INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF FLY ASHES AND EMISSIONS

I. OBRUSNÍK,* B. STÁRKOVÁ,** J. BLAŽEK**

*Nuclear Research Institute, 250 68 Řež near Prague (Czechoslovakia)
**Research Institute of Air Engineering, Prague (Czechoslovakia)

(Received November 12, 1975)

Instrumental neutron activation analysis (INAA) has been utilized for the analysis of 19 different fly ashes, 1 sample of coal and 3 samples of industrial emissions. Both short and long irradiations in a nuclear reactor have been used. The irradiated samples have been measured by means of a computer-based Ge(Li) gamma-ray spectrometer. The concentrations of 27 elements have been determined in the samples.

Introduction

Over the past several years there has been increasing concern about environmental pollution problems. A great interest has been devoted to air pollution analysis. Many analyses of pollution aerosols have been made all over the world. One of the analytical methods suitable for such kind of analyses is instrumental activation analysis (INAA).

The main sources of aerosols in air are: stationary industrial fossil fuel combustion (coal based power plants, thermal power plants etc.), various industrial processes (cement works, iron works, chemical industry etc.), automobile fuel combustion and, finally, the natural dust originating from soils.

Solid particles originating from fly ashes produced by the combustion of solid fuels (coal) contribute rather seriously to the air pollution in Czechoslovakia. Fine particles of the fly ashes penetrate through current separating devices of large combustion sources (e.g. particles with the size below 30 μm penetrate through mechanical separation devices while particles smaller than 5 μm penetrate through two-step separating devices).

Then, aerosols can be created by the dispersion of such fine particles in the surroundings of the combustion sources. The fly ashes emitted from the combustion sources are harmful and dangerous because they are carriers of a number of harmful and toxic elements.

INAA as a very sensitive multielemental analytical method, has been used most often for the complete analysis of aerosols (e.g. Refs 1-10). However, the papers dealing with an
INAA of fly ashes and other emissions are rather rare in comparison with the INAA of aerosols, even though these materials can seriously contribute to air contamination. Recently, the National Bureau of Standards (NBS) produced a standard reference material SRM 1633 made from fly ash, which seems to be a very promising standard reference material.

In this work, we have tried to analyze the samples of fly ashes and some other emissions taken from various sources by INAA. We have determined concentration ranges of some major, minor and trace elements in these samples. The next step in our work will be a comparative INAA of fly ashes and aerosols taken simultaneously from the area close to the large source of fly ash emission.

**Experimental**

**Sampling procedure**

Fly ashes or emissions were taken from a smoke duct by a sampling isokinetic tube either prior to or after passing through a separating device. 19 samples of different fly ashes from power stations and steam generating stations were analyzed. The samples of emissions were taken from cement works and fluorite mills. All samples were homogenized prior to analysis.

**Non-destructive neutron activation analysis**

A procedure for non-destructive NAA of fly ashes and emissions consisted of two irradiations: a short (10 min) irradiation and a long one (6 hrs).

(a) Short irradiation (10 min) was used for the determination of elements giving rise to short-lived isotopes. Samples and standards packed in polyethylene vials were placed in a rabbit which carried them through a pneumatic tube (35 sec) to a position in the core of the nuclear reactor in Rež with a neutron flux of \(1 \times 10^{13} \text{n cm}^{-2} \text{sec}^{-1}\). Each irradiated sample was then counted twice with a Plurimat 20 computer-based Ge(Li) 4096 channel gamma-ray spectrometer system. Two samples and one neutron flux monitor were irradiated simultaneously. The following schedule of counting was used:

First counting: The first sample-counting was started 10 min after the end of irradiation; counting geometry \(G_1\) (21 cm), counting interval 5 min, energy range up to 3200 keV. The second sample-counting was started 20 min after the end of irradiation; geometry \(G_2\) (8 cm), counting time 10 min, energy range up to 2000 keV. The isotopes \(^{27}\text{Al}\), \(^{52}\text{V}\), \(^{51}\text{Ti}\), \(^{56}\text{Mn}\), \(^{49}\text{Ca}\) and \(^{125}\text{I}\) were predominant in the spectra from the first counting. The irradiation of the next samples was carried out during the counting of the second sample.