

Determination of Trace Elements in a Natural Water Sample Using Ultrasonic Nebulization with Inductively Coupled Plasma Atomic Emission Spectrometry

Key Words

- ICP-OES
- Ultrasonic Nebulization
- Natural Waters
- Trace Elements

Introduction

Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-OES) is widely used for trace element determination in an extensive variety of samples. A number of important elements are more difficult to detect, including antimony, arsenic, lead, and selenium. The coupling of an efficient ultrasonic nebulizer accessory to a contemporary ICP-OES instrument can provide the necessary signal enhancement for accurate measurement of the above elements and others in a standard reference water sample.



Operating Conditions

THEMO iCAP 6000 ICP-OES INSTRUMENT:

ICP Power	1250 W
Auxiliary Gas Flow	0.5 L/min
Nebulizer Gas Pressure	25 psi
Viewing	axial for all elements
Integration Time	30 s
Replicates	3

CETAC US1000AT ULTRASONIC NEBULIZER:

Heater Temperature	140 °C
Chiller Temperature	3 °C
Sample Uptake Rate	2.4 mL/min
Nebulizer Gas Flow	approx. 0.8 L/min at 25 psi pressure

Note: A flow restriction fitting is attached to the gas port of the ultrasonic nebulizer to regulate the flow of gas from the ICP-OES instrument. An ICP-OES instrument equipped with a mass flow controller would not require this fitting.

Sample

The reference sample analyzed was NIST (National Institute of Standards and Technology) SRM 1640 Trace Elements in Natural Water. NIST SRM 1640 is composed of natural fresh water from Clear Creek, Colorado USA. The sample is filtered and stabilized with nitric acid to a concentration of 0.5M.

Sample Preparation and Calibration

Only an internal standard spike of 20 µg/L yttrium was added to the SRM 1640 natural water sample; no other sample treatment was performed. The ICP-OES instrument was calibrated with a reagent blank and two standards (also spiked with 20 µg/L yttrium) that covered the range of expected analyte concentrations. The three solutions were all made with high-purity nitric acid to a final concentration of 0.5 M, matching the concentration in the natural water sample.

A two-point background correction was performed for each analyte wavelength, and no interelement correction factors (IECs) were used for this sample matrix. Wavelengths were chosen for best performance for the analyte concentrations expected.

Note: Hydrogen peroxide can be added to samples and standards to correct for oxidation state variability for elements such as arsenic. The typical concentration of hydrogen peroxide is 0.4 % (v/v) from 30 % hydrogen peroxide. More details can be found in USEPA Method 200.15: "Determination of Metals and Trace Elements in Water by Ultrasonic Nebulization Inductively Coupled Plasma Atomic Emission Spectrometry".

Results

Table 1 lists measured values for certified elements and Table 2 lists measured values for reference elements. Values from the NIST certificate were converted from mass fractions (µg/kg) by multiplying by the density of SRM 1640 (1.0015 g/cm³ ± 0.0003 g/cm³). Uncertainties are based on a 95 % confidence interval. Overall agreement of the results obtained using the CETAC US1000AT[®] ultrasonic nebulizer with ICP-OES detection is excellent.

Determination Of Trace Elements

Zoltan Mester, Ralph E. Sturgeon



Determination Of Trace Elements:

Determination of Trace Elements Zeev B. Alfassi, 2008-07-11 The best way to determine trace elements This easy to use handbook guides the reader through the maze of all modern analytical operations Each method is described by an expert in the field The book highlights the advantages and disadvantages of individual techniques and enables pharmacologists environmentalists material scientists and food industry to select a judicious procedure for their trace element analysis

Water Quality. Determination of Trace Elements Using Atomic Absorption Spectrometry with Graphite Furnace British Standards Institute Staff, 2003-10-28 Water Quality Atomic absorption spectrophotometry Trace element analysis

Modern Methods for Trace Element Determination C. Vandecasteele, C. B. Block, 1997-03-06 Describes the theory apparatus performance and usage of modern methods for trace element determination atomic absorption emission fluorescence and mass spectroscopies x ray techniques and activation analysis Attention is given to sample preparation current calibration procedures and to methods for trace element speciation Contains in depth information on relatively new techniques such as ICP MS and PIXE All methods are illustrated with authentic examples from the ever expanding fields of environmental and biological analysis of high purity materials

[Sample Preparation for Trace Element Analysis](#) Zoltan Mester, Ralph E. Sturgeon, 2003-12-16 Following the collection of a sample every analytical chemist will agree that its subsequent preservation and processing are of paramount importance The availability of high performance analytical instrumentation has not diminished this need for careful selection of appropriate pretreatment methodologies intelligently designed to synergistically elicit optimum function from these powerful measurement tools Sample Preparation for Trace Element Analysis is a modern comprehensive treatise providing an account of the state of the art on the subject matter The book has been conceived and designed to satisfy the varied needs of the practicing analytical chemist It is a multi author work reflecting the diverse expertise arising from its highly qualified contributors The first five chapters deal with general issues related to the determination of trace metals in varied matrices such as sampling contamination control reference materials calibration and detection techniques The second part of the book deals with extraction and sampling technologies totaling 15 chapters providing theoretical and practical hints for the users on how to perform specific extractions Subsequent chapters overview seven major representative matrices and the sample preparation involved in their characterization This portion of the book is heavily based on the preceding chapters dealing with extraction technologies The last ten chapters are dedicated to sample preparation for trace element speciation First title to provide comprehensive sample preparation information dealing specifically with the analysis of samples for trace elements The 39 chapters are authored by international leaders of their fields

Inorganic Trace Analytics Henryk Matusiewicz, Ewa Bulska, 2017-12-18 Highly accurate chemical speciation is of great importance in environmental clinical and food sciences as well as in archaeometry Trace analysis via atomic spectrometry mass spectroscopy gas chromatography electron microprobing or X ray absorption spectroscopy

provides detailed information on surface and sub surface domain of samples The book comprehensively presents modern techniques timely application and data modeling *Foodstuffs. Determination of Trace Elements. Determination of Sodium and Magnesium by Flame Atomic Absorption Spectrometry (AAS) After Microwave Digestion* British Standards Institute Staff,2008-03-31 Food products Food testing Chemical analysis and testing Determination of content Trace element analysis Sodium Magnesium Calcium Flame atomic absorption spectrometry **Quantitative Trace Analysis of Biological**

Materials Hugh A. McKenzie,Lloyd Earle Smythe,1988 The understanding of the functions of trace elements in metabolism whether associated with microorganisms plants or animals has advanced considerably during the last twenty years There are two main aspects of the importance of trace elements in biological materials first their toxic effects and secondly the essential nature of some of the elements for normal growth and health Research in trace elements and their essential role in biological processes has advanced through several stages necessitating more and more effective methods of determination Despite the marked improvements in methods of trace analysis during these twenty years the ever increasing need for higher sensitivity to meet new demands has meant the greater need not only for improving the limits of detection but also for new standard reference materials better sampling better sample handling and better design of trace and ultra trace analysis laboratories This book focusses on all areas of trace element determination with detailed discussion on all major methods of analysis Additionally the determination of concentrations of major toxic and essential trace elements is discussed at length

Foodstuffs. Determination of Trace Elements. Determination of Lead, Cadmium, Zinc, Copper and Iron by Atomic Absorption Spectrometry (AAS) After Microwave Digestion British Standards Institute Staff,2003-04-24 Food products Food testing Chemical analysis and testing Trace element analysis Determination of content Lead Cadmium Zinc Copper Iron Metals Atomic absorption spectrophotometry Spectrophotometry Trace Element Analysis in Biological Specimens R.F.M. Herber,M. Stoeppler,1994-05-19 The major theme of this book is analytical approaches to trace metal and speciation analysis in biological specimens The emphasis is on the reliable determination of a number of toxicologically and environmentally important metals It is essentially a handbook based on the practical experience of each individual author The scope ranges from sampling and sample preparation to the application of various modern and well documented methods including quality assessment and control and statistical treatment of data Practical advice on avoiding sample contamination is included In the first part the reader is offered an introduction into the basic principles and methods starting with sampling sample storage and sample treatment with the emphasis on sample decomposition This is followed by a description of the potential of atomic absorption spectrometry atomic emission spectrometry voltammetry neutron activation analysis isotope dilution analysis and the possibilities for metal speciation in biological specimens Quality control and all approaches to achieve reliable data are treated in chapters about interlaboratory and intralaboratory surveys and reference methods reference materials and statistics and data evaluation The chapters of the second part provide detailed information on the

analysis of thirteen trace metals in the most important biological specimens The following metals are treated in great detail Aluminium arsenic cadmium chromium copper lead selenium manganese nickel mercury thallium vanadium and zinc The book will serve as a valuable aid for practical analysis in biomedical laboratories and for researchers involved with trace metal and species analysis in clinical biochemical and environmental research Microwave-Assisted Sample Preparation for Trace Element Determination Erico Marlon Moraes Flores, 2014-05-03 Microwave Assisted Sample Preparation for Trace Element Analysis describes the principles equipment and applications involved in sample preparation with microwaves for trace element analysis The book covers well established applications as well as new trends in this field Hot topics such as sample preparation for speciation metabolomics and halogen determination as well as the alternatives of sample preparation for special samples for example carbon nanotubes polymers petroleum products are also discussed The use of microwaves in sample preparation has increased in recent decades Several applications of microwaves for sample preparation can be found in the literature for practically all types of sample matrices especially for the determination of trace elements by atomic spectrometric techniques safely and cleanly reducing the time involved in this step Microwave assisted sample preparation is not only a tool for research but also for routine analysis laboratories the state of the art in sample preparation in trace element analysis This book is the only resource for chemists specifically focused on this topic The first book to describe the principles equipment and applications in microwave assisted sample preparation Written by experts in the field who provide a comprehensive overview of the important concepts Introduces new alternatives and trends in microwave assisted techniques **Trace Element Analysis of Food and Diet** Namik K. Aras, O. Yavuz Ataman, 2006 Trace element analysis has a key role to play in quality control of food and diet This timely book introduces the subject in a practical way from sampling and the techniques available for trace analysis to procedures for specific elements and data analysis Beginning with a brief introduction and discussion of statistical evaluation of data the subsequent chapter looks at trace analysis in general with its essentials and terminology Another section introduces sampling and preparation of foodstuffs such as wheat potato vegetables and milk This is followed by descriptions of the various spectrometric techniques atomic absorption atomic emission atomic fluorescence that are available Plasma techniques for both optical emission and mass spectrometry are presented as are nuclear activation analysis and X ray methods A comparison of the various analytical techniques is provided and a separate chapter handles speciation analysis Finally procedures for determining essential and toxic elements such as arsenic iron selenium and zinc are suggested using several recent references Detailed explanations and a simple format will appeal to laboratory technicians and graduate students as well as more experienced researchers Comprehensive coverage coupled with illustrations and a guide to relevant literature and manufacturers will make Trace Element Analysis of Food and Diet a valuable source of information for anyone working on analysis of trace elements in food diet or other biological or environmental samples particularly food engineers agricultural scientists and government testing agency employees

Foodstuffs. Determination of Trace Elements. Determination of Lead, Cadmium, Chromium and Molybdenum by Graphite Furnace Atomic Absorption Spectrometry (Gfaas) After Pressure Digestion British Standards Institute

Staff,2003-04-24 Food products Food testing Chemical analysis and testing Trace element analysis Determination of content

Lead Cadmium Chromium Molybdenum Metals Atomic absorption spectrophotometry Spectrophotometry Foodstuffs.

Determination of Trace Elements. Determination of Iodine by Icp-Ms (Inductively Coupled Plasma Mass Spectrometry)

British Standards Institute Staff,2007-04-30 Food testing Food products Dietetic foods Chemical analysis and testing

Determination of content Iodine Trace element analysis Mass spectrometry Extraction methods of analysis *Foodstuffs.*

Determination of Trace Elements. Determination of Tin by Inductively Coupled Plasma Mass Spectrometry (ICPMS) After

Pressure Digestion British Standards Institute Staff,1910-01-31 Food products Food testing Chemical analysis and testing

Determination of content Tin Trace element analysis Plasma Mass spectrometry Determination of Trace Elements, with

Special Reference to Fertilisers and Feeding Stuffs, Etc Society of Public Analysts, afterwards Society of Public Analysts and

other Analytical Chemists, afterwards Society for Analytical Chemistry (London). - Analytical Methods Committee. - Trace

Elements in Fertilisers and Feeding Stuffs Sub-Committee,1963 *Determination of Trace Elements* Paul Young,1966

Foodstuffs. Determination of Trace Elements. Determination of Mercury by Cold-Vapour Atomic Absorption Spectrometry (CVAAS) After Pressure Digestion British Standards Institute Staff,2002-09-10 Food products Food testing Trace element

analysis Mercury Determination of content Chemical analysis and testing Atomic absorption spectrophotometry *ICP-MS*

and Trace Element Analysis as Tools for Better Understanding Medical Conditions ,2022-05-25 ICP MS and Trace Element

Analysis as Tools for Better Understanding Medical Conditions Volume 97 discusses trace elements and how they play an

important role in biological functions and metabolism in the human body Chapters cover Biomedical analysis by ICP MS A

focus on single cell Advanced statistical tools and machine learning applied to trace element analysis associated with medical

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Covers metals isotopes and metalorganic species for medical conditions Includes ICP MS based techniques *Foodstuffs.*

Determination of Trace Elements. Determination of Iodine in Dietetic Foods by ICP-MS (inductively Coupled Plasma Mass

Spectrometry) British Standards Institute Staff,2005-12-01 Food testing Food products Dietetic foods Chemical analysis and

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