Content of Trace Elements in the Respirable Fractions of the Air Particulate of Urban and Rural Areas Monitored by Neutron Activation Analysis

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ABSTRACT

The concentrations (ng/m 3) of more than 30 trace elements have been determined in the total air particulate matter and in the size-segregated fractions collected in urban, industrialized, and rural residential areas in northern Italy by means of a multistage inertial impactor with the PM10 inlet. All measurements have been carried out by instrumental neutron activation analysis, except for Pb and Cd, which have been determined by electrothermal atomic absorption spectroscopy. Analytical quality assurance procedures have been developed with special regard to blanks, reagents, and sampling. Total concentrations and the granulometric distribution found in the different locations are reported and compared.

Index Entries: Trace elements; air pollution; particle size distribution; neutron activation analysis.

INTRODUCTION

The monitoring of trace elements (TEs) content in the atmospheric particulate may contribute to control and to evaluate the degree of the air pollution and furnishes additional information for assessing the air quality of our environment (1). Many TEs of anthropogenic origin may

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constitute a potential risk to the population, not only at the level of threshold concentrations but also in terms of prolonged exposure to low levels (2). However, a knowledge of the concentrations in the total suspended air particulate, although to representing an important parameter, is not sufficient for a closer evaluation of the possible impact to the public health. The monitoring of the concentrations in the fine particulate fractions involved in the respiratory system at alveolar and bronchial levels must be comprehensive. This has already been recommended by the health organizations, which suggested analyzing the "inhalable" particulate (i.e., the fraction containing the particles with an aerodynamic equivalent diameter of less than 10 µm [PM10]) (3). In this work, the PM10 has been further investigated to obtain the TE concentrations in the finest "respirable" fractions involved in the different tracts of the respiratory system. By means of inertial multistage impactors, the air particulate has been size fractionated in three subsequent fractions: alveolar (particles of 0–1.1 µm nominal diameter), bronchial (1.1–4.6 µm), and tracheo-pharynx (4.6 < 9 µm). In previous works (4,5), preliminary results have been obtained on the TE concentrations (ng/m³) in total as well as in size-segregated particles of air particulate matter collected during the years 1994 to 1996 in urban and industrialized areas. In this work, a more comprehensive study regarding the determination of additional TE and the sampling of air particulate of rural residential areas is accomplished. A new sampling campaign was carried out during the winter of 1998 (February) in an urban area (downtown Milan), in a suburban industrialized area (Cologno Monzese), and in a rural residential area (Cadrezzate-Ispra).

For the TE determination, the main analytical problems have arisen from the very low concentrations to be determined and the blank contribution deriving from the filtering membranes, the analytical processes, and the sampling procedures. To overcome these difficulties, a deep investigation of the field blanks, reagent purity, and handling operations was conducted. The splitting of the filters for the analysis with two analytical techniques (instrumental neutron absorption activation analyses [INAA] and electrothermal atomic absorption spectroscopy [ETAAS]) was avoided by carrying out two independent and simultaneous series of samplings. Before and after the collection, the samples have been handled in a clean laboratory. Samplings of 48 h each were carried out to increase the amount of air particulate matter collected in the rural residential area in order to obtain a better mass loading/filter blank ratio. All the analytical data were corrected for the blank contribution by carrying out replicate analyses of the trace element content in the filtering membranes as well as in the reagents used for the dissolution of the samples submitted to the ETAAS. Finally, the quality assurance of the primary standards and the overall analytical performances was accomplished by analyzing series of standard certified materials (NIST SRMs).