Application Brief

Hitachi High-Tech HITACHI

Hitachi High-Tech Science Corporation
RBM Tsukiji Bldg., 15-5, Shintomi 2-chome, Chuo-ku, Tokyo 104-0041
TEL:+81-3-6280-0068 FAX:+81-3-6280-0075
http://www.hitachi-hitec-science.com

SEA NO.23 APR.1999

Measurement by X-ray Fluorescence Analysis of Pb in Artificial Disgorged Matter

1. Overview

Lead (Pb) is an element that is easily processed, resists corrosion, makes a good alloy, and has a variety of uses including matches, electrical wire coating, solder, dry cell batteries, rust preventive material, hardening agent for rubber, and lead pipes. Nonetheless, lead poisoning in the production and use of lead is well known and Japan's Ministry of Labor has established lead poisoning prevention regulations. Also, emergency clinics have medical procedural manuals for stomach cleaning, antidotes, chelating reagents, etc. To treat a poison you must be able to quickly identify the poison. The energy dispersion fluorescent X-ray analyzer quickly measures multiple elements of hazardous metals without requiring that the sample be modifying. Here we created a lead poisoning scenario by measuring pottage and beef consommé with Pb added, as the artificial vomit or artificial stomach fluid of a poisoned victim.

2. Method of Measurement

2-1 Instrument

SEA5120 Bench-Top Micro Focus X-ray Fluorescence Analyzer

2-2 Sample

Added a standard lead solution for atomic absorption (1000mg/l) 1 mg to pottage and beef consommé. Amount of each sample was 10 ml.

Pottage Ingredients: starch, lactose, vegetable oil, dextrin, sugar, table salt, seasoning, onions, beef extract, cheese, butter, spices, yeast extract.

Beef Consommé Ingredients: table salt, dextrin, seasoning, sugar, beef extract, beef tallow, spices, roast onion, caramel coloring

2-3 Measurement Method

Sample was poured into a plastic cup, irradiated from overhead, and fluorescent X-rays (Pb L alpha) measured.

2-4 Measurement Conditions

X-ray tub	Mo
Applied voltage	45 kV
Tube current	20 μA
Collimator size	1.8 mm
Atmosphere	Air
Measurement Time	60 sec

3. Measurement Results

The table below shows fluorescent X-ray intensities.

Sample	Effective time (sec)	Gross Intensity (cps)	BKG Intensity (cps)
Pb 100 ppm added to distilled water	40	52.4	43.5
Pb 100 ppm added to pottage	42	47.1	41.2
Pb 100 ppm added to consommé	40	51.9	45.7

The net intensity of Pb 100 ppm within the matrix of all three samples is 6 to 8 cps. Accordingly, energy dispersion fluorescent X-ray analysis can easily and rapidly measure even solutions by pouring the solution into a suitable cup or a beaker. Also, there is not matrix effect from the pottage or consommé.

4. Detection Lower Limit

The detection lower limit of lead in a water solution was found to be 8.9 mg/l from the following equation. (Measurement time = 1000 seconds.)

$$\textit{Detection Lower Limit (DL)} = 3\,(B/T)^{1/2}/S = 8.87\ \textit{mg/l}$$

B = background (cps)
T = effective time (sec)
S = sensitivity (cps per unit density)

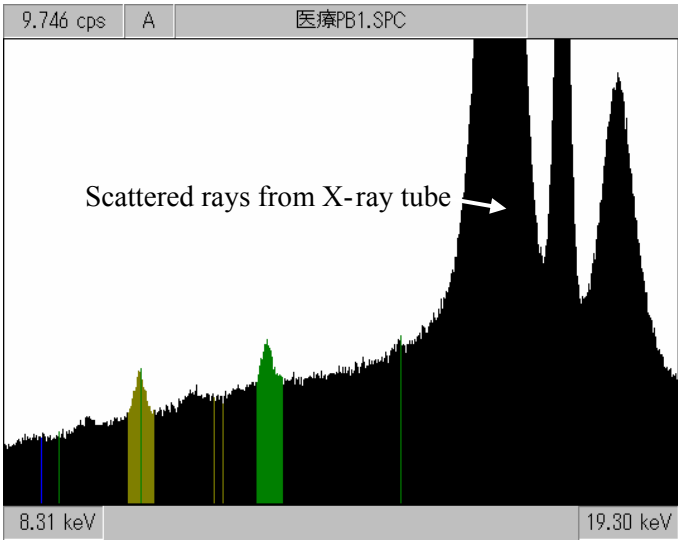

Figure 1 Fluorescent X-ray Spectrum of Pb 100 mg/L

5. Summary

The micro X-ray fluorescence analyzer rapidly performs non-contact, non-destructive qualitative and quantitative analysis of toxic elements (arsenic, lead, etc.) within disgorged matter, urine, and blood while visually verifying the sample without requiring modification of the sample. In this experiment, we measured 10ml samples in plastic containers for 60 seconds, while taking speed into consideration (DL is 1000 sec).

Lead compound toxins include soluble lead acetate LD50 of 82 mg/kg weight, insoluble lead sulfide LD50 of 1390 mg/kg weight (high dosage in abdomens of mice and rats). Fluorescent X-ray analysis is effective in rapidly finding which poisonous elements (Pb etc.) causes acute poisoning. Samples need no pre-treatment.