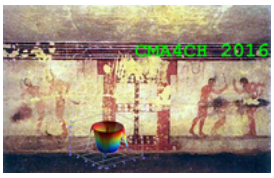
CMA4CH 2016, Mediterraneum Meeting
Straightforward approach in Cultural Heritage and Environment studies - Multivariate Analysis and Chemometry
6th ed., Rome, Italy, Europe, 18-20 December 2016



Mercury in Italy: Mapping and Behavior Across the Country

P. Avino[1], M. Manigrasso[1], R. Schirò[1], C. Giannico[2], F. Perri[2] and M. V. Russo[3]
[1]INAIL, DIT, via Roberto Ferruzzi 38/40, I-00143 Rome (Italy)
[2]INAIL, UOT Taranto, via Japigia, 2, I-74121 Taranto (Italy)
[3]DiAAA, University of Molise, via De Sanctis, I-86100 Campobasso (Italy)

Abstract

Mercury generally is present in the atmosphere in only very small amounts compared with other atmospheric pollutants; but mercury does not break down and after it washes out of the atmosphere it can be converted to a more toxic form such as methyl mercury.

This research would like to record mercury levels that included significant concentrations of a type called Reactive Gaseous Mercury. In particular, seasonal study campaigns were performed during 2010-12 in urban areas of three different Italian cities, Rome, Taranto and Venice, and in little island in South Italy, for investigating levels and behavior of this important pollutant.

For the sampling and analysis a portable instrument was used based on the atomic absorption methodology with the background correction through the Zeeman effect. The daily trends obtained by such measures are discussed in the present paper and, at the same time, the determined levels are compared with how reported in literature (very few data) and in the guidelines of the European Union document. No relevant situations for the human health were found.

This paper is dedicated to the memory of Carlo Giannico, a scientist and a friend, passed away in 2016.

Introduction

Among the different organic and inorganic species present mercury is a very important pollutant both for chemical and toxicological reasons.

In the environment, mercury can migrate between various media, such as air, soil and water. Conceptually, movements of mercury between these different environmental "compartments" are commonly known as "fluxes", and the quantities of mercury in the various compartments are often referred to as "pools".

Natural sources of mercury such as volcanic eruptions and emissions from the ocean have been estimated to contribute about a third of current worldwide mercury air emissions, whereas anthropogenic (human-caused) emissions account for the remaining two-thirds [1,2]. Much of the mercury circulating through today's environment is mercury released years ago, when mercury was commonly used in many industrial, commercial, and residential products and processes.

From the chemical point of view mercury exists as three different species in the atmosphere, each with very different chemical and physical properties, and therefore different source-receptor relationships: Gaseous Elemental Mercury (GEM), Reactive Gaseous Mercury, RGM (e.g., HgCl2), and Total Particulate Mercury (TPM). From the toxicological point of view mercury is extremely toxic. Elemental mercury vapor is highly toxic and is very hazardous to human health [3].

Materials & Methods

Sampling sites - Different locations such as Mestre, Rome, Taranto Lipari Island, have been chosen on the basis of their different urbanization: presence of industrial ports, different anthropogenic activities of great relief, urban installations not situated close to natural mercury sources, "remote" places.

Instrumental equipment - An RA-915+ atomic mercury spectrometer with an RP-91 attachment unit (Lumex, St. Petersburg, Russia) has been used as a mercury detector (Figure 4). A deep description of this instrument is reported by Pogarev et al. [3]. The RA-915+ is used for continuous mercury determination in air and for rapid analysis of solid and liquid samples. The spectrometer was placed in downtown of each city to investigate the mercury level and its behaviour.

The combination of the Zeeman Atomic Absorption Spectrometry using High Frequency Modulate light polarization (ZAAS-HFM) [4] and a multipath cell allows direct selective measuring of mercury at the background level up to 1 ng m^{-3} with a response time of 1 s.

Results

From an analytical point of view it is interesting to investigate the possibility of this instrument that allows to analyze the mercury level every 15 s in air. The LOD for this equipment has been established at 1 ng m^{-3}, analyzing the standards and the comparison with other spectrometric techniques.

It can be possible to evidence quite similar average mercury levels in the different zones investigated. In particular, extrapolating for the whole period, average levels of 2.36 ng m^{-3} and 2.92 ng m^{-3} for Venice e Taranto, respectively, are found.

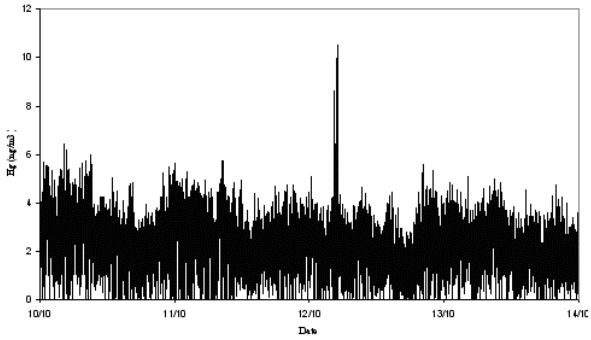


Fig. 1; Daily Reactive Gaseous Mercury concentration trends in downtown Mestre/Venezia in October 2010.

Looking at the plots reported in Figure 1 (daily Reactive Gaseous Mercury, RGM, recorded in Mestre/Venezia in 2010), the maximum peaks recorded every midday demonstrate regular emissions both from same source and same direction (W-SW). The identification of this source is not easy to individuate because it should be necessary to know exactly the anthropogenic activities (and eventually the presence of particular natural sources) in that area but it should be considered that this emission is not so strong and consequently the maximum reached peak is 8 ng m^{-3}.

In downtown Rome the situation was quite similar also taking in account the levels (ranging between 1 and 4 ng m^{-3}). No particular behavior was possible to identify and also the main sources such as sanitary waste incinerator was far from the sampling site.

Conclusions

This paper reports the preliminary results of an investigation on the mercury levels and behavior carried out in different locations throughout Italy. No relevant situations for the human health were found (the levels range between 1 and 15 ng m^{-3} according the areas). Finally, the mercury levels and behavior have been discussed to the atmospheric stability conditions. It should be noted that these data represent the first systematic investigation of this pollutant in Italian urban cities.

References

1) E. Pacyna, J.M.. Pacyna, N. Pirrone, 2001. Atmospheric mercury emissions in Europe from anthropogenic sources, *Atmos. Environ.*, 35, (2001) 2987-2996.
2) E.G. Pacyna, J.M. Pacyna, F. Steenhuisen, S. Wilson. Global anthropogenic mercury emission inventory for 2000, *Atmos. Environ.*, 40, (2006) 4048-4063.
3) S.E. Pogarev, V.V. Ryzhov, N.R. Mashyanov, S. Sholupov, V. Zharskaya, Direct measurement of the mercury content of exhaled air: a new approach for determination of the mercury dose received, *Anal. Bioanal. Chem.*, 374, (2002) 1039-1044.
4) S.E. Sholupov, A.A. Ganeyev, Zeeman absorption spectrometry using high frequency modulate light polarization, *Spectrochim. Acta B*, 50, (1995) 1227-1236.