAL PERFORMANCE OF THE CITY MODEL FILTERING STATION" AS AT 11th SEPTEMBER 2008

Concerning the study on the environmental performance of the systemlife City model filtering station submitted to the Department of Chemical Sciences of the University of Trieste**:**

1. documentation produced by Stazione Sperimentale del Vetro of Murano (Ve) [1] and the Padua Provincial Office of the ARPAV Agency [2] was acquired concerning the filtering efficiency of the City station;

2. the study entitled "*Fluid dynamic analysis of a filtering station*" [3] by the Engineering Department of the University of Ferrara and the study entitled "*Report on the efficiency of the systemlife Filtering Station for the treatment of urban air and relative tests*" [4] by the Department of Physics of the University of Ferrara, in particular by the research unit co-ordinated by Prof. F. Pedrielli, were acquired;

3. new raw data collected by the technical-scientific staff of the above research unit from 19th February to 2nd March concerning the variations in the concentrations of airborne particles PM_{10}, $PM_{2.5}$ and PM_1, measured using three series 1.108 Grimm Dust Monitor spectrometers for defining the size of airborne particles, in three positions (on the station itself and at distances of 90m and 200m), was acquired [5] and analysed.

The following are indicated below:

a) general assessments of the significant information contained in the above documents

b) specific assessments on the experiments performed and on the analysis of the raw data

a) Assessments on the significant information contained in documents [1], [2] and [3]

Documents [1] and [2] produced respectively by an public economic research body and by the Veneto regional control agency, showed significant levels of dust were removed by the systemlife City filtering station, both in extreme conditions (from totally suspended incoming dust amounting to 699 ug/m3 to 21 ug/m3 of total powders [1]) and in more common situations (from incoming PM_{10} equal to 53 ug/m3 and outgoing PM_{10} equal to 14 ug/m3 to 73 ug/m3 incoming and 23 ug/m3 outgoing in tests lasting approximately 24 hours [2]). Visual inspection of the filters following filtration clearly illustrates the removal of airborne dust performed by the filtering station.

The study [4] indicates that modelling simulations [3] reveal, according to the authors, the effectiveness of the filtering station at distances of up to 450 metres (inlet phase at 200 m and jet expulsion of 250 metres). The same study [4] also reports on the experimental investigations performed with portable spectrometers for the dimensional analysis of the aerosol, indicating – qualitatively- that filtration effectiveness varies according to the distance from the filtering station. A benefit in city surroundings at distances of up to 320/350 metres is also declared.

Considering the complexity of the phenomena that determine the concentrations of airborne dust (variability of sources of emission, obstacles to dust dispersion, weather factors that can greatly increase (e.g.: atmospheric stability, decrease in the height of the mixing layer) and decrease (e.g.. wind, rain) concentrations of atmospheric particulate), it is considered important to perform further experimental validation of the positive assessments acquired, both according to the analysis of currently available data (see point b) and by setting up new experiments (see chapter “Recommendations and current investigations”).

b) specific assessments on the experiments performed and on the analysis of the raw data

b1) Here, reference is made to the data [5] on atmospheric concentrations of PM_{10}, $PM_{2.5}$ and PM_1 collected - in the same way as indicated in [4] - from 19th February to 3rd March 2008. The experiment was conducted [4] at the Technological Pole of the University of Ferrara (southern car park, near Via Saragat). Grimm mod. 1.108 portable spectrometers were to determine the size of the airborne particles.

The instruments provide precious information by acquiring multi-channel signals every minute or even less. Acquired signal conversion algorithms [6] transform the signal readings into estimates of PM_{10}, $PM_{2.5}$ and PM_1 concentrations which can also be monitored in real-time. These instruments make it possible to map the spatial and temporal variability of dust concentrations. The systemlife City filtering station was positioned in the southern car park of the technological pole of the University of Ferrara and monitoring stations fitted with Grimm 1.108 analysers were positioned at 90 metres (ING station) and 210 metres (FIS station) respectively. Analysis of the temporal series shows that PM concentrations in ING are systematically greater than those found in FIS, presumably due to the site-specific morphological factors of the ING site.

It should be observed that the measurements of atmospheric particulate concentrations made by the Grimm spectrometry are considerably affected by atmospheric humidity [6] and the acquired PM values tend to be overestimated.

In this assessment, adequate meteorological situations for the instruments used to perform the measurements in the above sites (ING and FIS, respectively 90 and 210 metres from the filtering station) were identified in advance (absence of particularly elevated humidity and wind values). For the sake of example, the following graphs plot the various dimensional classes, PM_{10}, $PM_{2,5}$ and $PM_{1,}$ of atmospheric particulate acquired using the Grimm spectrometers during an experiment performed on 1st Mach 2008 when the station was activated for a period of 8 hours, from 10 to 18, and then turned off.

The chart in figure 1 shows the PM_{10} concentrations measured in the ING station 90 metres away from the f.s. in different colours (blue= PM_{10} when the filtering station was switched on, pink= PM_{10} while the f.s. was working, yellow= PM_{10} after the f.s. was switched off). Similarly, the chart in figure 2 shows the PM_{10} concentrations measured in the FIS station 210 metres from the f.s. in different colours (blue= PM_{10} when the filtering station was switched on, pink= PM_{10} while the f.s. was working, yellow= PM_{10} after the f.s. was switched off).

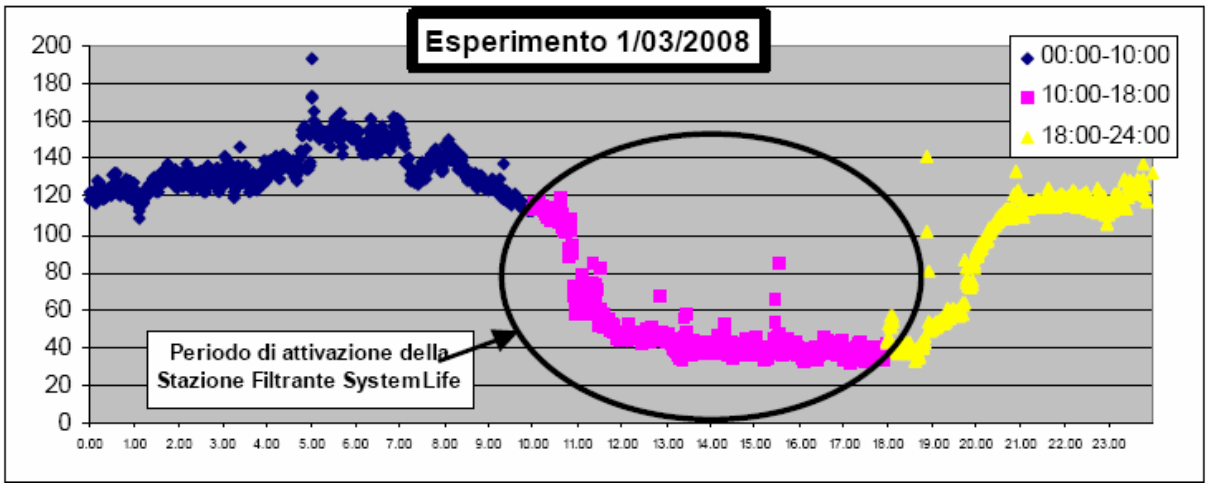

Fig.1: PM_{10} concentrations in the ING station measured at 1 minute intervals

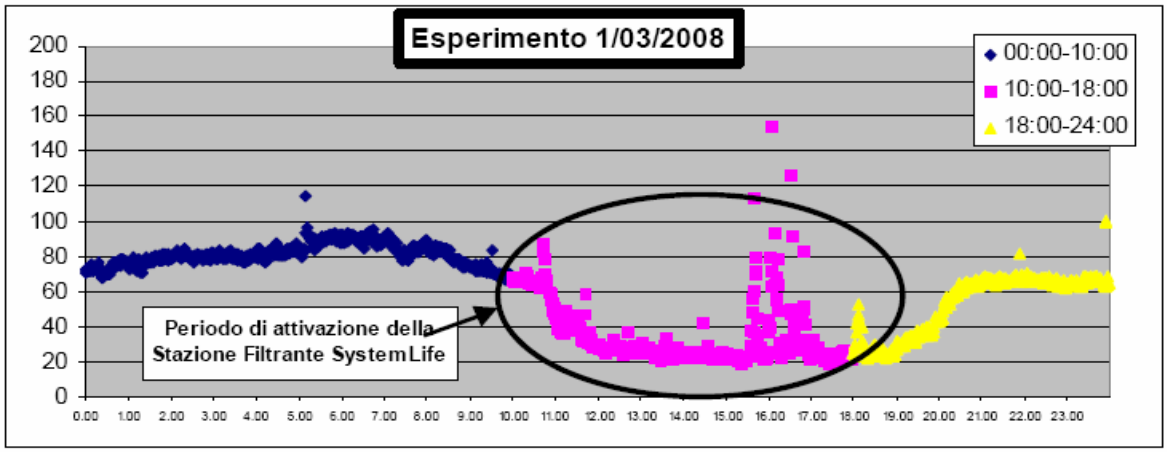

Fig.2: PM_{10} concentrations in the FIS station measured at 1 minute intervals

The data clearly shows that the activation of the filtering station affects concentrations at 90 metres (ING) with an reduction of approximately 60% in the initial concentration (average PM_{10} before switching on the f.s.=135 ug/m3, average PM_{10} while the f.s. was working=51 ug/m3, average after it was switched off =102 ug/m3). At 210 metres (FIS), the reduction in concentrations is equally appreciable.

The daily PM_{10} concentrations reported by the Provincial environmental agency of Ferrara ARPA ER [7] on 1st March 2008 for the two stations of the city of Ferrara were 77 ug/m3 and 82 ug/m3, comparable with the averages when the f.s. was switched off in FIS.

Figures 3 and 4 plot $PM_{2.5}$ and PM_1 concentrations respectively in the ING and FIS sites on 1st March 2008.

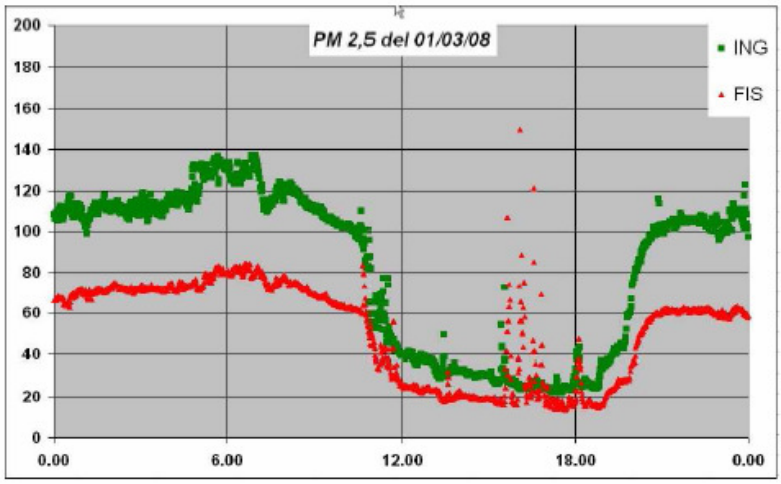

Fig.3: of $PM_{2.5}$ concentrations in the ING and FIS sites

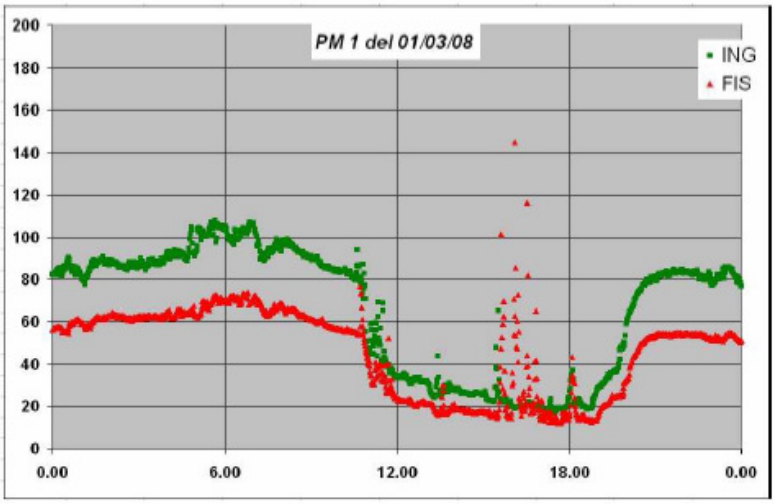

Fig.4: PM_1 Concentrations in the ING and FIS sites

The effectiveness of the reduction produced by the f.s. is noticeable also when examining $PM_{2.5}$ and PM_1 concentrations.

UNIVERSITY OF TRIESTE
Department of Chemical Sciences

Current recommendations and analyses

The number of the polluting sources and the complexity of the physical and chemical factors that determine the environmental concentrations of PM [8], highlight the need to make further experiments in controlled conditions in order to assess effectiveness in the various site-specific situations.

The information acquired from analysis of the data relative to the early months of 2008 [5] at Ferrara showed that measurements, in controlled conditions and not invalidated by adulterated data, can generate significant results, proving the effectiveness of the filtering station and showing a considerable reduction in PM concentrations at distances of 90 metres and 210 metres from the f.s..

The generalisation of the assessment of the effectiveness of the f.s. requires a study incorporating a site-specific control of meteorological variables, of the main movements of the air masses, and knowledge of the main local emissive dynamics. The availability of portable instruments that can acquire data on PM concentrations in "almost" real time, makes it possible to plan an experiment mapping of the reduction performance of the f.s. with greater spatial and temporal detail, in correspondence to controllable PM sources; an experiment at the systemlife headquarters in Camposampiero (PD) which sets out to identify the potential of the filtering station with greater statistical significance is currently being assessed.

In order to assess the performance of the f.s. with regulated methods [9] for the determination of PM_{10}, following pilot tests performed with portable spectrometers, samples will be taken by EN12341s-compliant samplers and the gravimetric measurements made as established in Ministerial Decree 60/2002.

Dr. Pierluigi Barieri

Environmental Chemistry Research Unit

Università degli Studi di Trieste
Dipartimento di Scienze Chimiche
via Licio Giorgieri,1 34127 Trieste
tel +39 040 558 3902
fax +39 040 558 3903
dipdsch@units.it
Dipartimento di Scienze Chimiche
Università degli Studi di Trieste
www.units.it
www.dsch.units.it

UNIVERSITY OF TRIESTE
Department of Chemical Sciences

Reference documents

[1] Nicola Favaro, Antonio Tucci "Performance Test – Filtration Station systemlife - City model" Stazione Sperimentale del Vetro, Murano Venice, 03/07/2008

[2] Alessandro Benassi "Measurement of PM10 concentrations entering and leaving the systemlife filtering station", ARPA Veneto Provincial Environmental Agency of Padua, 20th May 2008

[3] Michele Pinelli "Fluid dynamic analysis of a filtering station" Department of Engineering, University of Ferrara, 2007

[4] Pedrielli F. "*Report on the efficiency of the systemlife Filtering Station for the treatment of urban air and relative tests*" Department of Physics, University of Ferrara, 29th December

[5] Pedrielli F., Personal communication, September 2008.

[6] Manual for the Portable Dust Monitor Grimm Series 1.108, 1996

[7] ARPA Emilia Romagna: http://service.arpa.emr.it/qualitaaria/bollettino.aspx?prov=fe

[8] J.H. Seinfeld, S. N. Pandis "Atmospheric Chemistry and Physics", Wiley 1998

[9] Ministerial Decree n° 60 of 2nd April 2002 "Implementing Council Directive 1999/30/EC of 22nd April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air and directive 2000/69/EC relating to limit values for benzene and carbon monoxide in ambient air"

Università degli Studi di Trieste
Dipartimento di Scienze Chimiche
via Licio Giorgieri,1 34127 Trieste
tel +39 040 558 3902
fax +39 040 558 3903
dipdsch@units.it
Dipartimento di Scienze Chimiche
Università degli Studi di Trieste
www.units.it
www.dsch.units.it