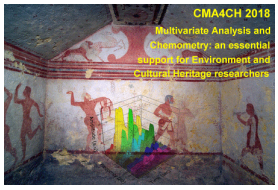

Submicron Particles in Urban, Industrial, Suburban and Remote Areas: Characterization, Evaluation and Comparison

M. Manigrasso[1], V. Mattei[2], S. Martellucci[2], C. Protano[3], M. Vitali[3], P. Avino[4,5]
[1]DIT, INAIL, Rome, Italy; [2]University Branch of Rieti "Sabina Universitas", Rieti, Italy; [3]Dept. Public Health, Sapienza University of Rome, Rome, Italy; [4]DiAA, University of Molise, Campobasso, Italy; [5]Institute of Ecotoxicology & Environmental Sciences, Kolkata, India

Abstract

PM has recently obtained more attention than other pollutants: firstly PM10 has been monitored, nowadays the scientists are focusing their studies on finer granulometric sizes because these particles are able to penetrate into the deeper airways and, hence, are very dangerous for the human health. The goal of this work is to investigate the exposure of the population to submicron particles (and UltraFine Particles, spefically) in outdoor environment in different locations subjected to different pollution conditions.

Measurements were performed by means of Fast Mobility Particle Sizer (TSI), equipment able to investigate the granulometric size range between 5.6 and 523 nm with a time-resolution of 1 s. performing such measurements the authors have managed to characterize an entire area, the Rieti Province, according to the urban, industrial, suburban and remote sites.

Introduction

Atmospheric particles are involved in different environmental phenomena. Their presence in atmosphere affects visibility and climatic variations while its deposition gives rise to a series of chemical-physical reactions causing deterioration of materials and damage to plant tissues. Another effect due to the particulate is the blackening of the surfaces of building material, which requires increasingly frequent cleaning operations and therefore reduces their durability. As for vegetation, the deposition of particulate on plants prevents the normal processes of gaseous exchange with the atmosphere.

With the term suspended total particles or particle material (PM), we mean all the atmospheric particles, solid or liquid, dispersed in the air and having a diameter ranging between 0.01 (10 nm) and 100 μm. Exposure to this pollutant poses a risk to human health: particularly, the danger related to the inhalation of suspended particulate material is linked to the particle size. Until now, the PM10 has been mainly monitored, but now the focus has shifted to finer sizes, which are more dangerous for human health because they are able to penetrate the deepest airways [1]. The World Bank has estimated that exposure to airborne particles above the limits set by the World Health Organization (WHO) is responsible for around 2-5% of all deaths in urban areas in developing countries [2].

In this study we focus the attention to the submicron particles, i.e. particles showing an aerodynamic diameter below 1 μm, and their evolution in different areas: urban, industrial, suburban and remote locations have been identified and the relative particle behaviour investigated.

Materials & Methods

The submicron particle sampling has been carried out at different sites in the Rieti Province: the sites are different for orographic and territorial characteristics and they insist on areas with different anthropization. Four sites have been identified: downtown Rieti (strongly anthropized area), Terminillo (considered "remote" area), Santa Rufina (industrial zone) and Poggio Moiano (sub-rural area). Sampling was carried out between July 2017 and January 2018

All the measurements were performed by means of a Fast Mobility Particle Sizer (FMPS, model 3091, TSI, Shoreview, USA), allowing to classify the particles in 32 channels size, in the range from 5.6 to 523 nm with temporal resolution 1s. This tool, technologically among the most advanced in the aerosol field, allows to obtain the granulometric distribution in the entire dimensional spectrum in a very short time (1 s): this is able to observe the ultrafine particles produced by combustion phenomena with respect to the particles formed by agglomerates of smaller particles (coagulation and/or gas-particle condensation), following simultaneously the kinetic [3].

Results

Preliminarily, it should be underlined that the various granulometric fractions are strongly influenced by PM1 level (from 100 % in some cases up to 50 %) and therefore it is necessary to study what happens in the submicronic fraction of the atmospheric particulate, with particular regard to ultrafine particles, i.e. less than 100 nm).
Therefore, it becomes important to analyze the particle size composition of PM1, the most significant particle fraction [4]. Figure 1 shows the trend of the total submicronic particles over 12 hours at downtown Rieti. As can be seen from the figure, the trend is strongly conditioned by the traffic that is extremely intense in the central hours of the day and during the evening.

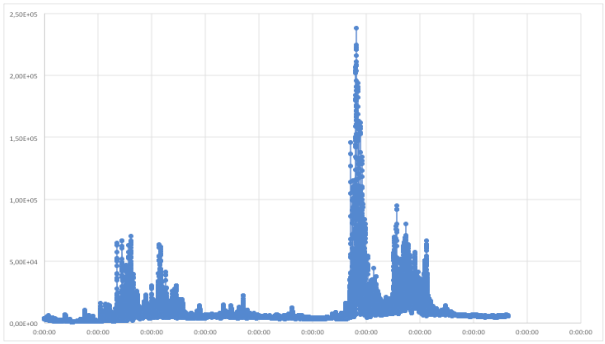

Fig. 1; Trend of the submicronic particles (# cm^{-3}) over 12 hours (location: downtown Rieti).

Figure 2 shows the typical granulometric profile as a function of the granulometric dimension: a very low net-particle peak is noted, indicating a process of generating "fresh" particles deriving from combustion processes. It can also be noted a double peak, very intense, over 100 nm, index instead of "old" particles, ready to aggregate to form larger particles.

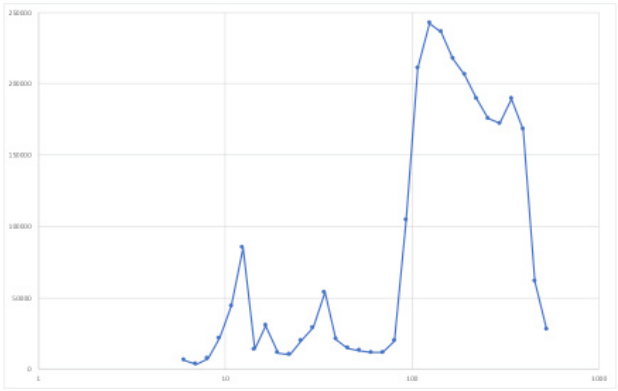

Fig. 2; Typical behaviour of submicronic particles in relationship with the granulometric size (location: downtown Rieti).

Conclusions

The samplings carried out in the four outdoor environments show great differences between the working and no-working days. In downtown Rieti the values are well-evidenced to be decidedly superior in submicronic particles, highlighting the strong contribution of vehicular traffic in generating such particles; on the other hand the sampling performed in the remote area is really interesting showing the background values of the submicron particles in absence of particle sources.

References

1) M. Manigrasso, P. Avino, Fast evolution of urban ultrafine particles: implications for deposition doses in the human respiratory system, *Atmos. Environ.*, 51, (2012) 116-123.
2) N. Künzli, R. Kaiser, S. Medina, M. Studnika, O. Chanel, P. Filliger, M. Hery, F. Horak Jr, T.V. Puybonnieux, P. Quenel, R. Eethaler, J.C. Vergnaud, H. Sommer, Public-health impact of outdoor and traffic-related air pollution: a European assessment, *Lancet*, 356, (2000) 795-801.
3) P. Avino, M. Manigrasso, Dynamic of submicrometer particles in urban environment, *Environ. Sci. Poll. Res.*, 24(16), (2017) 13908-13920.
4) M. Manigrasso, C. Natale, M. Vitali, C. Protano, P. Avino, Pedestrians in traffic environments: ultrafine particle respiratory doses, *Inter. J. Environ. Res. Pub. Health*, 14(3), (2017) 288.