Flow Injection Analysis in Industrial Biotechnology

Flow injection analysis (FIA) is an analytical chemical continuous-flow (CF) method which in contrast to traditional CF-procedures does not rely on complete physical mixing (homogenisation) of the sample and the reagent(s) or on attaining chemical equilibria of the chemical reactions involved. Exploiting controllable dispersion of the injected sample within the reagent-containing carrier stream and strictly reproducible timing of all events taking place, it is based on measuring transient signals, which not only implies very high sampling rates, but also, and most importantly, permits implementation of a number of novel methodologies which are not feasible when performed under batch conditions or by conventional CF-procedures. Demonstrated for selected bioanalytical and technological applications encompassing cellular and enzymatic assays as well as monitoring of culture media, the principles and operational characteristics of FIA are first outlined, and then its downscaled/miniatuized sequels, that is, sequential injection analysis (SIA) and lab-on-valve (LOV), are detailed. Thus, in SIA the sample and reagents are, via the use of a multiposition valve and an attached syringe pump operated under full programmable control, aspirated sequentially and then propelled forward allowing the sample and reagent(s) to be intermixed and, if called for, subjected to appropriate treatments before analyte detection. This infers that merely minute sample/reagents volumes are consumed, hence leading to generation of small amounts of waste. In LOV this downsampling is taken further by using a small monolithic structure within which all sample manipulations and ultimate analyte detection under programmable control can be effected. Even bead-materials with different surface groups/characteristics, including live cells, can be handled and utilized as demonstrated. Because the syringe pump in SIA and LOV can be used for accurately aspirating, propelling or even stopping the flow, these modi operandi allow fully to exploit the interplay between the kinetics and the thermodynamics of the chemical reactions involved, so that there are no restrictions whatsoever as to the chemistries that can be implemented, even if they entail multi-step reactions. Representative bioanalytical examples of this interplay are presented.
Evaluation of the readesorption of plutonium and americium in dynamic fractionations of environmental solid samples

A dynamic extraction system exploiting sequential injection (SI) for sequential extractions incorporating a specially designed extraction column is developed to fractionate radionuclides in environmental solid samples such as soils and sediments. The extraction column can contain a large amount of soil sample (up to 5 g), and under optimal operational conditions it does not give rise to creation of back pressure. Attention has been placed on studies of the readesorption problems during sequential extraction using a modified Standards, Measurements and Testing (SM&T) scheme with 4-step sequential extractions. The degree of readesorption in dynamic and conventional batch extraction systems are compared and evaluated by using a double-spiking technique. A high degree of readesorption of plutonium and americium (>75%) was observed in both systems, and they also exhibited similar distribution patterns of the two radionuclides. However, the dynamic system is fully automated, eliminates manual separations, significantly reduces the operational time required, and offers detailed kinetic information.
Flow injection analysis. Its origin and progress

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Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Number of pages: 786
Interfacing microfluidic handling with spectroscopic detection for real-life applications via the lab-on-valve platform: A review

One of the current needs within the analytical spectrometric community is the development of straightforward and cost-effective, yet rugged, sample processing procedures aimed at precluding both spectroscopic and non-spectroscopic matrix interferences while fostering concomitant sample enrichment. Illustrated via selected representative examples, this review presents and discusses the current state of the art in implementing miniaturised and automated sample treatments for environmental and biochemical assays via microfluidic systems exploiting the lab-on-a-valve (LOV) platform in hyphenation with syringe pump propelling devices as a front end to a plethora of spectroscopic detection schemes including UV-Vis spectroscopy, spectrofluorimetry, chemiluminescence, AAS, AFS and ICP-AES/MS. In contrast to lab-on-a-chip units, the versatile configuration of the micromachined LOV readily facilitates the implementation of on-line unit operations at will encompassing not merely the introduction of minute, well-defined volumes of sample followed by chemical derivatization, but the potential for accommodation of solid-phase extraction, hydride/vapour generation, precipitation/coprecipitation and bead injection protocols with no need for chip redesign.

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Web of Science (2015): Indexed yes
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Scopus rating (2014): SJR 1.199 SNIP 1.947 CiteScore 4.36
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Scopus rating (2013): SJR 0.78 SNIP 1.405 CiteScore 3.37
ISI indexed (2013): ISI indexed yes
On-line sample processing methods in flow analysis

In this chapter, the state of the art of flow injection and related approaches thereof for automation and miniaturization of sample processing regardless of the aggregate state of the sample medium is overviewed. The potential of the various generation of flow injection for implementation of in-line dilution, derivatization, separation and preconcentration methods encompassing solid reactors, solvent extraction, sorbent extraction, precipitation/coprecipitation, hydride/vapor generation and digestion/leaching protocols as hyphenated to a plethora of detection devices is discussed in detail and relevant examples published in the literature up to April 2007 are pinpointed.

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Authors: Miró, M. (Ekstern), Hansen, E. H. (Intern)
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Publisher: Wiley-VCH
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Edition: 1
Recent developments in automatic solid-phase extraction with renewable surfaces exploiting flow-based approaches

Solid-phase extraction (SPE) is the most versatile sample-processing method for removal of interfering species and/or analyte enrichment. Although significant advances have been made over the past two decades in automating the entire analytical protocol involving SPE via flow-injection approaches, on-line SPE assays performed in permanent mode lack sufficient reliability as a consequence of progressively tighter packing of the bead reactor, contamination of the solid surfaces and potential leakage of functional moieties. This article overviews the current state-of-the-art of an appealing tool for overcoming the above shortcomings, so-called bead-injection (BI) analysis, based on automated renewal of the sorbent material per assay exploiting the various generations of flow-injection analysis. It addresses novel instrumental developments for implementing BI and a number of alternatives for online chemical-derivatization reactions, and it pinpoints the most common instrumental detection techniques utilized. We present and discuss in detail relevant environmental and bioanalytical applications reported in the past few years.
Retro-review of flow injection analysis

It is indeed unusual for authors to review their own monograph – J. Ruzicka, E.H. Hansen, Flow Injection Analysis, 2nd Edition, Wiley, Chichester, West Sussex, UK, 1988. – and even more so if the book was published 20 years ago. Yet such an exercise might yield a perspective on the progress of analytical instrumentation in general and on the development of flow-injection analysis (FIA) techniques in particular. By reviewing what was written and proposed 20 years ago, it is interesting to observe what proved to be of lasting value, what became accepted, and, above all, what we missed and failed to anticipate.

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Authors: Ruzicka, J. (Ekstern), Hansen, E. H. (Intern)
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Main Research Area: Technical/natural sciences

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BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.437 SNIP 2.322 CiteScore 7.24
BFI (2014): BFI-level 2
A multisyringe flow-through sequential extraction system for on-line monitoring of orthophosphate in soils and sediments

A fully automated flow-through microcolumn fractionation system with on-line post-extraction derivatization is proposed for monitoring of orthophosphate in solid samples of environmental relevance. The system integrates dynamic sequential extraction using 1.0 mol l-1 NH₄Cl, 0.1 mol l-1 NaOH and 0.5 mol l-1 HCl as extractants according to the Hietjles-Lijklema (HL) scheme for fractionation of phosphorus associated with different geological phases, and on-line processing of the extracts via the Molybdenum Blue (MB) reaction by exploiting multisyringe flow injection as the interface between the solid containing microcolumn and the flow-through detector. The proposed flow assembly, capitalizing on the features of the multicommutation concept, implies several advantages as compared to fractionation analysis in the batch mode in terms of saving of extractants and MB reagents, shortening of the operational times from days to hours, highly temporal
resolution of the leaching process, and the capability for immediate decision for stopping or proceeding with the ongoing extraction. Very importantly, accurate determination of the various orthophosphate pools is ensured by minimization of the hydrolysis of extracted organic phosphorus and condensed inorganic phosphates within the time frame of the assay. The potential of the novel system for accommodation of the harmonized protocol from the Standards, Measurement and Testing (SMT) Program of the Commission of the European Communities for inorganic phosphorus fractionation was also addressed. Under the optimized conditions, the lowest detectable concentration at the 3σ level was ≤ 0.02 mg P l−1 for both the HL and SMT schemes regardless of the extracting media. The repeatability of the MB assay was better than 2.5 % and the dynamic linear range extended up to 7.0 mg P l−1 in NH4Cl and NaOH media and 15 mg P l−1 whenever HCl is utilized as extractant for both the HL and SMT protocols.

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Authors: Buanuam, J. (Ekstern), Miró, M. (Ekstern), Hansen, E. H. (Intern), Shiowatana, J. (Ekstern), Estela, J. M. (Ekstern), Cerdà, V. (Ekstern)
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Main Research Area: Technical/natural sciences

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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.187 SNIP 1.327 CiteScore 3.99
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.201 SNIP 1.296 CiteScore 3.71
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.201 SNIP 1.399 CiteScore 3.74
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.421 SNIP 1.46 CiteScore 3.74
ISI indexed (2012): ISI indexed yes
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BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.429 SNIP 1.518 CiteScore 3.91
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.456 SNIP 1.366
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.319 SNIP 1.338
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2007): SJR 1.428 SNIP 1.506
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.305 SNIP 1.377
How Flow Injection Analysis (FIA) over the past 25 years has changed our way of performing chemical analyses

Briefly looking back on the impact of flow injection analysis (FIA), as reflected in the rapid growth of publications in the scientific literature, and touching upon many of the novel and unique analytical chemical possibilities that FIA and its sequels, sequential injection analysis (SIA) and Lab-on-Valve (LOV), have offered, we emphasize assays based on kinetic discrimination schemes, where, even subtle, differences in the reaction rates of the chemical reactions that occur are judiciously exploited. We give a number of examples, covering homogeneous as well as heterogeneous conversions techniques, determinations of low levels of metals in complex matrices via suitable pre-treatment procedures, and soil fractionation schemes.

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Miniaturization of environmental chemical assays in flowing systems: The lab-on-a-valve approach vis-à-vis lab-on-a-chip microfluidic devices

The analytical capabilities of the microminiaturised lab-on-a-valve (LOV) module integrated into a microsequential injection (muSI) fluidic system in terms of analytical chemical performance, microfluidic handling and on-line sample processing are compared to those of the micro total analysis systems (muTAS), also termed lab-on-a-chip (LOC). This paper illustrates, via selected representative examples, the potentials of the LOV scheme vis-à-vis LOC microdevices for environmental
assays. By means of user-friendly programmable flow and exploitation of the interplay between the thermodynamics and the kinetics of the chemical reactions at will, LOV allows accommodation of reactions which, at least at the present stage, are not feasible by application of microfluidic LOC systems. Thus, in LOV one may take advantage of kinetic discriminations schemes, where even subtle differences in reactions are utilized for analytical purposes. Furthermore, it is also feasible to handle multi-step sequential reactions of divergent kinetics; to conduct multi-parametric determinations without manifold reconfiguration by utilization of the inherent open architecture of the micromachined unit for the implementation of peripheral modules and automated handling of a variety of reagents; and most importantly, it offers itself as a versatile front end to a plethora of detection schemes. Not the least, LOV is regarded as an emerging downscaled tool to overcome the dilemma of LOC microsystems to admit real-life samples. This is nurtured via its intrinsic flexibility for accommodation of sample pre-treatment schemes aimed at the on-line manipulation of complex samples. Thus, LOV is playing a prominent role in the environmental field, whenever the monitoring of trace level concentration of pollutants is pursued, because both matrix isolation and concentration of target analytes is most often imperative, or in fact necessary, prior to sample presentation to the detector.

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Authors: Miró, M. (Intern), Hansen, E. H. (Intern)
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BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.94
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
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Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
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Scopus rating (2012): CiteScore 4.55
ISI indexed (2012): ISI indexed yes
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BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 4.62
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
BFI (2009): BFI-level 1
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Web of Science (2008): Indexed yes
Web of Science (2007): Indexed yes
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Utilizing a sequential injection system furnished with an extraction microcolumn as a novel approach for executing sequential extractions of metal species in solid samples

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Organisations: Department of Chemistry
Authors: Chomchoei, R. (Ekstern), Hansen, E. H. (Intern), Shiowatana, J. (Ekstern)
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.94
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.64
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.74
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Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.55
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 4.62
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Web of Science (2011): Indexed yes
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BFI (2009): BFI-level 1
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Development of Methodologies for Determination of Trace-level Concentrations of Elements by Atomic Spectrometry via On-line Pretreatment Procedures Exploiting Sequential Injection (SI) Lab-on-Valve (LOV) Schemes

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Organisations: Department of Chemistry
Authors: Long, X. (Intern), Hansen, E. H. (Intern)
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Are Flow Injection-based Approaches Suitable for Automated Handling of Solid Samples?
Flow-based approaches were originally conceived for liquid-phase analysis, implying that constituents in solid samples generally had to be transferred into the liquid state, via appropriate batch pretreatment procedures, prior to analysis. Yet, in recent years, much effort has been focused on the design and characterisation of sample processings units coupled with flowing systems aiming to enable the direct introduction and treatment of solid samples of environmental and agricultural origin in an automated fashion [1]. In this respect, various sample pre-treatment techniques including electrolytic or aqueous leaching, on-line dialysis/microdialysis, in-line filtration, and pervaporation-based procedures have been successfully implemented in continuous flow/flow injection systems. In this communication, the new generation of flow analysis, including sequential injection, multicommuted flow, multisyringe flow injection, and micro-Lab-on-valve are presented as appealing approaches for on-line handling of solid samples. Special emphasis is given to the capability of flow systems to accommodate sequential extraction protocols for partitioning of trace elements and nutrients in environmental solids (e.g., soils, sediments, sludges), and thus, ascertaining the potential mobility, bioavailability and eventual impact of anthropogenic elements on biota [2]. In this context, the principles of sequential injection-microcolumn extraction (SI-MCE) for dynamic fractionation are explained in detail along with the potential hyphenation with modern analytical instrumentation for automated monitoring of the content of targeted species in the on-line generated extracts [3,4]. [1] Z.-L. Zhi, A. Ríos, M. Valcárcel, Crit. Rev. Anal. Chem., 26 (1996) 239. [2] M. Míró, E.H. Hansen, R. Chomchoei, W. Frenzel, TRAC-Trends Anal. Chem., 24 (2005) 759. [3] R. Chomchoei, M. Míró, E.H. Hansen, J. Shiowatana, Anal. Chem., 77 (2005) 2720. [4] X.-B. Long, M. Míró, E.H. Hansen, Analyst, 131 (2006) 132.
Determination of Low Level Concentrations of Metals by Means of Sequential Injection (SI) and Lab-on-Valve (LOV) Methodologies

In recent years sequential injection (SI) analysis and Lab-on-Valve (LOV) approaches have proven themselves as powerful and versatile front ends to implement suitable pre-treatment procedures (separation and pre-concentration) for the assay of low concentrations of metals, as amply reflected in the increasing number of papers appearing in the scientific literature. These novel generations of flow injection analysis have demonstrated themselves as attractive substitutes for labour-intensive, manual sample pre-treatment and solution handling methods prior to analyte detection by atomic absorption/emission spectrometric devices such as FAAS, ETAAS, AFS, ICP-AES, and ICP-MS. While earlier separation and pre-concentration schemes of metals in liquid samples primarily have been centred on the use solvent extraction, or precipitate/(co)-precipitate collection in incorporated knotted reactors, or permanent columns packed with suitable materials, the emphasis in this lecture will be on applying solid-phase extraction in the SI/LOV mode. Providing unique characteristics and specific advantages, particularly allowing to take advantage of the so-called renewable approach, where the solid-phase material, if called for, can be replaced for each analytical cycle via the bead-injection concept, a number of examples will be given, comprising both the determination of various metals and also its use for speciation procedures. Recently, these miniaturised methodologies have also been shown to constitute appealing options to handle solid samples of environmental interest as demonstrated by the accommodation of both single and sequential extraction schemes for metal fractionation of solid samples of environmental concern (e.g. soils and sediments) packed within dedicated microcartridges. A brief account of the construction and the experimental modes of operandi of this novel approach for executing metal extraction/fractionation schemes will, to the extent that time allows it, also be given.

Development of a simple extraction cell with bi-directional continuous flow coupled on-line to ICP-MS for assessment of elemental associations in solid samples

A continuous-flow system comprising a novel, custom-built extraction module and hyphenated with inductively coupled plasma-mass spectrometric (ICP-MS) detection is proposed for assessing metal mobilities and geochemical associations in soil compartments as based on using the three step BCR (now the Measurements and Testing Programme of the European Commission) sequential extraction scheme. Employing a peristaltic pump as liquid driver, alternate directional flows of the extractants are used to overcome compression of the solid particles within the extraction unit to ensure a steady partitioning flow rate and thus to maintain constant operationally defined extraction conditions. The proposed flow set-up is proven to allow for trouble-free handling of soil samples up to 1 g and flow rates ≤ 10 mL min⁻¹. The miniaturized extraction system was coupled to ICP-MS through a flow injection interface in order to discretely introduce appropriate extract volumes to the detector at a given time and with a given dilution factor. The proposed hyphenated method demonstrates excellent performance for on-line monitoring of major and trace elements (Ca, Mn, Fe, Ni, Pb, Zn and Cd) released when applying the various extracting reagents as addressed in the BCR scheme, that is, 0.11 M CH₃COOH, 0.1 NH₂OH·HCl and 30% H₂O₂, even when a well recognized matrix-sensitive detector, such as ICP-MS, is used. As a result of the enhanced temporal resolution of the ongoing extraction, insights into the breaking down of phases and into the
kinetics of the metal release are obtained. With the simultaneous multielement detection capability of ICP-MS, the dynamic fractionation system presents itself as an efficient front-end for evaluation of actual elemental association by interelement comparison of metals leached concurrently during the extraction time. Thus, the intimate elemental association between Cd and Zn in contaminated soils could be assessed.

**General information**

State: Published
Organisations: Department of Chemistry, Mahidol University, University of the Balearic Islands
Authors: Buanum, J. (Ekstern), Tiptanasup, K. (Ekstern), Shiowatana, J. (Ekstern), Miró, M. (Ekstern), Hansen, E. H. (Intern)
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- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 1.006 SNIP 0.913 CiteScore 2.5
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 1.051 SNIP 1.054 CiteScore 2.21
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 0.992 SNIP 0.951
- ISI indexed (2013): ISI indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): SJR 1.033 SNIP 0.868
- ISI indexed (2012): ISI indexed yes
- BFI (2011): BFI-level 1
- Scopus rating (2011): SJR 0.954 SNIP 0.902
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 1
- Scopus rating (2010): SJR 0.989 SNIP 0.715
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 1.088 SNIP 0.985
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 0.889 SNIP 0.907
- Scopus rating (2007): SJR 0.777 SNIP 0.895
- Web of Science (2007): Indexed yes
- Scopus rating (2006): SJR 0.743 SNIP 0.819
- Web of Science (2006): Indexed yes
- Scopus rating (2005): SJR 0.741 SNIP 0.888
- Scopus rating (2004): SJR 0.693 SNIP 0.79
- Scopus rating (2003): SJR 0.502 SNIP 0.712
- Scopus rating (2002): SJR 0.495 SNIP 0.816
- Scopus rating (2001): SJR 0.402 SNIP 0.581
Evaluation of degree of readsorption of radionuclides during sequential extraction in soil: comparison between batch and
dynamic extraction systems.

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Authors: Petersen, R. (Intern), Hansen, E. H. (Intern), Hou, X. (Intern)
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Event: Paper presented at Seminar for young scientists in the fields of radiophysics, radiochemistry, radioecology and
radiation protection and related fields, Helsinki, Finland,
Main Research Area: Technical/natural sciences
Source: orbit
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Published: Research - peer-review › Journal article – Annual report year: 2006

FIA - the CD-ROM - Flow injection analysis: CD-ROM tutorial

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BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.437 SNIP 2.322 CiteScore 7.24
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.194 SNIP 2.253 CiteScore 6.54
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.292 SNIP 2.204 CiteScore 6.47
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.346 SNIP 2.057 CiteScore 5.9
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.715 SNIP 2.084 CiteScore 6.52
ISI indexed (2011): ISI indexed yes
Highly selective micro-sequential injection lab-on-valve (μSI-LOV) method for determination of ultra trace concentrations of nickel in saline matrices using detection by electrothermal atomic absorption spectrometry

A highly selective procedure is proposed for the determination of ultra trace level concentrations of nickel in saline aqueous matrices exploiting a micro sequential injection lab-on-valve (μSI-LOV) sample pretreatment protocol comprising bead injection separation/pre-concentration and detection by electrothermal atomic absorption spectrometry (ETAAS).

Based on the dimethylglyoxime (DMG) gravimetric procedure used for nickel analysis, the sample, as contained in pH 9.0 buffer, is, after on-line merging with the chelating reagent, transported to a reaction coil attached to one of the external ports of the LOV to assure sufficient reaction time for the formation of Ni(DMG)₂ chelate. The non-ionic coordination compound is then collected in a renewable micro-column packed with a reversed-phase copolymeric sorbent [namely, poly(divinylbenzene-co-N-vinylpyrrolidone)] containing a balanced ratio of hydrophilic and lipophilic monomers. Following elution by a 50 μL methanol plug in an air-segmented modality, the nickel is finally quantified by ETAAS. Under the optimized conditions and for a sample volume of 1.8 mL, a retention efficiency of 70 % and an enrichment factor of 25 were obtained. The proposed methodology showed high tolerance to the commonly encountered alkaline earth matrix elements in environmental waters, that is, calcium and magnesium, and was successfully applied for the determination of nickel in an NIST standard reference material (NIST 1640-Trace elements in natural water), household tap water of high hardness and local seawater. Satisfying recoveries were achieved for all spiked environmental water samples with maximum deviations of 6%. The experimental results for the standard reference material were not statistically different to the certified value at a significance level of 0.05.
Hyphenating multisyringe flow injection lab-on-valve analysis with atomic fluorescence spectrometry for on-line bead-injection preconcentration and determination of trace levels of hydride-forming elements in environmental samples
In this work, the third generation of flow injection analysis, that is, the so-called micro-Lab-on-Valve (μLOV) approach, is proposed for the first time for the separation, preconcentration and monitoring of metalloids as hyphenated with atomic fluorescence spectrometry (AFS). This was made feasible by interfacing the micromachined LOV-module with AFS by a multisyringe flowing stream network for on-line post column derivatization of the eluate aimed at the generation of hydride species. The potential of this new hyphenated technique for environmental assays was ascertained via the determination of ultratrace level concentrations of total inorganic arsenic in freshwater. Employing quantitative preoxidation of As(III) to As(V) in the samples by means of permanganate, the method involves the preconcentration of arsenate at pH 10 on a renewable anion exchanger, namely Q-Sepharose, packed in a LOV microcolumn. The analyte species is afterwards stripped out and concurrently pre-reduced by a 300 μL eluent plug containing 6 mol L-1 HCl and 10% KI. The eluate is downstream merged with a metered volume of sodium tetrahydroborate (0.3% w/v) for generation of arsine, which is subsequently quantified by AFS. The flow system facilitates on-column reduction of the retained arsenic with no need for application of programmable stopped-flow. Yet, the high concentration of reductant and extreme pH conditions for elution hinder the sorbent to be re-used due to the gradual deactivation of the functional moieties, so that maximum benefit can be taken from the application of the bead renewal strategy. The proposed procedure is characterized by a high tolerance to metal species and interfering hydride forming elements. In fact, ratios of Se(IV) to As ≤ 5000 and Sb(V) to As ≤ 500 are tolerated at the 10% interference level. Under the optimized experimental conditions, a detection limit (3σ) of 0.02 ng mL-1 As, a dynamic linear range of 0.05-2.0 ng mL-1 As (by tailoring the AFS gain), an enrichment factor of 8.8 for arsenate, and a precision better than 6.0% at the 0.1 ng mL-1 level were obtained for the bead-injection mode whenever the loading sample volume was affixed at 3.0 mL. The reliability and accuracy of the automated procedure was ascertained by determining total inorganic arsenic in both spiked environmental waters and certified reference materials of variable matrix complexity (TMDA-54.3 and ERM-CA010) at the low ng mL-1 level. No significant differences were found between the experimental results and the certified values at a significance level of 0.05.
Multisyringe flow injection lab-on-valve systems coupled to hydride generation atomic fluorescence spectrometry for on-line bead-injection preconcentration and determination of total inorganic arsenic in environmental waters

In this work, the third generation of flow injection analysis, that is, the so-called micro-Lab-on-Valve (LOV) approach, is hyphenated for the first time to atomic fluorescence spectrometry (AFS) for the separation, preconcentration and monitoring of hydride forming elements. A multisyringe flowing stream network is assembled for accurate handling of solutions and on-line post column derivatization of the eluate for the generation of the volatile species. The potential of the new hyphenated technique for environmental assays was ascertained via the determination of ultratrace levels of total inorganic arsenic in freshwaters. The method involves the preconcentration of arsenate(V) at pH 10 on a renewable anion exchanger, namely Q-Sepharose, packed in a LOV micro-column. The analyte species is afterwards stripped out, and concurrently pre-reduced, by a 0.25 mL of eluent containing 6 mol L⁻¹ HCl and 10% KI. The eluate merges downstream with a defined plug of sodium tetrahydroborate (0.3% w/v) for generation of arsine, which is subsequently quantified by AFS. An oxidation agent, namely 2x10⁻⁶ M potassium permanganate, was employed for the quantitative oxidation of As(III) to As(V) in the samples before loading into the multisyringe flow system. The flow system facilitates on-column reduction with no need for application of programmable stopped-flow. Yet, the high electrolyte concentrations and extreme pH conditions for elution prevents the sorbent to be re-used, so that maximum benefit can be taken from the application of the bead disposal strategy. The proposed procedure is characterized by a high tolerance to interfering hydride forming elements. In fact, ratios of Se(IV) to As ≤ 5000 and Sb(V) to As ≤ 250 are tolerated at the 10% interference level. Under the optimized experimental conditions, a detection limit (3σ) of 0.02 ng mL⁻¹ and a precision better than 6.0% at the 0.1 g L⁻¹ level were obtained for the bead-injection mode whenever the loading sample volume was affixed at 3.0 mL. The procedure was validated by the determination of arsenic in certified reference materials of variable matrix complexity (TMDA-54.3 and LGC-CA010). No significant differences were found between the experimental results and the certified values at a significance level of 0.05.

General information
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Organisations: Department of Chemistry, Department of Chemistry, University of the Balearic Islands
Authors: Long, X. (Intern), Miró, M. (Ekstern), Hansen, E. H. (Intern), Estela, J. M. (Ekstern), Cerdà, V. (Ekstern)
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Source: orbit
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On-line dynamic extraction and automated determination of readily bioavailable hexavalent chromium in solid substrates using micro-sequential injection bead-injection lab-on-valve hyphenated with electrothermal atomic absorption spectrometry

A novel and miniaturized micro-sequential injection bead injection lab-on-valve (µSI-BI-LOV) fractionation system was developed for in-line microcolumn soil extraction under simulated environmental scenarios and accurate monitoring of the content of easily mobilisable hexavalent chromium in soil environments at the sub-low parts-per-million level. The flow system integrates dynamic leaching of hexavalent chromium using deionized water as recommended by the German Standard DIN 38414-S4 method; on-line pH adjustment of the extract by a 0.01 mol L⁻¹ Tris-HNO₃ buffer solution; isolation of the chromate leached from the matrix constituents onto a Q Sepharose strong anion-exchanger freshly packed
into the microconduits of the μSI-assembly; air-segmented elution of the sorbed species by a 40 μL plug of 0.5 mol L-1 NH4NO3 (pH 8) eluent; and detection by electrothermal atomic absorption spectrometry (ETAAS). The effect of simulated acidic rain on the accessibility of chromate forms for plant uptake was also investigated. The proposed approach offers several advantages over conventional speciation/fractionation protocols in the batch mode, including immediate separation with concomitant preconcentration of the released chromate, minimization of Cr(VI) to Cr(III) interconversion risks, enhanced accuracy, and non-existence of re-adsorption/re-distribution problems along with a detailed pattern of the kinetics of the leaching process. The reliability of the proposed method was evaluated via spiking of a moderately polluted agricultural soil material (San Joaquin Soil-Baseline Trace Element Concentrations) with water-soluble Cr(VI) salts at different concentration levels. The potential of the μSI-BI-LOV set-up with renewable surfaces for flame-AAS determination of high levels of readily bioavailable chromate in contaminated soils is also addressed.

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Scopus rating (2016): CiteScore 3.92
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 4.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 4.1
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.11
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 3.88
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 4.16
ISI indexed (2011): ISI indexed yes
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BFI (2010): BFI-level 1
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Web of Science (2009): Indexed yes
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Web of Science (2001): Indexed yes
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Source: orbit
On-line dynamic fractionation and automatic determination of inorganic phosphorous in environmental solid substrates exploiting sequential injection microcolumn extraction and flow injection analysis

Sequential injection microcolumn extraction (SI-MCE) based on the implementation of a soil containing microcartridge as external reactor in a sequential injection network is, for the first time, proposed for dynamic fractionation of macronutrients in environmental solids, as exemplified by the partitioning of inorganic phosphorous in agricultural soils. The on-line fractionation method capitalises on the accurate metering and sequential exposure of the various extractants to the solid sample by application of programmable flow as precisely coordinated by a syringe pump. Three different soil phase associations for phosphorus, that is, exchangeable, Al- and Fe-bound and Ca-bound fractions, were elucidated by accommodation in the flow manifold of the 3 steps of the Hietjles-Litjkema (HL) scheme involving the use of 1.0 M NH4Cl, 0.1 M NaOH and 0.5 M HCl, respectively, as sequential leaching reagents. The precise timing and versatility of SI for tailoring various operational extraction modes were utilised for investigating the extractability and extent of phosphorous re-distribution for variable partitioning times. Automatic spectrophotometric determination of soluble reactive phosphorous in soil extracts was performed by a flow injection (FI) analyser based on the molybdenum blue (MB) chemistry. The 3σ detection limit was 0.02 mg P L-1 while the linear dynamic range extended up to 20 mg P L-1 regardless of the extracting media. Despite the variable chemical composition of the HL extracts, a single FI set-up was assembled with no need for either manifold re-configuration or modification of chemical composition of reagents. The mobilization of trace elements, such as Cd, often present in grazed pastures as a result of the application of phosphate fertilizers, was also explored in the HL fractions by electrothermal atomic absorption spectrometry.

General information

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Organisations: Department of Chemistry, Mahidol University, University of the Balearic Islands
Authors: Buanum, J. (Ekstern), Miró, M. (Ekstern), Hansen, E. H. (Intern), Shiowatana, J. (Ekstern)
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Scopus rating (2016): CiteScore 5.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.94
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.64
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.74
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.55
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 4.62
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Recent advances and perspectives in analytical methodologies for monitoring the bioavailability of trace metals in environmental solid substrates

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Organisations: Department of Chemistry, University of the Balearic Islands
Authors: Miró, M. (Ekstern), Hansen, E. H. (Intern)
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BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.113 SNIP 1.087 CiteScore 4.46
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.069 SNIP 1.07 CiteScore 3.89
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.992 SNIP 1.035 CiteScore 3.72
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.083 SNIP 1.006 CiteScore 3.52
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.108 SNIP 1.044 CiteScore 3.24
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.913 SNIP 1.025 CiteScore 2.74
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.962 SNIP 0.877
Recent developments in automated determinations of trace level concentrations of elements and on-line fractionations schemes exploiting the micro-sequential injection - lab-on-valve approach

The determination of trace level concentrations of elements, such as metal species, in complex matrices by atomic absorption or emission spectrometric methods often require appropriate pretreatments comprising separation of the analyte from interfering constituents and analyte preconcentration. In this context sequential injection (SI) and lab-on-valve (LOV) schemes have proven themselves as superb vehicles to act as front-end microanalytical methodologies, particularly when employing solid-phase extraction (SPE) procedures. In this communication, selected SPE-procedures in a bead-renewable fashion are presented as based on the exploitation of micro-sequential injection (μSI-LOV) using hydrophobic as well as hydrophilic bead materials. The examples given comprise the presentation of a universal approach for SPE-assays, front-end speciation of Cr(III) and Cr(VI) in a fully automated and enclosed set-up, and the combination of SPE with fractionation schemes of environmentally interesting solid samples (such as soils or sediments) in order to conduct ecotoxicological studies.

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Organisations: Department of Chemistry, University of the Balearic Islands
Authors: Hansen, E. H. (Intern), Mird, M. (Ekstern), Long, X. (Ekstern), Petersen, R. (Ekstern)
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Scopus rating (2016): SJR 0.34 SNIP 0.395 CiteScore 1.17
BFI (2015): BFI-level 1
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BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.372 SNIP 0.488 CiteScore 1.04
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Scopus rating (2016): SJR 2.499 SNIP 2.402 CiteScore 8.09
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.437 SNIP 2.322 CiteScore 7.24
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.194 SNIP 2.253 CiteScore 6.54
Solid reactors in sequential injection analysis: Recent trends in the environmental field
The second generation of flow injection analysis (FIA), so-called sequential injection (SI), has already been consolidated as an attractive flowing-stream approach in several analytical fields, with advantages over the first generation of FIA in terms of automation, miniaturization, and sample/reagent consumption. A further noteworthy feature is the inherent versatility of the flow network to implement unit operations at will with no need for manifold re-configuration. The present review discusses the potential of SI to accommodate solid reactors and packed columns in the flow set-up for environmental applications, aiming to facilitate on-line chemical derivatization, chromatographic separation of target species, removal of interfering matrix compounds, or determination of trace levels of analyte via sorptive preconcentration procedures. In this context, the concept of renewable surfaces, so-called SI-bead injection (SI-BI), used in either the jet-ring or lab-on-valve configurations, is presented as a front-end to many detectors. This article also outlines recent trends focused on exploiting SI as an automated tool for handling solid samples of environmental concern and accommodating dynamic fractionation schemes for trace elements.

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The potentials of the third generation of flow injection analysis for nutrient monitoring and fractionation analysis

In the present communication, the third generation of flow injection analysis, the so-called micro sequential-injection Laboratory-on-Valve (μSI-LOV), is presented as a miniaturized, automated approach for on-line monitoring of nutrients in different environmental compartments as effected under enclosed and strictly controlled conditions. Special emphasis is placed on coupling μSI-LOV on-line with a recently developed microcolumn to perform dynamic fractionation schemes for ascertaining the availability of phosphorous forms in solid substrates for biota uptake under simulated environmental scenarios.

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Organisations: Department of Chemistry, University of the Balearic Islands, Mahidol University
Authors: Miró, M. (Ekstern), Hansen, E. H. (Intern), Buanuam, J. (Ekstern)
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BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.022 SNIP 0.871 CiteScore 2.42
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.032 SNIP 0.888 CiteScore 2.15
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.338 SNIP 0.864 CiteScore 2.51
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.239 SNIP 0.862 CiteScore 2.32
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.13 SNIP 0.781 CiteScore 2.01
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.736 SNIP 0.603
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.795 SNIP 0.615
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.87 SNIP 0.817
Scopus rating (2007): SJR 0.992 SNIP 0.723
Scopus rating (2006): SJR 0.753 SNIP 0.702
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.552 SNIP 0.662
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Publication: Research - peer-review › Journal article – Annual report year: 2006
An automatic micro-sequential injection bead injection lab-on-valve (muSI-BI-LOV) assembly for speciation analysis of ultra trace levels of Cr(III) and Cr(VI) incorporating on-line chemical reduction and employing detection by electrothermal atomic absorption spectrometry (ETAAS)

A novel, miniaturized micro-sequential injection Lab-on-Valve (muSI-LOV) system hyphenated with electrothermal atomic absorption spectrometry (ETAAS) is proposed for the automatic preconcentration and speciation analysis of Cr(III) and Cr(VI) utilizing solid-phase extraction on hydrophilic chelating Sepharose beads in the renewable bead injection (BI) mode. Exploiting on-line reduction of Cr(VI) to Cr(III), the aspirated sample solution is initially divided into two portions, which are treated simultaneously. Thus, while Cr(III) ions are separated from the matrix constituents and preconcentrated on the beads and subsequently eluted by a small volume of eluent (0.1 mol L-1 HNO3) and quantified by ETAAS, the Cr(VI) ions in the second portion are mixed with a reducing agent and parked under stopped-flow conditions in an open tubular reactor attached to one of the peripheral ports of the LOV unit. Following quantification of the native Cr(III) content, the Cr(III) generated from Cr(VI) plus the original Cr(III) are subjected to the same separation/preconcentration/elution procedure. All sample manipulations are controlled automatically by the integrated software. Under optimized chemical and physical conditions, the flow system, by using a total sample loading volume of 3.6 mL, featured retention efficiencies for Cr(III) as high as 86%, and preconcentration factors of 62 and 42 and detection limits (3s) of 0.010 and 0.020 µg L-1 for Cr(III) and Cr(VI), respectively. The relative standard deviations were 4.7 and 4.5% (n=6) at the 0.2 µg L-1 for Cr(III) and Cr(VI), respectively, when employing the microcolumn in a renewable fashion, while permanently used sorbent reactors yielded repeatabilities better than 3.0%. The proposed muSI-BI-LOV analyser was successfully applied to the speciation and determination of trace levels of Cr(III) and Cr(VI) in environmental samples. The method was validated by determination of chromium species in CRM and NIST standard reference materials, and by spike recoveries of surface waters. Statistical comparison of means between experimental results and the total chromium certified values for the CRM and NIST materials revealed the non-existence of significant differences at a 95% confidence level.

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Authors: Long, X. (Ekstern), Miró, M. (Ekstern), Hansen, E. H. (Intern)
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Web of Science (2017): Indexed Yes
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.002 SNIP 1.208 CiteScore 3.19
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.979 SNIP 1.395 CiteScore 3.22
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.064 SNIP 1.233 CiteScore 3.24
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.195 SNIP 1.095 CiteScore 2.99
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.119 SNIP 1.129 CiteScore 3.03
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.393 SNIP 1.202
A Universal Approach for Selective Trace Metal Determinations via Sequential Injection-Bead Injection-Lab-on-Valve (SI-BI-LOV) Using Renewable Reagent-loaded Hydrophobic Beads

A new sample pretreatment approach is presented for selective and sensitive determination of trace metals via electrothermal atomic absorption spectrometry (ETAAS) based on the principle of bead injection (BI) with renewable reagent-loaded hydrophobic beads in a Sequential Injection-Lab-on-Valve (SI-LOV) mode. The methodology uses poly(styrene-divinylbenzene) beads containing pendant octadecyl moieties (C18-PS/DVB), which are pre-impregnated with a selective organic metal chelating agent prior to the automatic manipulation of the beads in the microbore conduits of the LOV unit. By adapting this approach, the immobilization of the most suitable chelating agent can be effected irrespective of the kinetics involved, optimal reaction conditions can be used for implementing the chelating reaction of the target metal analyte with the immobilized reagent, and an added degree of freedom is offered in selecting the most favourable elution mode in order to attain the highest sensitivity. Cr(VI) is used as model analyte to demonstrate the potential of the SI-BI-LOV scheme, in which 1,5-diphenylcarbazide (DPC) is pre-impregnated on the beads, the surface of which serves as the active microzone. It is shown that the bead material can endure very high acidity which is a prerequisite for the reaction. On-line sample pH adjustment prevents alteration of the original distribution of the chromium species, while assuring fast rates for the DPC-Cr(VI) reaction. The proposed procedure was successfully applied for the determination of trace levels of Cr(VI) in natural waters of variable complexity. Furthermore, it was validated by the determination of total chromium in a NIST standard reference material (NIST 1640, natural water) after Cr(III) oxidation.

Automated sequential injection-microcolumn approach with on-line flame atomic absorption spectrometric detection for implementing metal fractionation schemes of homogeneous and non-homogeneous solid samples of environmental interest
An automated sequential injection (SI) system incorporating a dual-conical microcolumn is proposed as a versatile approach for the accommodation of both single and sequential extraction schemes for metal fractionation of solid samples of environmental concern. Coupled to flame atomic absorption spectrometric detection and used for the determination of Cu as a model analyte, the potentials of this novel hyphenated approach are demonstrated by the ability of handling up to 300 mg sample of a nonhomogeneous sewage amended soil (viz., CRM 483). The three steps of the endorsed Standards, Measurements, and Testing sequential extraction method have been also performed in a dynamic fashion and critically compared with the conventional batch-wise protocols. The ecotoxicological relevance of the data provided by both methods with different operationally defined conditions is thoroughly discussed. As compared to traditional batch systems, the developed SI assembly offers minimum risks of sample contamination, absence of metal re-distribution/re-adsorption, and dramatic saving of operational times (from 16 h to 40-80 min per partitioning step). It readily facilitates the accurate manipulation of the extracting reagents into the flow network and the minute, well-defined injection of the desired leachate volume into the detector. Moreover, a highly time-resolved information on the ongoing extraction is given, which is particular relevant for monitoring fast leaching kinetics, such as those involving strong chelating agents. On-line and off-line (for Cu, Pb and Zn) single extraction schemes are also proven to constitute attractive alternatives for fast screening of metal pollution in solid samples, and for predicting the current, rather than the potential, element bioavailability by the assessment of the readily mobilisable metal forms.
Determination of Low Level Concentrations of Metals by Means of Sequential Injection (SI) and Lab-on-Valve (LOV) Methodologies

In recent years sequential injection (SI) analysis and Lab-on-Valve (LOV) approaches have proven themselves as powerful and versatile front ends to implement suitable pre-treatment procedures (separation and pre-concentration) for the assay of low concentrations of metals, as amply reflected in the substantial number of papers that have emerged in the scientific literature. These novel generations of flow injection analysis have demonstrated themselves as attractive substitutes for labour-intensive, manual sample pre-treatment and solution handling methods prior to analyte detection by atomic absorption/emission spectrometry (FAAS, ETAAS, ICP-AES, ICP-MS). The lecture will initially give an overview of various automated alternatives for facilitating appropriate SI/LOV-separation and pre-concentration schemes of metals in liquid samples, including examples of solid-phase extraction with permanent columns or renewable surfaces via the bead-injection concept, solvent extraction-back extraction, and molecular sorption and precipitate/(co)-precipitate collection onto the walls of knotted reactors. Recently, these miniaturised methodologies have also been shown to constitute appealing options to handle solid samples of environmental interest as demonstrated by the accommodation of both single and sequential extraction schemes for metal fractionation of solid samples of environmental concern (e.g. soils and sediments) packed within dedicated microcartridges. An account of the construction and the experimental modes of operandi of this novel approach for executing metal extraction/fractionation schemes will be given, while a detailed discussion of the ecotoxicological relevance of the data thus provided, and set into context with other fractionation methodologies, will be offered in a separate presentation given by the second author.

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Authors: Hansen, E. H. (Intern), Miró, M. (Ekstern), Petersen, R. (Intern)
Publication date: 2005
Determination of trace metal ions via on-line separation and preconcentration by means of chelating Sepharose beads in a sequential injection lab-on-valve (SI-LOV) system coupled to electrothermal atomic absorption spectrometric detection

The analytical performance of an on-line sequential injection lab-on-valve (SI-LOV) system using chelating Sepharose beads as sorbent material for the determination of ultra trace levels of Cd(II), Pb(II) and Ni(II) by electrothermal atomic absorption spectrometry (ETAAS) is described and discussed. The samples are adjusted to pH 5.0 on-line in the system for optimum operation. The target ions are adsorbed by chelation on the surface of the beads, contained in a 20 μl microcolumn within the LOV, and following elution by 50 μl 2M nitric acid, the eluate is, as sandwiched by air segments, introduced into the ETAAS. Based on the consumption of 1.8 ml sample solution, retention efficiencies of 95%, 75% and 90%, enrichment factors of 86, 68 and 81, and determination limits of 0.001, 0.07 and 0.02 μg l⁻¹ were obtained for Cd(II), Pb(II) and Ni(II), respectively. The beads can be used repeatedly for at least 20 times without decrease of performance, yet can be replaced at will if the circumstances should so dictate. The optimized procedural parameters showed that 12 sample h⁻¹ could be prepared and successfully analyzed. The results obtained for three standard reference materials agreed very well with the certified values.

General information
State: Published
Organisations: Department of Chemistry, University of the Balearic Islands
Authors: Long, X. (Ekstern), Hansen, E. H. (Intern), Miró, M. (Ekstern)
Pages: 1326-1332
Publication date: 2005
Main Research Area: Technical/natural sciences

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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.187 SNIP 1.327 CiteScore 3.99
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.201 SNIP 1.296 CiteScore 3.71
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.201 SNIP 1.399 CiteScore 3.74
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.421 SNIP 1.46 CiteScore 3.74
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.429 SNIP 1.518 CiteScore 3.91
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.456 SNIP 1.366
Web of Science (2010): Indexed yes
Does gravitational segregation of ions really exist?

General information
State: Published
Organisations: Department of Chemistry
Authors: Heydorn, K. (Intern), Hansen, E. H. (Intern)
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BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.671 SNIP 1.282 CiteScore 2.68
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.878 SNIP 1.763 CiteScore 2.96
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.885 SNIP 1.419 CiteScore 2.67
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.869 SNIP 1.643 CiteScore 2.68
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Dynamic flow-through approaches for metal fractionation in environmentally relevant solid samples

In the recent decades, batchwise equilibrium-based single or sequential extraction schemes have been consolidated as analytical tools for fractionation analyses to assess the ecotoxicological significance of metal ions in solid environmental samples. However, taking into account that naturally occurring processes always take place under dynamic conditions, recent trends have been focused on the development of alternative methods aimed at mimicking environmental events more correctly than their classical extraction counterparts. The present review details the state-of-the-art and the fundamental principles of automated, miniaturised strategies for on-line metal fractionation studies in solid substrates based on the concepts of stirring chambers, rotating coiled columns and packed microcartridges, mostly exploiting the attractive features of continuous-flow analysis, and of the first and second generations of flow-injection analysis. Special attention is also paid to a novel, robust, non-invasive approach for on-site continuous sampling of soil solutions, capitalizing on flow-through microdialysis, which presents itself as an appealing complementary approach to the conventional lysimeter experiments. In addition, a critical comparison between the time-resolved analytical information provided by these novel dynamic extraction procedures and that of the traditional schemes is given and thoroughly discussed in the bulk of the text.

General information
State: Published
Organisations: Department of Chemistry, University of the Balearic Islands, Technische Universität Berlin, Mahidol University
Authors: Miró, M. (Ekstern), Hansen, E. H. (Intern), Chomchoei, R. (Ekstern), Frenzel, W. (Ekstern)
Pages: 759-771
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Trends in Analytical Chemistry
Volume: 24
Issue number: 8
ISSN (Print): 0165-9936
Dynamic Flow-through Methods for Metal Fractionation in Environmental Solid Samples

Accumulation of metal ions in different compartments of the biosphere and their possible mobilization under changing environmental conditions induce a perturbation of the ecosystem and may cause adverse health effects. Nowadays, it is widely recognized that the information on total content of elements is quite insufficient to estimate their physicochemical mobility, potential bioavailability, and, consequently, toxicity. Within the last two decades, batchwise equilibrium-based...
single or sequential extraction schemes have been consolidated as analytical tools for fractionation analyses to assess the ecotoxicological significance of metal ions in solid environmental samples. The background of end-over-end fractionation for releasing metal species bound to particular soil phases is initially discussed, its relevant features and limitations being thoroughly described. However, taking into account that naturally occurring processes always take place under dynamic conditions, recent trends have been focused on the development of alternative flow-through dynamic methods aimed at mimicking environmental events more correctly than their classical extraction counterparts. In this lecture particular emphasis is paid to the state-of-the-art and fundamental principles of automated, miniaturized strategies for on-line fractionation studies based on the concepts of stirring chambers, rotating coiled columns and packed microcartridges, mostly exploiting the attractive features of the first and second generations of flow injection analysis. Selected examples are given to illustrate the unrivalled features and relevant information provided by these novel on-line approaches, that can be summarized as follows: (1) Monitoring of the kinetics of the ongoing leaching process for evaluation of the actual than potential trace metal availability; (2) Simplification of the overall procedure (from days to hours); (3) Automation of the extraction procedure and detection; (4) Minimization of risks of sample contamination; (5) Easy manipulation of reagents via Sequential Injection schemes; (6) Ability to implement a multitude of operational modes depending upon the kinetics of the targeted phases; and (7) Evaluation of the efficiency of extractants and the maximum pool of available fractions.

**Letter to the Editor: Does gravitational segregation of ions really exist?**

**General information**

State: Published
Organisations: Department of Chemistry
Authors: Heydorn, K. (Intern), Hansen, E. H. (Intern)
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**Publication information**

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- Scopus rating (2015): SJR 0.671 SNIP 1.282 CiteScore 2.68
- BFI (2014): BFI-level 2
- Scopus rating (2014): SJR 0.878 SNIP 1.763 CiteScore 2.96
- BFI (2013): BFI-level 2
- Scopus rating (2013): SJR 0.885 SNIP 1.419 CiteScore 2.67
- ISI indexed (2013): ISI indexed yes
- BFI (2012): BFI-level 2
- Scopus rating (2012): SJR 0.869 SNIP 1.643 CiteScore 2.68
- ISI indexed (2012): ISI indexed yes
- BFI (2011): BFI-level 2
- Scopus rating (2011): SJR 0.76 SNIP 1.342 CiteScore 2.27
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 2
Miniaturisation and automation of metal fractionation schemes applied to environmental solid samples by sequential injection microcolumn extraction procedures

General information
State: Published
Organisations: Department of Chemistry, University of the Balearic Islands
Authors: Miró, M. (Ekstern), Hansen, E. H. (Intern)
Pages: 878-880
Publication date: 2005
Main Research Area: Technical/natural sciences

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Journal: Analytical and Bioanalytical Chemistry
Volume: 382
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ISSN (Print): 1618-2642
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.943 SNIP 1.039 CiteScore 3.03
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.064 SNIP 1.083 CiteScore 3.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.126 SNIP 1.222 CiteScore 3.26
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.229 SNIP 1.282 CiteScore 3.55
ISI indexed (2013): ISI indexed yes
Sequential injection system incorporating a micro extraction column for automatic fractionation of metal ions in solid samples: Comparison of the extraction profiles when employing uni-, bi-, and multi-bi-directional flow plus stopped-flow sequential extraction modes

Recently a novel approach to perform sequential extractions (SE) of elements in solid samples was developed by this group, based upon the use of a sequential injection (SI) system incorporating a specially designed extraction microcolumn. Entailing a number of distinct advantages as compared to conventional batch methods, this fully automated approach furthermore offers the potentials of a variety of operational extraction protocols. Employing the three-step sequential extraction BCR scheme to a certified homogeneous soil reference material (NIST, SRM 2710), this communication investigates four operating modes, namely uni, bi- and multi bi-directional flow and stopped-flow, allowing comparison of the metal fractionation profiles. Apart from demonstrating the versatility of the novel approach, the data obtained on the metal distribution in the various soil phases might offer valuable information as to the kinetics of the leaching processes and chemical associations in different soil geological phases. Special attention is also paid to the potentials of the microcolumn flowing technique for automatic processing of solid materials with variable homogeneity, as demonstrated with the sewage amended CRM483 soil which exhibits inhomogeneity in the particle size distribution.

General information
State: Published
Organisations: Department of Chemistry, Mahidol University, University of the Balearic Islands
Authors: Chomchoei, R. (Ekstern), Miró, M. (Ekstern), Hansen, E. H. (Intern), Shiowatana, J. (Ekstern)
Pages: 183-190
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Analytica Chimica Acta
Volume: 536
Trends and perspectives of flow injection/sequential injection on-line sample-pretreatment schemes coupled to ETAAS

Flow injection (FI) analysis, the first generation of this technique, became in the 1990s supplemented by its second
generation, sequential injection (SI), and most recently by the third generation (i.e., Lab-on-Valve). The dominant role
played by FI in automatic, on-line, sample pretreatments in recent decades is amply demonstrated by the large number of
publications to which it has given rise. Among these, its hyphenation with electrothermal atomic absorption spectrometry
(ETAAS) is one of the most attractive sub-branches because of the high sensitivity of ETAAS instruments for metal
species. After a decade of development, it is apparent from the literatures that the topic of coupling FI sample
pretreatments with ETAAS remains most dynamic in the new millennium; meanwhile, it is exciting to note that some novel
trends associated with this subject have also have emerged. The aim of this mini-review is thus to illustrate the state-of-
the-art progress in implementing miniaturised FI/Sl systems for on-line separation and preconcentration of trace metals
with detection by ETAAS since 2000. We also discuss future perspectives in this field.

General information
Universal approach for selective trace metal determinations via sequential injection-bead injection-lab-on-valve using renewable hydrophobic bead surfaces as reagent carriers

A new concept is presented for selective and sensitive determination of trace metals via electrothermal atomic absorption spectrometry (ETAAS) based on the principle of bead injection (BI) with renewable reversed-phase surfaces in a sequential injection-lab-on-valve (SI-LOV) mode. The methodology involves the use of poly(styrene-divinylbenzene) beads containing pendant octadecyl moieties (C18-PS/DVB), which are preimpregnated with a selective organic metal chelating agent prior to the automatic manipulation of the beads in the microbore conduits of the LOV unit. By adapting this approach, the immobilization of the most suitable chelating agent can be effected irrespective of the kinetics involved, optimal reaction conditions can be used for implementing the chelating reaction of the target metal analyte with the immobilized reagent, and an added degree of freedom is offered in selecting the most favourable elution mode in order to attain the highest sensitivity. The potential of the SI-BI-LOV scheme is demonstrated by taking Cr(VI) as a model analyte, using a 1,5-diphenylcarbazide (DPC)-loaded bead column as the active microzone. As this reaction requires the use of high acidity, it is also shown that the bead material exhibits excellent chemical stability at low pH values. On-line pH sample adjustment prevents alteration of the original distribution of chromium species while assuring fast rates for the DPC-Cr(VI) reaction. The proposed procedure was successfully applied to the determination of trace levels of Cr(VI) in natural waters containing high levels of dissolved salts (such as seawater and hard tap water) without requiring any dilution step. Method validation was performed by determination of total chromium in an NIST standard reference material (NIST 1640, natural water) after Cr(III) oxidation, and the results were in good agreement with the certified value.

General information
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Organisations: Department of Chemistry, University of the Balearic Islands
Authors: Long, X. (Ekstern), Miró, M. (Ekstern), Hansen, E. H. (Intern)
Pages: 6032-6040
Publication date: 2005
Main Research Area: Technical/natural sciences

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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 6
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 5.79
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 6.01
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 5.8
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 5.86
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Use of flow injection and sequential injection analysis schemes for the determination of trace-level concentrations of metals in complex matrices by ETAAS and ICPMS

Despite their excellent analytical chemical capacities for determination of low levels of metal species, electrothermal atomic absorption spectrometry and inductively coupled plasma mass spectrometry often require suitable pretreatment (separation and preconcentration) of the sample material to facilitate the desired sensitivity and selectivity of measurement. Such pretreatment schemes are advantageously performed in flow injection (FI) or sequential injection (SI) manifolds, where all unit operations can be effected on-line and under enclosed and strictly controlled conditions. Various separation/preconcentration procedures are feasible, such as liquid-liquid extraction (possibly including back extraction), (co)precipitation with collection in knotted coils, adsorption on hydrophilic or hydrophobic reactors, hydride generation, or the use of ion exchange/chelating packed columns. After describing the particulars and characteristics of FI and SI, we present, via selected examples, various separation/preconcentration FI/SI schemes for the determination of trace levels of metals, with particular emphasis on the use of the novel extension of FI/SI, that is, the so-called lab-on-valve concept.

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Pages: 1507-1524
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Conference: 2nd Asian International Conference on Ecotoxicology and Environmental Safety, Song-Khla, THAILAND, 01/01/2004
Main Research Area: Technical/natural sciences

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Scopus rating (2016): SJR 0.511 SNIP 0.649 CiteScore 1.52
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BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.513 SNIP 0.677 CiteScore 1.34
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.546 SNIP 0.657 CiteScore 1.23
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.52 SNIP 0.605 CiteScore 1.2
Evaluation of a novel PTFE material for separation and preconcentration of trace levels of metal ions in sequential injection (SI) and sequential injection lab-on-valve (SI-LOV) systems interfaced with detection by ETAAS

The operational characteristics of a novel PTFE bead material, granular Algoflon®, used for separation and preconcentration of metal ions via adsorption of on-line generated non-charged metal complexes, were evaluated in a sequential injection (SI) system furnished with an external packed column and in a sequential injection lab-on-valve (SI-LOV) system. Employed for the determination of cadmium(II), complexed with diethyldithiophosphate (DDPA), and detection by electrothermal atomic absorption spectrometry (ETAAS), its performance was compared to that of a previously used material, Aldrich PTFE, which had demonstrated that PTFE was the most promising for solid-state pretreatments. By comparing the two materials, the Algoflon® beads exhibited much higher sensitivity (1.6107 versus 0.2956 μg l⁻¹ per integrated absorbance (s)), and better retention efficiency (82% versus 74%) and enrichment factor (20.8 versus 17.2), although a slightly smaller linear dynamic range (0.05-0.25 μg l⁻¹ versus 0.05-1.00 μg l⁻¹). Moreover, no flow resistance was encountered under the experimental conditions used. The results obtained on three standard reference materials were in good agreement with the certified values.
Evaluation of a novel PTFE material for use as a means for separation and preconcentration of trace levels of metal ions in sequential injection (SI) and sequential injection lab-on-valve (SI-LOV) systems. Determination of cadmium (II) with detection by electrothermal atomic absorption spectrometry (ETAAS)

The operational characteristics of a novel poly(tetrafluoroethylene) (PTFE) bead material, granular Algoflon®, used for separation and preconcentration of metal ions via adsorption of on-line generated non-charged metal complexes, were evaluated in a sequential injection (SI) system furnished with an external packed column and in a sequential injection lab-on-valve (SI-LOV) system. Employed for the determination of cadmium(II), complexed with diethyldithiophosphate (DDPA), and detection by electrothermal atomic absorption spectrometry (ETAAS), its performance was compared to that of a previously used material, Aldrich PTFE, which had demonstrated that PTFE was the most promising for solid-state pretreatments. By comparing the two materials, the Algoflon® beads exhibited much higher sensitivity (1.6107 versus 0.2956 μg l-1 per integrated absorbance (s)), and better retention efficiency (82% versus 74%) and enrichment factor (20.8 versus 17.2), although a slightly smaller linear dynamic range (0.05-0.25 μg l-1 versus 0.05-1.00 μg l-1). Moreover, no flow resistance was encountered under the experimental conditions used. The results obtained on three standard reference materials were in good agreement with the certified values.
Flow Injection Analysis

This chapter provides an introduction to automated chemical analysis, which essentially can be divided into two groups: batch assays, where the solution is stationary while the container is moved through a number of stations where various unit operations performed; and continuous-flow procedures, where the system is stationary while the solution moves through a set of conduits in which all required manipulations are performed. Emphasis is placed on flow injection analysis (FIA) and its further developments, that is, sequential injection analysis (SIA) and the Lab-on-Valve (LOV) approach. Since FIA is based on the creation of a concentration gradient of the injected sample solution and on reproducible and precise timing of all events, it allows exploitation of a transient read-out. This in turn implies that not only does FIA allow the augmentation of existing analytical techniques, but it permits the execution of novel and unique analytical procedures which are difficult or even impossible by conventional means. The performance and applicability of FIA, SIA and LOV are illustrated by a series of practical examples.

Flow Injection/Sequential Injection Analysis

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Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Pages: 1001-1022
Publication date: 2004

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Chapter: 31
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 136007
Publication: Research - peer-review › Book chapter – Annual report year: 2004
Separation and preconcentration of trace amounts of Cd(II) with sequential injection analysis AAS

General information
State: Published
Organisations: Department of Chemistry, Poznan University of Technology, Mahidol University
Authors: Gała, P. (Ekstern), Long, X. (Ekstern), Chomchoei, R. (Ekstern), Hansen, E. H. (Intern)
Publication date: 2004
Event: Poster session presented at Modern Methods of Sample Preparation and Determination of Trace Elements, Poznan, Poland.
Main Research Area: Technical/natural sciences

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Source: orbit
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Publication: Research - peer-review › Poster – Annual report year: 2004

Separation and preconcentration of ultratrace levels of cadmium(II) in a sequential injection (SI) system with a PTFE packed column as a mimic sequential injection lab-on-valve (SI-LOV) system with renewable column employing detection by electrothermal atomic absorption spectrometry (ETAAS)

A sequential injection (SI) on-line separation and preconcentration system furnished with an external column packed with PTFE beads, serving as a mimic renewable microcolumn used in a sequential injection lab-on-valve (SI-LOV) system, was investigated for the determination of ultratrace levels of cadmium(II) by detection with electrothermal atomic absorption spectrometry (ETAAS). The non-charged complex formed between the analyste and the chelating reagent diethyldithiophosphate (DDPA) was selectively adsorbed on the surface of the PTFE beads and eluted by ethanol before being directed to the ETAAS. Two kinds of sorbents were investigated, that is, granular Algoflon® PTFE and Aldrich PTFE. A mimic external packed column was employed since difficulties of aspirating and discarding beads plus a high background signal were encountered in the renewable microcolumn SI-LOV system. As compared with the Aldrich PTFE material, the Algoflon® beads exhibited much higher sensitivity (1.6107 versus 0.2956 μg l⁻¹ per integrated absorbance (s)), and better retention efficiency (82% versus 74%) and enrichment factor (20.8 versus 17.2), although a slightly smaller linear dynamic range (0.05-0.25 μg l⁻¹ versus 0.05-1.00 μg l⁻¹). Moreover, no flow resistance was encountered under the experimental conditions used. The results obtained on three standard reference materials were in good agreement with the certified values.

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Organisations: Department of Chemistry, Mahidol University, Poznan University of Technology
Authors: Long, X. (Ekstern), Chomchoei, R. (Ekstern), Gała, P. (Ekstern), Hansen, E. H. (Intern)
Publication date: 2004
Main Research Area: Technical/natural sciences
Source: orbit
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Publication: Research - peer-review › Poster – Annual report year: 2004

The impact of flow injection on modern chemical analysis: has it fulfilled our expectations? And where are we going?

Presenting a condensation of the opening lecture of the 12th ICFIA conference, this communication presents a view of the impact that flow injection analysis (FIA) has had on modern analytical chemistry, evaluated both within the academic community and outside it, i.e., in "industry". The ensuing developments of FIA, encompassing sequential injection analysis (SIA) and bead injection lab-on-valve (BI-LOV), are described and their individual features discussed. Finally some recent results of the activities from the author's own research group are briefly mentioned.

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Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Pages: 1076-1083
Publication date: 2004
Conference: International Conference on Flow Injection Analysis, Including Related Techniques, Merida, Venezuela, 01/01/2003
Main Research Area: Technical/natural sciences

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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.187 SNIP 1.327 CiteScore 3.99
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.201 SNIP 1.296 CiteScore 3.71
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.201 SNIP 1.399 CiteScore 3.74
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.421 SNIP 1.46 CiteScore 3.74
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.429 SNIP 1.518 CiteScore 3.91
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.456 SNIP 1.366
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.319 SNIP 1.338
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2007): SJR 1.428 SNIP 1.506
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.305 SNIP 1.377
Scopus rating (2005): SJR 1.113 SNIP 1.453
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.173 SNIP 1.523
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.987 SNIP 1.353
Scopus rating (2002): SJR 0.998 SNIP 1.278
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.939 SNIP 1.18
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.964 SNIP 1.22
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.932 SNIP 1.116
Original language: English
DOIs:
The Impact of Flow Injection on Modern Chemical Analysis
There is no doubt that Flow Injection Analysis (FIA) has had a profound impact on the ways and means that modern analytical chemical procedures are performed. This is amply reflected in the voluminous scientific literature, which by the middle of 2004 passed more than 14,500 FIA-publications in international periodicals, to which should be added a couple of dozens monographs plus several hundreds Ph.D. theses. This wealth of publication activity clearly reflects that not only has FIA given birth to numerous ingenious methods and novel applications, but quite a few of them have, in fact, allowed to implement procedures which previously were difficult or, actually, impossible to execute by conventional means. Clever examples are exploitation of bio-or chemiluminescence, methods relying on kinetic discrimination schemes, assay of metastable constituents, or the use of on-line separation and preconcentration procedures. In recent years, FIA has been supplemented by Sequential Injection Analysis (SIA) and the Lab-on-Valve (LOV) approach. Following a brief historic introduction and an account of the impact of FIA in academia, the lecture will describe these two new generations of FIA, accompanied by selected examples, emphasis being placed on the determination of trace-level concentrations of metal ions in complex matrices with detection by ETAAS and ICP-MS.

The Three Generations of Flow Injection Analysis
The characteristics of the three generations of flow injection analysis, that is, FIA, sequential injection analysis (SIA), and bead injection-lab-on-valve (BI-LOV), are briefly outlined, their individual advantages and shortcomings are discussed, and selected practical applications are presented.

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern), Wang, J. (Intern)
Publication date: 2004
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Tre generationer af Flow Injection Analysis

General information
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Authors: Hansen, E. H. (Intern), Chomchoei, R. (Ekstern), Long, X. (Ekstern)
Pages: 58-63
Publication date: 2004
Main Research Area: Technical/natural sciences

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Volume: 85
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Web of Science (2007): Indexed yes
Web of Science (2004): Indexed yes
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Source: orbit
Source-ID: 136008
Utilizing a sequential injection system furnished with an extraction microcolumn as a novel approach for executing sequential extractions of metal species in solid samples

This communication presents a novel approach to perform sequential extraction of elements in solid samples by using a sequential injection (SI) system incorporating a specially designed extraction microcolumn. Based on the operation of the syringe pump, different modes of extraction are potentially feasible, uni-directional and bi-directional flow schemes being used herein. A three-step sequential extraction scheme, using conventionally adopted extractants, was used to evaluate the system by determining Ca, Fe, Mn, Cu, Zn in a soil certified reference material (NiST, SRM 2710). It is demonstrated that the system entails many advantages such as being fully automated, and besides being characterised by rapidity, ease of operation and robustness, it is less prone to risks of contamination and personal errors as encountered in traditional batch systems. Moreover, improvement of the precision and accuracy of the chemical fractionation of metal in solids as compared with previous reports are obtained. The system ensures that extraction is performed at designated pH values. Variation of sample weight to column volume ratios do not affect the amounts of extractable metals, nor do extraction flow rates ranging from 50 to 100 ml sec⁻¹ show any effect on the extractability of the metals studied. With uni-directional and bi-directional flows the extractable amounts of metals are, with the exception of Mn, not different from those obtained in conventional procedures, but the saving in operation time is drastic (a few hours as compared to days).

General information
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Organisations: Department of Chemistry, Mahidol University
Authors: Chomchoei, R. (Ekstern), Hansen, E. H. (Intern), Shiwatana, J. (Ekstern)
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.94
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.64
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.74
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.55
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 4.62
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
BFI (2009): BFI-level 1
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Web of Science (2008): Indexed yes
Web of Science (2007): Indexed yes
Exploiting the bead-injection approach in the integrated sequential injection Lab-on-Valve format using hydrophobic packing materials for on-line matrix removal and preconcentration of trace levels of cadmium in environmental and biological samples via formation of non-charged chelates prior to ETAAS detection

The concept of renewable microcolumns within the conduits of an automated single injection lab-on-valve system was exploited in a sorption/elution fashion using sorbents of hydrophobic nature. The scheme's practical applicability was demonstrated for the electrothermal atomic absorption spectrometry determination of trace level concentrations of cadmium in complex matrices. Statistical comparisons between the proposed procedure and certified values revealed no significant differences at the 95% confidence level.

General information
State: Published
Organisations: Department of Chemistry
Authors: Miró, M. (Ekstern), Jonczyk, S. (Ekstern), Wang, J. (Intern), Hansen, E. H. (Intern)
Pages: 89-98
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Main Research Area: Technical/natural sciences

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BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.009 SNIP 1.18 CiteScore 3.3
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.002 SNIP 1.208 CiteScore 3.19
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.979 SNIP 1.395 CiteScore 3.22
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.064 SNIP 1.233 CiteScore 3.24
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.195 SNIP 1.095 CiteScore 2.99
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.119 SNIP 1.129 CiteScore 3.03
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Exploiting the Lab-on-Valve Concept for Determination of Trace Levels of Metals in Complex Matrices with Detection by ETAAS and ICPMS

Termed the third generation of flow injection analysis, the Sequential Injection (SI)-Lab-on-Valve (LOV) concept has proven to entail specific advantages and to allow novel and unique applications. Both in term of its use in the automation and micro-miniatuerization of suitable on-line sample pretreatments such as separation of the analyte from potentially interfering matrix constituents and preconcentration in order to bring the concentration of the analyte into the dynamic measuring range of the detection device applied, and also as a versatile front end to a variety of detection techniques. Following a brief introduction into the characteristics of the SI-LOV approach, special emphasis is placed on its utilisation in conjunction with the bead injection scheme for on-line separation and preconcentration of ultra-trace levels of metals in complex matrices by exploiting the renewable microcolumn approach [1,2]. Coupled to detection by ETAAS and ICPMS, and illustrated by recent exploits in the authors’ laboratory, it is shown that this methodology eliminates the problems encountered in conventional on-line column preconcentration systems and at the same time improves the overall operational efficiency and yields the robustness necessary for use in routine assays. References 1. J.-H. Wang, E. H. Hansen, J. Anal. At. Spectrom., 16 (2001) 1349. 2. J.-H. Wang, E. H. Hansen, Anal. Chim. Acta, 467 (2002) 3.

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern), Wang, J. (Intern)
Publication date: 2003
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 43018
Publication: Research - peer-review › Journal article – Annual report year: 2003

Flow Injection Analysis. How it was conceived, developed and succeeded - despite all odds

General information
State: Published
Flow injection and sequential injection: The optimal solutions for executing appropriate on-line separation and preconcentration schemes for detection of trace-level concentrations of metals in complex matrices by ICPMS

Despite its excellent analytical chemical capacity, ICPMS (and also ETAAS), nevertheless, often requires suitable pretreatment of the sample material to facilitate the desired sensitivity and selectivity of measurement. Either because of the presence of potentially interfering matrix constituents, or because the analyte material, in addition to suitable separations, needs to be subjected to preconcentration. Such pretreatments schemes are advantageously performed in flow injection (FI) or sequential injection (SI) manifolds, where all unit operations can be effected on-line and under enclosed and strictly controlled conditions. Various separation/preconcentration procedures are feasible, such as liquid-liquid extraction encompassing back-extraction into an aqueous solution, (co)precipitation with collection in knotted reactors, adsorption on columns packed with hydrophophilic or hydrophobic materials, hydride generation, or the use of ion-exchanger packed reactors. Apart from hydride generation, where the analyte is converted into a gaseous species, the common denominator for these approaches is that the analyte material finally is contained within a well-defined small volume of eluate, which then is introduced into the analytical instrument. While the graphite tube of the ETAAS can accommodate merely up to 50 l of solution, yet might tolerate organic but preferably should be subjected to inorganic eluates, the ICPMS has potentially a larger volumetric capacity yet cannot accept organic solvents as these adversely will impair its performance. In the lecture, selected examples of separation/preconcentration FI/SI-procedures for the determination of trace levels of metals will be presented, particular emphasis being placed on the use of the novel “lab-on-valve” (LOV) concept.

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State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
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Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 43082
Publication: Research - Annual report year: 2003

Lab-on-Valve Micro Sequential Injection: A Versatile Approach for Implementing Integrated Sample Pre-preparations and Executing (Bio)Chemical Assays

In the last decade, Flow Injection Analysis (FIA) became supplemented by Sequential Injection Analysis (SIA), which, although it inherently entails some limitations as compared to FIA, offers specific advantages, notably in terms of significantly reduced sample and reagent(s) consumption and hence waste generation. Most recently, the Lab-on-Valve (LOV) approach has emerged. Termed the third generation of FIA, the conceptual basis of the LOV is to incorporate all the necessary unit operational manipulations required in a chemical assay, and, when possible, even the detection device, into a single small integrated microconduit, or “laboratory”, placed atop a selection valve. In the lecture emphasis will be placed on the LOV approach. Proven itself as a versatile front end to a variety of detection techniques, its utility will be exemplified by various applications. Particular focus will be directed towards its use as a vehicle for on-line pretreatment of complex sample matrices for determination of trace-level concentrations of metal ions by electrothermal atomic absorption spectrometry (ETAAS) and inductively coupled plasma mass spectrometry (ICPMS) via exploitation of the renewable solid-phase microcolumn concept utilising hydrophobic as well as hydrophilic bead materials. Although ETAAS and ICPMS both are characterised by excellent analytical chemical capabilities, they nevertheless often require that the samples be subjected to suitable pretreatment in order to obtain the necessary sensitivity and selectivity. Either in order to separate the analyte from potentially interfering matrix constituents, or to preconcentrate the analyte material to bring it into the dynamic range of the detector. As will be shown, such pretreatments are advantageously performed in FIA/SIA/LOV manifolds, where all appropriate unit operations can be effected under enclosed and strictly controlled conditions.

General information
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Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Publication date: 2003
On-line sample-pre-treatment schemes for trace-level determinations of metals by coupling flow injection or sequential injection with ICP-MS

Within the last decade, the first generation of flow injection (FI) has been supplemented by sequential injection (SI), also termed the second generation, and, recently, by the third generation, i.e., SI-Lab-on-Valve (SI-LOV). As apparent from the literature, FI and/or SI have become dominant as substitutes for labor-intensive, manual, sample-pre-treatment and/or solution-handling procedures prior to analyte detection by inductively coupled plasma mass spectrometry (ICP-MS). The present review presents and discusses the progress of the state of the art in implementing miniaturized FI/SI systems for on-line matrix separation and pre-concentration of trace levels of metals with detection by ICP-MS. It highlights some of the frequently applied on-line, sample-pre-treatment schemes, including solid phase extraction (SPE), on-wall molecular sorption and precipitate/(co)-precipitate retention using a polytetrafluoroethylene (PTFE) knotted reactor (KR), solvent extraction-back extraction and hydride/vapor generation. It also addresses a novel, robust approach, whereby the protocol of SI-LOV-bead injection (BI) on-line separation and pre-concentration of ultra-trace levels of metals by a renewable microcolumn is interfaced to ICP-MS, as conducted in the present authors’ group. It discusses the future outlook in this field.
Sequential injection/bead injection lab-on-valve schemes for on-line solid phase extraction and preconcentration of ultra-trace levels of heavy metals with determination by ETAAS and ICPMS

This communication presents an overview of the state-of-the-art of the exploitation of sequential injection (SI)-bead injection (BI)-lab-on-valve (LOV) schemes for automatic on-line sample pre-treatments interfaced with ETAAS and ICPMS detection as conducted in the authors' group. The discussions are focused on the applications of SI-BI-LOV protocols for on-line microcolumn based solid phase extraction of ultra-trace levels of heavy metals, employing the so-called renewable surface separation and preconcentration manipulatory scheme. Two types of sorbents have been employed as packing material, that is, the hydrophilic SP Sephadex C-25 cation exchange and iminodiacetate based Muromac A-1 chelating resins, and the hydrophobic poly(tetrafluoroethylene) (PTFE) and poly(styrene-divinylbenzene) copolymer alkylated with octadecyl groups (C18-PS/DVB). Using ETAAS as detection device, the easy-to-handle hydrophilic renewable reactors hold the features of improved R.S.D.s and LODs as compared to those operated in the conventional, permanent mode, in addition to the elimination of flow resistance. The hydrophobic columns fall into two categories, that is, the renewable one packed with C18-PS/DVB beads entails analogous R.S.D.s and LODs with respect to the conventional approach, while those with PTFE beads result in slightly inferior R.S.D.s and LODs by similar comparison, yet offering a wider dynamic range than when using an external permanent column. Moreover, the hydrophilic materials result in much higher enrichment of the analyte than the hydrophobic ones, although PTFE is the packing material that exhibits the best retention efficiency.
Sequential injection lab-on-valve: the third generation of flow injection analysis

Termed the third generation of flow injection analysis, sequential injection (SI)-lab-on-valve (LOV) has specific advantages and allows novel, unique applications - not least as a versatile front end to a variety of detection techniques. This review presents and discusses progress to date of the SI-LOV approach as well as its applications in the automation and miniaturization of on-line sample pre-treatment. Special emphasis is placed on using SI-LOV in conjunction with bead injection (BI) for on-line separation and pre-concentration of ultra-trace levels of metals by exploiting the renewable micro-column approach. With detection by ETAAS and ICP-MS, it is shown, as illustrated by recent results in the authors’ laboratory, that this methodology eliminates the problems encountered in conventional on-line column pre-concentration systems, improves the overall operational efficiency and yields the robustness necessary for routine assays. Also discussed is the future potential of the SI-LOV approach as a front end to various analytical protocols.

General information
State: Published
Organisations: Department of Chemistry
Authors: Wang, J. (Intern), Hansen, E. H. (Intern)
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Main Research Area: Technical/natural sciences

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General information
State: Published
Coupling sequential injection on-line preconcentration using a PTFE beads packed column to direct injection nebulization inductively coupled plasma mass spectrometry

An automated sequential injection on-line preconcentration procedure for trace metals by using a PTFE bead-packed microcolumn coupled to ICP-MS is described, and used for simultaneous analyses of cadmium and lead. In dilute nitric acid (0.5%, v/v), neutral complexes between the analytes and chelating reagent, diethyldithiophosphate (DDPA), are formed and adsorbed onto the surface of the PTFE beads. The adsorbed complexes are afterwards eluted with 20% nitric acid and the leading part of the eluate (40 μl) is stored in a sample loop (SL), the contents of which are subsequently transported, via a direct injection high efficiency nebulizer (DIHEN), into the ICP-MS for quantification. The packed column (PC) generates considerably lower hydrodynamic impedance than other commonly used sorbent columns, while its preconcentration efficiencies, in terms of retention efficiency and enrichment factor, are significantly improved as compared to a knotted reactor (KR). Inherently, the column approach results in low blank values and consequently in low limits of detection (LODs). With a 40 s sample loading time at 4.5 ml/min, along with a sampling frequency of 18 s/h, the retention efficiencies/enrichment factors for cadmium and lead were 96%/72 and 104%/81, respectively, versus 45%/34 and 54%/41 for a knotted reactor with similar internal surface area. In addition, the limits of detection (LODs) and precisions were at the same levels, i.e., the LODs were 2.9 ng/l Cd (PC), 3.5 ng/l Cd (KR), 6.0 ng/l Pb (PC) and 4.7 ng/l
Pb (KR), while the RSDs were 1.9% (Cd, PC), 2.7% (Cd, KR), 2.2% (Pb, PC) and 2.5% (Pb, KR). The procedure was validated by determination of trace cadmium and lead in certified reference materials and urine samples.

**General information**

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Organisations: Department of Chemistry
Authors: Wang, J. (Intern), Hansen, E. H. (Intern)
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Main Research Area: Technical/natural sciences

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BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.009 SNIP 1.18 CiteScore 3.3
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.002 SNIP 1.208 CiteScore 3.19
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.979 SNIP 1.395 CiteScore 3.22
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.064 SNIP 1.233 CiteScore 3.24
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.195 SNIP 1.095 CiteScore 2.99
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.119 SNIP 1.129 CiteScore 3.03
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.393 SNIP 1.202
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.106 SNIP 1.093
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.209 SNIP 1.083
Scopus rating (2007): SJR 1.255 SNIP 1.143
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.369 SNIP 1.031
Scopus rating (2005): SJR 1.353 SNIP 1.15
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.701 SNIP 1.254
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.424 SNIP 1.261
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.993 SNIP 1.307
Web of Science (2002): Indexed yes
Development of an automated sequential injection on-line solvent extraction-back extraction procedure as demonstrated for the determination of cadmium with detection by electrothermal atomic absorption spectrometry

An automated sequential injection (SI) on-line solvent extraction-back extraction separation/preconcentration procedure is described. Demonstrated for the assay of cadmium by electrothermal atomic absorption spectrometry (ETAAS), the analyte is initially complexed with ammonium pyrrolidinedithiocarbamate (APDC) in citrate buffer and the chelate is extracted into isobutyl methyl ketone (IBMK), which is separated from the aqueous phase by means of a newly designed dual-conical gravitational phase separator. A metered amount of the organic eluate is aspirated and stored in the PTFE holding coil (HC) of the SI-system. Afterwards, it is dispensed and mixed with an aqueous back extractant of dilute nitric acid containing Hg(II) ions as stripping agent, thereby facilitating a rapid metal-exchange reaction with the APDC ligand and transfer of the Cd into the aqueous phase. The aqueous phase is separated in a second dual-conical gravitational phase separator, and 30μl of it is entrapped and metered in a sample loop (SL) and subsequently introduced via air segmentation into the graphite tube for analyte quantification. The ETAAS determination is performed in parallel with the separation/preconcentration process of the ensuing sample. An enrichment factor of 21.4, a detection limit of 2.7 ng/l, along with a sampling frequency of 13s/h were obtained at a sample flow rate of 6.0ml/min. The precision (R.S.D.) at the 0.4 μg/l level was 1.8% as compared to 3.2% when quantifying the organic extractant directly. The applicability of the procedure is demonstrated for the determination of trace levels of cadmium in three certified reference materials.

General information

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Authors: Wang, J. (Intern), Hansen, E. H. (Intern)
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BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.94
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.64
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.74
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.55
ISI indexed (2012): ISI indexed yes
Exploiting Sequential Injection on-line Solvent Extraction/Back Extraction with Detection by ETAAS or ICPMS

Electrothermal atomic absorption spectrometry (ETAAS) and inductively coupled plasma mass spectrometry (ICPMS) are highly sensitive techniques for trace metal analyses. Nevertheless, separation/preconcentration procedures are often called for in order to overcome their inherent low matrix tolerances. With detection by ETAAS, separation/preconcentration by solvent extraction has enjoyed much use. However, this approach is not necessarily the optimal one since introduction of organic eluates directly into the graphite tube might lead to deteriorated reproducibility and lower sensitivity. And for ICPMS, organics are prohibitive because they give rise to an unstable plasma, and excessive carbon deposited on the sampling and skimmer cones might result in a gradual loss of sensitivity. All of these difficulties can be readily overcome by using solvent extraction/back extraction. Surprisingly, this approach has not been much used, probably because it is laborious and intricate to implement. However, automated in a sequential injection system, it is unproblematic to operate and effectively eliminates sample contamination, thereby presenting itself as a most attractive on-line procedure. This poster presents an on-line SI-solvent extraction/back extraction procedure used in connection with detection by either ETAAS or ICPMS. Incorporating two newly designed dual-conical gravitational phase separators, its performance is demonstrated for the determination of various metals in reference materials.

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Main Research Area: Technical/natural sciences
Source: orbit
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Publication: Research › Poster – Annual report year: 2002

F/SI on-line solvent extraction/back extraction preconcentration coupled to direct injection nebulization inductively coupled plasma mass spectrometry for determination of copper and lead

An automated sequential injection on-line preconcentration procedure for determination of trace levels of copper and lead via solvent extraction/back extraction coupled to ICP-MS is described. In citrate buffer of pH 3, neutral complexes between the analytes and the chelating reagent, ammonium pyrrolidinedithiocarbamate (APDC), are extracted into isobutyl methyl ketone (IBMK). The organic phase is separated from the aqueous one by means of a dual-conical gravitational phase separator, and stored in a PTFE holding coil. Afterwards, the organic phase is propelled and mixed with an aqueous back extractant of nitric acid containing Pd(II) ions as stripping agent, thereby facilitating a rapid metal exchange reaction with the APDC ligand and transfer of the analytes back into the aqueous phase. The aqueous phase is separated in a second dual-conical gravitational phase separator, and 30 μl is entrapped in a sample loop, the content of which is subsequently introduced into the ICP-MS, via a direct injection high efficiency nebulizer (DIHEN), for quantification. Enrichment factors of 29.6 (Cu) and 23.3 (Pb), detection limits of 17 ng/l (Cu) and 11 ng/l (Pb), along with a sampling frequency of 13 s/h
were obtained at a sample flow rate of 6.0 ml/min. The precisions (RSD) at the 0.2 μg/l level were 4.4% (Cu) and 4.8% (Pb), respectively. The applicability of the procedure is demonstrated for the determination of copper and lead in three certified reference materials and a urine sample.
Flow injection on-line preconcentration of low levels of Cr(VI) with detection by ETAAS: Comparison of using an open tubular PTFE knotted reactor and a column reactor packed with PTFE beads

A flow injection (FI) on-line sorption preconcentration procedure utilizing a packed column reactor and combined with electrothermal atomic absorption spectrometry (ETAAS) is proposed for the determination of low levels of Cr(VI) in water samples. Polytetrafluoroethylene (PTFE) beads packed in a mini-column is used as sorbent material. The complex formed between Cr(VI) and ammonium pyrrolidine dithiocarbamate (APDC) is sorbed on the PTFE beads, and is subsequently eluted by an air-monsolemented discrete zone of absolute ethanol (35μl), the analyte being quantified by ETAAS. The preconcentration procedure using the proposed column significantly enhances the preconcentration efficiency as compared with the preconcentration approach incorporating an open tubular PTFE knotted reactor (KR). Comparing the two procedure for equal surface sorption area, the advantages of using a packed column are observed in terms of limit of detection, enrichment factor and retention efficiency. With a preconcentration time of 60 s, and a sample flow rate of 5.0 ml l⁻¹, the enrichment factor (30.1) and the retention efficiency (24.1%) were doubled, yielding a detection limit (3σ) as low as 8.8 ng/l. The sample frequency was 16.7 s/h. The concentration efficiency was 8.38 and the precision was 1.05% at 0.5 mug/l of Cr(VI). The proposed column has been applied successfully to the analysis of natural water and synthetic seawater. Its performance was verified by the analysis of two certified Cr(VI)-reference materials and by recovery measurements on spiked samples.

General information
State: Published
Organisations: Department of Chemistry, Chiang Mai University
Authors: Som-aum, W. (Ekstern), Liawruangrath, S. (Ekstern), Hansen, E. H. (Intern)
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BFI (2016): BFI-level 2
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.94
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.64
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.74
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.55
ISI indexed (2012): ISI indexed yes
Implementation of suitable flow injection/sequential injection on-line sample pretreatment schemes. Separation and preconcentration procedures for the determination of trace metal concentrations by ETAAS and/or ICPMS

Despite their excellent analytical chemical capacities, ETAAS and ICPMS, nevertheless, often require suitable pretreatment of the sample material in order to obtain the necessary sensitivity and selectivity. Either in order to separate/preconcentrate the analyte material, or because of the presence of potentially interfering matrix constituents. Such pretreatments are advantageously performed in flow injection (FI) or sequential injection (SI) manifolds, where all appropriate unit operations can be effected under enclosed and strictly controlled conditions. Various separation/preconcentration procedures are feasible, such as liquid-liquid extraction, (co)precipitation with collection in knotted reactors, adsorption, hydride generation, or the use of ion-exchange columns. Apart from hydride generation, where the analyte is converted into a gaseous species, the common denominator for these approaches is that the analyte material finally is contained within a well-defined small volume of eluate, which then is introduced into the analytical instruments. While the graphite tube of the ETAAS only can accommodate up to 50 μl solution, yet might tolerate organic but preferably should be subjected to inorganic eluates, the ICPMS has potentially a larger volumetric capacity yet cannot accept organic solvents as these adversely will impair its performance. In the lecture, selected examples of separation/preconcentration FI/SI-procedures will be presented, with particular emphasis on the use of the novel "lab-on-valve" concept.

General information
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Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern), Wang, J. (Intern)
Publication date: 2002
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 43068
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Implementation of suitable flow injection/sequential-sample separation/preconcentration schemes for determination of trace metal concentrations using detection by electrothermal atomic absorption spectrometry and inductively coupled plasma mass spectrometry

Various preconditioning procedures encomprising appropriate separation/preconcentration schemes in order to obtain optimal sensitivity and selectivity characteristics when using electrothermal atomic absorption spectrometry (ETAAS) and inductively coupled plasma mass spectrometry (ICPMS) are presented and discussed. Demonstrating that such pretreatments advantageously are to be performed in flow injection (FI) or sequential injection (SI) manifolds, where all appropriate unit operations can be effected under enclosed and strictly controlled conditions, procedures based on ion-exchange, precipitation/coprecipitation, adsorption, liquid-liquid extraction, extraction/back-extraction and hydride generation are reviewed. Emphasising the use of SI-systems, special attention is paid to the use of the newly introduced
approach termed the lab-on-valve (LOV), where all necessary manipulations required prior to detection are effected in a microconduit placed on top of an SI selection valve.

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Organisations: Department of Chemistry
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.94
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.64
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.74
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.55
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 4.62
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
BFI (2009): BFI-level 1
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Web of Science (2008): Indexed yes
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Web of Science (2005): Indexed yes
Web of Science (2004): Indexed yes
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Web of Science (2001): Indexed yes
Web of Science (2000): Indexed yes
Original language: English
Source: orbit
Source-ID: 43011
Publication: Research - peer-review › Journal article – Annual report year: 2002
Lab-on-Valve Micro Sequential Injection: A Versatile Approach for Implementing Integrated Sample Pre-preparations and Executing (Bio)Chemical Assays

Since its introduction in 1975, Flow Injection Analysis (FIA) has established itself as an indispensable analytical concept that not only has permitted the implementation of numerous intriguing analysis procedures. But, more importantly, it has made it possible to facilitate the execution of procedures which are difficult or, in fact, otherwise impossible to do, thereby opening new and novel avenues for analytical methods relying on concepts such as kinetic discriminations schemes, exploitation of metastable constituents of attractive analytical characteristics, or utilisation of detection by bio- and chemiluminescence. In recent years, FIA has been supplemented by Sequential Injection Analysis (SIA), which, although it inherently entails some limitations as compared to FIA, offers specific advantages, notably in terms of significantly reduced sample and reagent(s) consumption and hence waste generation. Most recently, the so-called third generation of FIA has emerged, that is, the Lab-on-Valve (LOV) approach, the conceptual basis of which is to incorporate all the necessary unit operational manipulations required, and, when possible, even the detection device into a single small integrated microconduit, or "laboratory", placed atop a selection valve. The lecture will detail the evolution of the three generations of FIA, emphasis being placed on the LOV approach. Proven itself as a versatile front end to a variety of detection techniques, its utility will be exemplified by a series of applications. Particular focus will be placed on its use as a vehicle for pretreatment of complex sample matrices for determination of trace-level concentrations of metal ions by electrothermal atomic absorption spectrometry (ETAAS) and inductively coupled plasma mass spectrometry (ICPMS) via exploitation of the renewable microcolumn concept. Despite their excellent analytical chemical capabilities, ETAAS as well as ICPMS often require that the samples are subjected to suitable pretreatment in order to obtain the necessary sensitivity and selectivity. Either in order to separate the analyte from potentially interfering matrix constituents, or to preconcentrate the analyte material to bring it into the dynamic range of the detector. As will be shown, such pretreatments are advantageously performed in FIA/SIA/LOV manifolds, where all appropriate unit operations can be effected under enclosed and strictly controlled conditions.

New Trends in Flow Injection Analysis: Exploitation of Sequential and Lab-on-Valve Schemes

Over the past 25 years, Flow Injection Analysis (FIA) has established itself as an indispensable analytical concept that not only has permitted the implementation of numerous intriguing analysis procedures. But, more importantly, it has made it possible to facilitate the execution of procedures which are difficult or, in fact, otherwise impossible to do, thereby opening new and novel avenues for analytical methods relying on concepts such as kinetic discriminations schemes, exploitation of metastable constituents of attractive analytical characteristics, or utilisation of detection by bio- and chemiluminescence. In recent years, FIA has been supplemented by Sequential Injection Analysis (SIA), which, although it inherently entails some limitations as compared to FIA, offers specific advantages, especially concerning sample and reagent(s) consumption. Most recently, the so-called third generation of FIA has appeared, that is, the Lab-on-Valve (LOV) approach, the conceptual basis of which is to incorporate all the necessary unit operational manipulations required, and, when possible, even the detection device into a single small integrated microconduit, or "laboratory", placed atop a selection valve. The lecture will detail the evolution of the three generations of FIA, emphasis being placed on the LOV approach. Proven itself as a versatile front end to a variety of detection devices, these detection devices, nevertheless, often require that the samples are subjected to suitable pretreatment in order to obtain the necessary sensitivity and selectivity. Either in order to separate/preconcentrate the analyte material, or because of the presence of potentially interfering matrix constituents. Such pretreatments are advantageously performed in FIA/SIA/LOV manifolds, where all appropriate unit operations can be effected under enclosed and strictly controlled conditions.

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Publication date: 2002
Main Research Area: Technical/natural sciences
Sequential injection on-line matrix removal and trace metal preconcentration using a PTFE beads packed column as demonstrated for the determination of cadmium by electrothermal atomic absorption spectrometry

A sequential injection (SI) on-line matrix removal and trace metal preconcentration procedure by using a novel microcolumn packed with PTFE beads is described, and demonstrated for trace cadmium analysis with detection by electrothermal atomic absorption spectrometry (ETAAS). The analyte is initially complexed with diethyldithiophosphate (DDPA) and adsorbed onto the column, which is afterwards eluted with 50 µl of ethanol and subsequently introduced via air segmentation into the graphite tube for quantification. The ETAAS determination is synchronized with sample pre-treatment in the SI system. No flow resistance is encountered at a flow rate of 9.0 ml/min through the column. The preconcentration efficiency was improved significantly by using the packed column as compared with a knotted reactor. With a 40 s sample loading time at 4.5 ml/l along with a sampling frequency of 16 s/h, quantitative adsorption of cadmium (99% retention efficiency) and an enrichment factor of 59.4 were obtained, as compared with only 46.7% and 28.0 by using a knotted reactor of similar internal surface area as the packed column. The detection limits and precision (RSD, 0.1 µg/l Cd) are at the same levels, i.e., 1.3 ng/l (LOD), 1.3% (RSD) for the packed column, and 1.2 ng/l (LOD), 1.5% (RSD) for the knotted reactor. The practical applicability of the procedure is demonstrated by the determination of trace levels of cadmium in three certified reference materials.

General information
State: Published
Organisations: Department of Chemistry
Authors: Wang, J. (Intern), Hansen, E. H. (Intern)
Pages: 248-252
Publication date: 2002
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Analytical and Atomic Spectrometry
Volume: 17
Issue number: 3
ISSN (Print): 0267-9477
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.009 SNIP 1.18 CiteScore 3.3
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.002 SNIP 1.208 CiteScore 3.19
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.979 SNIP 1.395 CiteScore 3.22
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.064 SNIP 1.233 CiteScore 3.24
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.195 SNIP 1.095 CiteScore 2.99
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.119 SNIP 1.129 CiteScore 3.03
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.393 SNIP 1.202
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.106 SNIP 1.093
The Lab-on-Valve: A new promising tool for Flow Injection Analysis

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Pages: 1-1
Publication date: 2002
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Flow Injection Analaysis
Volume: 19
ISSN (Print): 0911-775X
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Source: orbit
Source-ID: 43013
Publication: Research - peer-review › Journal article – Annual report year: 2002

Coupling sequential injection on-line preconcentration by means of a renewable microcolumn with ion-exchange beads with detection by electrothermal atomic absorption spectrometry. Comparing the performance of eluting the loaded beads with transporting them directly into the graphite tube, as demonstrated for the determination of nickel in environmental and biological samples.

The design of a flow injection/sequential injection (FIA/SIA) on-line preconcentration system incorporating a renewable microcolumn with ion-exchange beads and interfaced with an electrothermal atomic absorption spectrometry (ETAAS) detector is described, and its practical applicability is demonstrated for the determination of trace level concentrations of nickel. The column is loaded with a defined volume of SP Sephadex C-25 cation-exchange resin beads and subsequently exposed to a metered volume of sample solution. The analyte loaded beads are afterwards eluted with 30μl of diluted nitric acid, and the eluate transported via air segmentation into the graphite tube. The used beads are then discarded. The ETAAS determination is performed in parallel with the preconcentration process of the ensuing sample. An improved precision of R.S.D. 1.5% is obtained as compared to the 3.4% for the procedure in which the loaded beads are transported directly to the graphite furnace for pyrolysis and atomization, and even improved in comparison to the
traditional unidirectional and bidirectional repetitive elution procedures which under comparable conditions yield R.S.D.-
values of 5.8 and 4.9%, respectively. The tolerance limits for cations such as Pb(II), Zn(II), Co(II) and Mn(II) were
improved up to 10-50-folds, and the linear calibration range extended to comprise 0.02-1.20μg/l. Because of lower
operating temperature, the life time of the graphite tube is extended. An enrichment factor of 71.1 and a detection limit of
10.2ng/l along with a sampling frequency of 12 s/h were obtained, which are at the same levels as those for the previously
described procedure without elution. The present approach was validated by determination of the nickel contents in two
certified reference materials, an industrial waste water sample and a human urine sample.
Exploiting flow injection and sequential injection for trace metal determinations in conjunction with detection by electrothermal atomic absorption spectrometry and inductively coupled plasma mass spectrometry

Despite their excellent analytical chemical capacities, Electrothermal Atomic Absorption Spectrometry (ETAAS) and Inductively Coupled Plasma Mass Spectrometry (ICPMS), nevertheless, often require suitable pretreatment of the sample material in order to obtain the necessary sensitivity and selectivity. Either in order to separate/preconcentrate the analyte material, or because of the presence of potentially interfering matrix constituents. Such pretreatments are advantageously performed in flow injection (FI) or sequential injection (SI) manifolds, where all appropriate unit operations can be effected under enclosed and strictly controlled conditions, thereby ensuring that all samples are subjected to identical and reproducible manipulations and at the same time minimizing the risk for contamination from the environment. Various separation/preconcentration procedures are feasible, such as liquid-liquid extraction, (co)precipitation with collection in knotted reactors, adsorption, hydride generation, or the use of ion-exchange columns. Apart from hydride generation, where the analyte is converted into a gaseous species, the common denominator for these approaches is that the analyte material finally is contained within a well-defined small volume of eluate, which then is introduced into the analytical instruments. While the graphite tube of the ETAAS only can accommodate up to 50 l solution, yet can tolerate inorganic as well as organic eluates, the ICPMS has a larger volumetric capacity yet cannot accept organic solvents as these adversely will impair its performance. This apparent disadvantage can, however, be circumvented by using a combination of extraction and back-extraction, where the analyte material via suitable chemical treatment first is extracted into an organic solvent and secondly is back-extracted into an aqueous phase before being presented to the plasma. Selected examples of separation/preconcentration FI/SI-procedures will be presented, emphasis being placed on the determination of trace levels of metals in elevated salt-containing matrices. Such samples are traditionally very difficult to analyse.

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Publication date: 2001
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 43006
Publication: Research - peer-review › Journal article – Annual report year: 2001

Exploiting flow injection and sequential injection schemes for trace metal determinations by electrothermal atomic absorption spectrometry

Determination of low or trace-level amounts of metals by electrothermal atomic absorption spectrometry (ETAAS) often requires the use of suitable preconcentration and/or separation procedures in order to attain the necessary sensitivity and selectivity. Such schemes are advantageously executed in flow injection (FI) or sequential injection (SI) systems, which, in addition to reducing sample and reagent consumption, allow all manipulations to be made on-line under enclosed and strictly controlled conditions, thereby minimizing the risk for contamination from the environment. Various separation/preconcentration procedures have been suggested and applied, such as liquid-liquid extraction, (co)precipitation with collection in knotted reactors, adsorption, hydride generation, or ion-exchange. Selected examples of some of these procedures will be discussed. Emphasis will be placed on the use of FI/SI-systems incorporating ion-exchange column reactors. Although extensively used, such devices suffer from some inherent drawbacks. Thus, because many ion-exchange resins undergo volume change when they are converted from the acid to the basic form, long-term use might lead to progressively tighter packing and hence increased flow resistance. This can, however, to a large extent be alleviated by using countercurrent flow. Besides, the surface properties of the resin might be irreversibly changed after having been subjected to a large number of samples, either due to contamination, deactivation, or even loss of its functional groups. These problems are especially serious when using ETAAS as the detection device, because the limited accommodation volume of the graphite tube requires that the retained analyte must be eluted completely – or at least to a reproducible degree - within a very small volume of eluent. All these problems might be readily overcome by using an approach where the ion-exchange material is discarded and renewed after each measuring cycle. Based on the so-called lab-on-valve SI-system, which in its design only consumes very minute amounts of ion-exchange material, the cost per assay is amply compensated by superior performance and versatility. In fact, two approaches are conceivable: The analyte-loaded ion-exchange beads might either be transported directly into the graphite tube where they are pyrolyzed and the measurand is atomized and quantified; or the loaded beads can be eluted and the eluate forwarded to the ETAAS instrument for measurement. Both approaches will be illustrated.
Exploiting sequential injection on-line solvent extraction/back extraction with detection by ETAAS and ICPMS

Electrothermal atomic absorption spectrometry (ETAAS) and inductively coupled plasma mass spectrometry (ICPMS) are highly sensitive techniques for trace metal analyses. Nevertheless, separation/preconcentration procedures are often called for in order to overcome their inherent low matrix tolerance. With detection by ETAAS, separation/preconcentration by solvent extraction has enjoyed much use. However, this approach is not necessarily the optimal one since introduction of organic eluates directly into the graphite tube might lead to deteriorated reproducibility and lower sensitivity. And for ICPMS, organics are prohibitive because they give rise to an unstable plasma, and excessive carbon deposited on the sampling and skimmer cones might result in a gradual loss of sensitivity. All of these difficulties can be readily overcome by using solvent extraction/back extraction. Surprisingly, this approach has not been much used, probably because it is laborious and intricate to implement. However, automated in a sequential injection system, it is unproblematic to operate and effectively eliminates sample contamination, thereby presenting itself as a most attractive on-line procedure. This poster presents an on-line SI-solvent extraction/back extraction procedure used in connection with detection by either ETAAS or ICPMS. Incorporating two newly designed dual-conical gravitational phase separators, its performance is demonstrated for the determination of various metals in reference materials.

Flow injection on-line dilution for multi-element determination in human urine with detection by inductively coupled plasma mass spectrometry

A simple flow injection on-line dilution procedure with detection by inductively coupled plasma mass spectrometry (ICP-MS) was developed for the determination of copper, zinc, arsenic, lead, selenium, nickel and molybdenum in human urine. Matrix effects were minimized by employing a dilution factor of 16.5 with on-line standard addition, and sup/103/Rh was used as internal standard to compensate for signal fluctuation. The procedure was validated by the analysis of two standard reference materials SRM 2670 (NIST) and Seronorm(TM) Trace Elements in Urine. Recovery experiments were performed by spiking the reference materials as well as artificial urine. The detection limits (μg/l) were 0.12, 0.96, 0.30, 0.09, 0.45, 0.08, 0.09, and the precisions (RSD,%) were 2.6, 2.3, 3.0, 3.7, 3.7, 4.9, 2.8 for Cu, Zn, As, Pb, Se, Ni and Mo, respectively. The procedure was applied to the analysis of 41 human urine samples. No correlations between the concentrations of the elements were observed.
Implementation of suitable FI/SI-sample separation/preconcentration schemes for determinations of trace-metal concentrations when using detection by ETAAS and ICPMS

Despite their excellent analytical chemical capacities, Electrothermal Atomic Absorption Spectrometry (ETAAS) and Inductively Coupled Plasma Mass Spectrometry (ICPMS), nevertheless, often require suitable pretreatment of the sample material in order to obtain the necessary sensitivity and selectivity. Either in order to separate/preconcentrate the analyte material, or because of the presence of potentially interfering matrix constituents. Such pretreatments are advantageously performed in flow injection (FI) or sequential injection (SI) manifolds, where all appropriate unit operations can be effected.
under enclosed and strictly controlled conditions. Various separation/preconcentration procedures are feasible, such as liquid-liquid extraction, (co)precipitation with collection in knotted reactors, adsorption, hydride generation, or the use of ion-exchange columns. Apart from hydride generation, where the analyte is converted into a gaseous species, the common denominator for these approaches is that the analyte material finally is contained within a well-defined small volume of eluate, which then is introduced into the analytical instruments. While the graphite tube of the ETAAS only can accommodate up to 50 l solution, yet can tolerate inorganic as well as organic eluates, the ICPMS has a larger volumetric capacity yet cannot accept organic solvents as these adversely will impair its performance. Selected examples of separation/preconcentration FI/SI-procedures will be presented, with particular emphasis on the use of the novel "lab-on-valve" concept.

**General information**

State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern), Wang, J. (Intern)
Publication date: 2001
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 43062
Publication: Research › Paper – Annual report year: 2001

**Implementation of suitable FI/SI-sample separation/preconcentration Schemes for determinations of trace-metal concentrations when using detection by ETAAS and ICPMS**

**General information**

State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Publication date: 2001
Event: Poster session presented at 11th International Conference on Flow Injection Analysis, Chiang Mai, Thailand.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 50573
Publication: Research › Poster – Annual report year: 2001

**Interfacing sequential injection on-line preconcentration using a renewable micro-column incorporated in a 'lab-on-valve' system with direct injection nebulization inductively coupled plasma mass spectrometry**

A sequential injection (SI) on-line 'lab-on-valve' separation/preconcentration system incorporating a renewable ion-exchange microcolumn interfaced with inductively coupled plasma mass spectrometry (ICP-MS) via a home-made direct injection high efficiency nebulizer (DIHEN) is described. Aimed at eliminating spectroscopic and non-spectroscopic interferences, the renewable microcolumn is first loaded by aspirating 15 µl of a SP Sephadex C-25 cation-exchanger bead suspension and then exposed to a defined volume of sample solution. Residuals of matrix components are pre-eluted with carrier solution (nitric acid, 1:80 v/v), and the measurands are subsequently eluted with a defined volume of nitric acid (1:16, v/v). The leading part of the eluate (ca. 30 µl) is collected and introduced into the plasma via the DIHEN. The eluted beads are then discarded and a new column aspirated for the next operation. Data acquisition is performed in parallel with the ensuing preconcentration process. With 2.0 ml sample loading, the enrichment factors are 35.2 (0.05-2.4 µg l-1) for Ni, and 9.1 (0.04-1.6 µg l-1) and 28.4 (1.6-3.2 µg l-1) for Bi. The detection limits (3s) are 15 ng l-1 (Ni) and 4 ng l-1 (Bi), while the sampling frequency is 12 h-1. The precisions are 2.9% (0.8 µg l-1 Ni) and 1.7% (0.8 µg l-1 Bi), respectively. The procedure is validated by determination of nickel and bismuth in a certified reference material (CRM 320, River Sediment), and the recoveries are measured by spiking two human urine samples.

**General information**

State: Published
Organisations: Department of Chemistry
Authors: Wang, J. (Intern), Hansen, E. H. (Intern)
Pages: 1349-1355
Publication date: 2001
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Journal of Analytical Atomic Spectrometry
Volume: 16
Issue number: 12
ISSN (Print): 0267-9477
Ratings:
Metrology for Chemical Engineers
The first full-semester course on Quality Assurance in Chemical Measurement was held at the Technical University of Denmark from September to December 1999. The course required sufficient knowledge of basic statistics to understand and apply the methods recommended in ISO 5725-1/6 Accuracy of Measurement Methods and Results. The main purpose of the course was, however, to familiarize PhD students with the BIPM philosophy, using the International Organization for Standardization (ISO) Guide to Expression of Uncertainty in Measurement, which was accepted by IUPAC and other international scientific organizations in 1993. Chemists are notoriously reluctant to accept the BIPM
philosophy, but the appearance of a new Draft Guide Quantifying Uncertainty in Analytical Measurement at the EURACHEM Workshop in Helsinki in June 1999 stimulated us to make an attempt to overcome such chemical prejudice. After thorough reading of the examples presented in the Draft Guide, each of the participating students had to prepare an uncertainty budget for their own particular project and present it to the other participants for discussion. Eventually the students learned how to verify their uncertainty budgets by means of experimental results. this invariably entailed a reevaluation of the uncertainty components in the original budget. The revised budget was again verified, and this iteration was continued until the budget correctly predicted the uncertainty of individual results covering the whole range of applicability of the analytical method. The paper presents the detailed structure of this first course, as well as improvements in the next course scheduled for the year 2000.
MicroSequential Injection. A versatile approach to (bio)chemical assays using the Lab-on-Valve system

General information
State: Published
Organisations: Department of Chemistry, Department of Chemistry
Authors: Hansen, E. H. (Intern), Ruzicka, J. (Ekstern)
Publication date: 2001
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 43059
Publication: Research › Paper – Annual report year: 2001

On-line ion exchange preconcentration in a sequential injection lab-on-valve microsystem incorporating a renewable column with ETAAS for the trace-level determination of bismuth in urine and river sediment

A sequential injection system for on-line ion-exchange separation and preconcentration of trace-level amounts of metal ions with ensuing detection by electrothermal atomic absorption spectrometry (ETAAS) is described. Based on the use of a renewable microcolumn incorporated within an integrated lab-on-valve microsystem, the column is initially loaded with a defined volume of beads of an SP Sephadex C-25 cation exchange resin. After having been exposed to a metered amount of sample solution, the loaded bead suspension is precisely manipulated within the valve to allow reproducible elution of the retained measurand by 30 μl of nitric acid (1:16, v/v), which then via air segmentation are transported into the graphite tube for quantification. The content of the used column is afterwards discarded and new column material is aspirated for the next run. The ETAAS determination is performed in parallel with the preconcentration process of the ensuing sample. The performance of the system is demonstrated for the determination of bismuth. With 2.4 ml sample loading, an enrichment factor of 33.4, a detection limit of 27 ng/l, along with a sampling frequency of 10 was obtained. The relative standard deviation was 2.3% for the determination of 2.0 μg/l Bi (n = 7). The procedure was validated by determination of bismuth in a certified reference material CRM 320 (river sediment), and by bismuth spike recoveries in two human urine samples.
Coupling on-line preconcentration by ion-exchange with ETAAS. A novel flow injection approach based on the use of a renewable microcolumn as demonstrated for the determination of nickel in environmental and biological samples

A novel way of exploiting flow injection/sequential injection (FIA/SIA) on-line ion-exchange preconcentration with detection by electrothermal atomic absorption spectrometry (ETAAS) is described and demonstrated for the determination of trace-levels of nickel. Based on the use of a renewable microcolumn incorporated within an integrated micro FI-system, the column is loaded with a defined volume of small beads of an SP Sephadex C-25 cation-exchange resin and subsequently exposed to a metered amount of sample solution. However, instead of eluting the retained analyte from the organic ion-exchange resin, the beads are along with 30 μl of carrier (buffer) solution transported via air segmentation directly into the graphite tube, where they are ashed during the pyrolysis and atomization process. The ETAAS determination is performed in parallel with the preconcentration process of the ensuing sample. An enrichment factor of 72.1, a detection limit of 9 ng l(-1), along with a sampling frequency of 12 h(-1) were obtained with 150 s of sample loading time at a sample flow rate of 12 μl s(-1) (corresponding to 0.72 ml min(-1)). The relative standard deviations were 3.4%. The procedure was validated by determination of the nickel contents in two certified reference materials and in a human urine sample. (C) 2000 Elsevier Science B.V. All rights reserved.

General information
State: Published
Organisations: Department of Chemistry
Authors: Wang, J. (Intern), Hansen, E. H. (Intern)
Pages: 223-232
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Analytica Chimica Acta
Volume: 424
ISSN (Print): 0003-2670
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.94
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.64
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Flow Injection Analysis - From Beaker to Microfluidics

General information
State: Published
Organisations: Department of Chemistry
Authors: Ruzicka, J. (Ekstern), Hansen, E. H. (Intern)
Pages: 212A-217A
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Analytical Chemistry
Volume: 72
Issue number: 5
ISSN (Print): 0003-2700
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.08
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 6
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 5.79
Flow injection on-line two-stage solvent extraction preconcentration coupled with electrothermal atomic absorption spectrometry for determination of bismuth in biological and environmental samples

**General information**
State: Published  
Organisations: Department of Chemistry  
Authors: Wang, J. (Intern), Hansen, E. H. (Intern)  
Pages: 2747-2766  
Publication date: 2000  
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Analytical Letters  
Volume: 33  
Issue number: 13  
ISSN (Print): 0003-2719  
Ratings:  
BFI (2017): BFI-level 1  
Web of Science (2017): Indexed Yes  
BFI (2016): BFI-level 1  
Scopus rating (2016): SJR 0.34 SNIP 0.395 CiteScore 1.17  
BFI (2015): BFI-level 1  
Scopus rating (2015): SJR 0.358 SNIP 0.474 CiteScore 1.13  
BFI (2014): BFI-level 1  
Scopus rating (2014): SJR 0.372 SNIP 0.488 CiteScore 1.04  
BFI (2013): BFI-level 1  
Scopus rating (2013): SJR 0.345 SNIP 0.528 CiteScore 1.03
Interfacing Flow Injection Analysis (Sequential Injection Analysis) and Electro-Thermal Atomic Absorption Spectrometry

Determination of Trace-levels of Cr(VI) via On-line Pre-concentration by Adsorption in a Knotted Reactor and by Liquid-Liquid Extraction

General information
State: Published
Organisations: Department of Chemistry
Authors: Nielsen, S. (Ekstern), Hansen, E. H. (Intern)
Pages: 47-62
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication Information
Volume: 422
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.94
Web of Science (2015): Indexed yes

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Pages: 607-608
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Talanta
Volume: 51
Issue number: 3
ISSN (Print): 0039-9140
Ratings:
  BFI (2017): BFI-level 1
  Web of Science (2017): Indexed Yes
  BFI (2016): BFI-level 1
  Scopus rating (2016): SJR 1.162 SNIP 1.27 CiteScore 4.19
  Web of Science (2016): Indexed yes
  BFI (2015): BFI-level 1
1999 Lecture Notes for Course 21455 - Instrumental Analysis (Experimental)

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern), Andersen, J. E. T. (Intern), Thale, E. I. (Intern)
Publication date: 1999

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
1999 Lecture notes in course 21250 - Instrumental Analysis

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Publication date: 1999

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 173326
Publication: Research - peer-review › Book – Annual report year: 1999

A Practical Exercise for the Determination of As(III) by Flow Injection Hydride Generation-Atomic Absorption Spectrometry

General information
State: Published
Organisations: Department of Chemistry, Analytical Chemistry
Authors: Hansen, E. H. (Intern), Andersen, J. E. T. (Intern)
Pages: 91-100
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: Laboratory Automation and Information Management
Volume: 34
Issue number: 2
ISSN (Print): 1381-141X
Ratings:
BFI (2008): BFI-level 1
Scopus rating (2002): SJR 0.261 SNIP 0.641
Scopus rating (2001): SJR 0.3 SNIP 0.253
Scopus rating (2000): SJR 0.166 SNIP 0.168
Scopus rating (1999): SJR 0.181 SNIP 0.121
Original language: English
Source: orbit
Source-ID: 173331
Publication: Research - peer-review › Journal article – Annual report year: 1999

Combination of Flow Injection and Electrothermal Atomic Absorption Spectrometry

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern), Nielsen, S. (Intern)
Pages: 17-21
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: Dansk Kemi
Volume: 80
Issue number: 4
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Division of Analytical Chemistry, 1998

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Pages: 31-33
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: Dansk Kemi
Volume: 80
Issue number: 4
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Web of Science (2007): Indexed yes
Web of Science (2004): Indexed yes
Original language: Danish
Source: orbit
Source-ID: 173328
Publication: Research › Journal article – Annual report year: 1999

Exercises in Inorganic Chemistry at Course "Nature and Techniques I - Water"

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Publication date: 1999

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 173329
Publication: Research - peer-review › Book – Annual report year: 1999

Flow Injection will be 25 years

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Pages: 14-16
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: Dansk Kemi
Volume: 80
Issue number: 4
Ratings:
Selective Flow Injection Analysis of Ultra-trace Amounts of Cr(VI), Preconcentration of It by Solvent Extraction, and Determination by Electrothermal Atomic Absorption Spectrometry (ETAAS)

A rapid, robust, sensitive and selective time-based flow injection (FI) on-line solvent extraction system interfaced with electrothermal atomic absorption spectrometry (ETAAS) is described for analyzing ultra-trace amounts of Cr(VI). The sample is initially mixed on-line with isobutyl methyl ketone (IBMK). The Cr(VI) is complexed by reaction with ammonium pyrrolidine dithiocarbamate (APDC), and the non-charged Cr(VI)-PDC chelate formed is extracted into IBMK in a knotted reactor made from PTFE tubing. The organic extractant is separated from the aqueous phase by a gravity phase separator with a small conical cavity and delivered into a collector tube, from which 55 μl of organic concentrate is subsequently introduced via an air flow into the graphite tube of the ETAAS instrument. The operations of the FI-system and the ETAAS detector are synchronously coupled. A significant advantage of the approach is that matrix constituents, such as high salt contents, effectively are eliminated. The extraction procedure was optimized by a simplex approach. A central composite design was subsequently employed to verify the estimated operational optimum. An 18-fold enhancement in sensitivity of Cr(VI) was achieved after preconcentration for 99 s at a sample flow rate of 5.5 ml min-1, as compared to direct introduction of 55 μl of sample, yielding a detection limit (3sigma) of 3.3 ng l-1. The sampling frequency was 24.2 samples h-1. The proposed method was successfully evaluated by analyzing a NIST Cr(VI)-reference material, synthetic seawater and waste waters, and waste water samples from an incineration plant and a desulphurization plant, respectively.

General information
State: Published
Organisations: Department of Chemistry
Authors: Nielsen, S. (Intern), Sturup, S. (Intern), Spliid, H. (Intern), Hansen, E. H. (Intern)
Pages: 1027-1044
Publication date: 1999
Main Research Area: Technical/natural sciences
Publication information
Journal: Talanta
Volume: 49
Issue number: 5
ISSN (Print): 0039-9140
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.162 SNIP 1.27 CiteScore 4.19
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.187 SNIP 1.327 CiteScore 3.99
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.201 SNIP 1.296 CiteScore 3.71
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.201 SNIP 1.399 CiteScore 3.74
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.421 SNIP 1.46 CiteScore 3.74
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.429 SNIP 1.518 CiteScore 3.91
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.456 SNIP 1.366
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.319 SNIP 1.338
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2007): SJR 1.428 SNIP 1.506
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.305 SNIP 1.377
Scopus rating (2005): SJR 1.113 SNIP 1.453
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.173 SNIP 1.523
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.987 SNIP 1.353
Scopus rating (2002): SJR 0.998 SNIP 1.278
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.939 SNIP 1.18
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.964 SNIP 1.22
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.932 SNIP 1.116
Original language: English
On-line preconcentration of Cr(VI), Extraction of Cr(VI)-PDC complex, FI-ETAAS, Assay of inorganic Cr(VI)
DOIs:
10.1016/S0039-9140(99)00044-2


**Analytical Chemistry - Leaving the 90's and on the Threshold**

**General information**
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Pages: 4-5
Publication date: 1998
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Dansk Kemi
Volume: 79
Issue number: 9
Ratings:
- ISI indexed (2013): ISI indexed no
- ISI indexed (2012): ISI indexed no
- ISI indexed (2011): ISI indexed no
- Web of Science (2007): Indexed yes
- Web of Science (2004): Indexed yes
Original language: Danish
Source: orbit
Source-ID: 169949
Publication: Research › Journal article – Annual report year: 1998

**Dilution Methods in Flow Injection Analysis. Evaluation of Different Approaches as Exemplified for the Determination of Nitrosyl in Concentrated Sulphuric Acid**

**General information**
State: Published
Organisations: Department of Chemistry
Authors: Jørgensen, U. V. (Ekstern), Nielsen, S. (Intern), Hansen, E. H. (Intern)
Pages: 2181-2194
Publication date: 1998
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Analytical Letters
Volume: 31
Issue number: 13
ISSN (Print): 0003-2719
Ratings:
- BFI (2017): BFI-level 1
- Web of Science (2017): Indexed Yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): SJR 0.34 SNIP 0.395 CiteScore 1.17
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 0.358 SNIP 0.474 CiteScore 1.13
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 0.372 SNIP 0.488 CiteScore 1.04
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 0.345 SNIP 0.528 CiteScore 1.03
- ISI indexed (2013): ISI indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): SJR 0.398 SNIP 0.479 CiteScore 1.01
- ISI indexed (2012): ISI indexed yes
Flow Injection Analysis - Where are We Heading?

General information
State: Published
Organisations: Department of Chemistry, University of Washington
Authors: Ruzicka, J. (Ekstern), Hansen, E. H. (Intern)
Pages: 69-73
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Trends in Analytical Chemistry
Volume: 17
Issue number: 2
ISSN (Print): 0165-9936
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 2.499 SNIP 2.402 CiteScore 8.09
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.437 SNIP 2.322 CiteScore 7.24
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.194 SNIP 2.253 CiteScore 6.54
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.292 SNIP 2.204 CiteScore 6.47
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.346 SNIP 2.057 CiteScore 5.9
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.715 SNIP 2.084 CiteScore 6.52
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.636 SNIP 1.861
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.791 SNIP 1.851
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 2.498 SNIP 1.936
Web of Science (2008): Indexed yes
Flow Injection and Atomic Absorption Spectrometry - An Effective and Attractive Analytical Chemical Combination

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern), Nielsen, S. (Intern)
Pages: 347-354
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Laboratory Robotics and Automation
Volume: 10
Issue number: 6
ISSN (Print): 0895-7533
Ratings:
BFI (2008): BFI-level 1
Scopus rating (2003): SJR 0.295 SNIP 0.524
Scopus rating (2002): SJR 0.42 SNIP 0.501
Scopus rating (2001): SJR 0.302 SNIP 0.461
Scopus rating (2000): SJR 0.348 SNIP 0.725
Scopus rating (1999): SJR 0.307 SNIP 0.517
Original language: English
Source: orbit
Source-ID: 169940
Publication: Research - peer-review › Journal article – Annual report year: 1998

IKT-Kemi (review)

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Pages: 24
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Dansk Kemi
Lecture Notes for Course 21250 - Instrumental Analysis

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Publication date: 1998

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 169953
Publication: Research - peer-review › Book – Annual report year: 1998

Notes for Course 21455 - Instrumental Analysis (Experimental Course)

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern), Andersen, J. E. T. (Intern), Thale, E. I. (Intern)
Publication date: 1998

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 169955
Publication: Research - peer-review › Book – Annual report year: 1998

Publications in Danish about Quality Assurance (Review)

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Pages: 59-60
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Dansk Kemi
Volume: 79
Issue number: 9
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Web of Science (2007): Indexed yes
Selective Flow-Injection Quantification of Ultra-trace Amounts of Cr(VI) via On-line Complexation and Preconcentration with APDC Followed by Determination by Electrothermal Atomic Absorption Spectrometry

A rapid, sensitive and selective time-based flow injection (FI) preconcentration procedure is described for the determination of ultra-trace amounts of Cr(VI) via on-line reaction with ammonium pyrrolidine dithiocarbamate (APDC) and formation of the Cr(VI)-PDC complex. The preconcentration is effected by adsorption on the inner wall of a knotted reactor made from PTFE tubing. The complex is subsequently eluted with a monosegmented discrete zone of ethanol (55 μl), and the analyte is quantified by electrothermal atomic absorption spectrometry (ETAAS). The operations of the FI-system and the ETAAS-detector are synchronously coupled.

Efforts have been made to design a generic and versatile FI-ETAAS system that allows all necessary manipulatory operations to be executed on-line which, in addition to effective entrapment of the analyte in the preconcentration unit, comprise washing the surface of the retained analyte in order to remove possibly interfering matrix components; quantitative dissolution of the retained analyte in the smallest possible volume of eluent to satisfy the volumetric requirements of the graphite tube (platform); reproducible transport of the concentrate to the ETAAS instrument at minimum dispersion; and, finally, a thorough cleansing of all pertinent conduits in the FI-system in order to prevent carry-over between individual samples.

A 19-fold enhancement in sensitivity of Cr(VI) was achieved after preconcentration for 60 s at a sample flow rate of 5.0 ml min(-1) as compared to direct introduction of 55 μl samples, yielding a detection limit (3 sigma) of 4.2 ng l(-1). The sample frequency was 21.2 samples per hour. The proposed method was evaluated by analyzing drinking water, a NIST Cr(VI)-reference material and synthetic sea water. A major contribution to successful operation of the system can, to a large extent, be ascribed to the incorporation of a newly developed mixing-point component, which is attached directly to the commercially available 8-port rotary valve. (C) 1998 Elsevier Science B.V.
Simultaneous determination of trace-levels of alloying zinc and copper by semi-mercury-free potentiometric stripping analysis with chemometric data treatment

Assays of copper and zinc in brass samples were performed by Semi-Mercury Free Potentiometric Stripping Analysis (SMF PSA) using a thin-film mercury covered glassy-carbon working electrode and dissolved oxygen as oxidizing agent during the stripping step. The stripping peak transients were resolved by chemometrics which enabled simultaneous determination of both the copper and the zinc concentrations, thereby eliminating the conventional necessary pretreatment of the sample solution, such as initial addition of Ga(III) or solvent extraction of copper. The brass samples were diluted by factors in the range 2.104 - 5.105 which resulted in quantification of the copper and of zinc contents comparable to the specified values within 10%. On the basis of the chemometric treatment, an empirical expression is deduced relating the stripping time to the recorded potential.

General information
State: Published
Organisations: Department of Chemistry
Authors: Andersen, J. E. T. (Intern), Hansen, E. H. (Intern)
Pages: 77-83
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Fresenius' Journal of Analytical Chemistry
Volume: 362
ISSN (Print): 0937-0633
Ratings:
BFI (2008): BFI-level 1
Scopus rating (2005): SJR 0.868 SNIP 1.532
Scopus rating (2004): SJR 0.876 SNIP 1.451
Scopus rating (2003): SJR 0.855 SNIP 1.482
Scopus rating (2002): SJR 0.981 SNIP 1.038
Scopus rating (2001): SJR 0.815 SNIP 0.859
Scopus rating (2000): SJR 0.872 SNIP 0.953
Scopus rating (1999): SJR 1.035 SNIP 0.874
Sir Alan Walsh 1916-1998

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Pages: 6
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Dansk Kemi
Volume: 79
Issue number: 11
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Web of Science (2007): Indexed yes
Web of Science (2004): Indexed yes
Original language: Danish
Source: orbit
Source-ID: 169951
Publication: Research › Journal article – Annual report year: 1998


General information
State: Published
Organisations: Department of Chemistry
Authors: Hilligsøe, B. (Ekstern), Hansen, E. H. (Intern)
Pages: 775-780
Publication date: 1997
Main Research Area: Technical/natural sciences

Publication information
Journal: Fresenius' Journal of Analytical Chemistry
Volume: 358
Issue number: 7-8
ISSN (Print): 0937-0633
Ratings:
BFI (2008): BFI-level 1
Scopus rating (2005): SJR 0.868 SNIP 1.532
Scopus rating (2004): SJR 0.876 SNIP 1.451
Scopus rating (2003): SJR 0.855 SNIP 1.482
Scopus rating (2002): SJR 0.981 SNIP 1.038
Scopus rating (2001): SJR 0.815 SNIP 0.859
Scopus rating (2000): SJR 0.872 SNIP 0.953
Scopus rating (1999): SJR 1.035 SNIP 0.874
Original language: English
Source: orbit
Source-ID: 168671
Determination of As(III) and As(V) by Flow Injection-Hydride Generation-Atomic Absorption Spectrometry via On-line Reduction of As(V) by KI

A volume-based flow injection (FI) procedure is described for the determination and speciation of trace inorganic arsenic, As(III) and As(V), via hydride generation-atomic absorption spectrometry (HG-AAS) of As(III). The determination of total arsenic is obtained by on-line reduction of As(V) to As(III) by means of 0.50% (w/v) ascorbic acid and 1.0% (w/v) potassium iodide in 4 M HCl. The combined sample and reduction solution is initially heated by flowing through a knotted reactor immersed in a heated, thermostatted oil bath at 140 degrees C, and subsequently, for cooling the reaction medium, a knotted reactor immersed in a water bath at 10 degrees C. By using the very same volume-based FI-HG-AAS system without the heating and cooling reactors, and employing mild hydrochloric acid conditions, As(V) is not converted to arsine, thereby allowing the selective determination of As(III). The injected sample volume is 100 μl while the total sample consumption per assay is 1.33 ml, and the sampling frequency is 180 samples per hour. The detection limit (3 sigma) for the on-line reduction procedure was 37 ng l(-1) and at the 5.0 μg l(-1), the relative standard deviation (RSD) was 1.1% (n=10) by calibrating with As(III) standards; by calibrating with As(V) standards the detection limit was 33 ng l(-1) and the RSD was 1.3% (n=10). For the selective determination of As(III) the detection limit was 111 ng l(-1) and the RSD was 0.7% (n=10) at 5.0 μg l(-1). Both procedures are most tolerant to potential interferents. Thus, without impairing the assay, interferents such as Cu, Co, Ni and Se could, at a As(V) level of 5 μg l(-1), be tolerated at a weight excess of 2000, 30000, 200 and 200 times, respectively. The assay of a certified drinking water sample by means of multiple standard addition (five levels; each three replicates) was 9.09+/-0.05 μg l(-1) (certified value 9.38+/-0.71 μg l(-1)).
How Does a University Prepare the Candidates to Metrology and Quality Assurance and to European Conformity Assessment?

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Publication date: 1997

Host publication information
Title of host publication: Confidence in Testing - Customers Needs
Place of publication: Espoo (F)
Publisher: NORDTEST
Main Research Area: Technical/natural sciences
Conference: EUROLAB workshop, Copenhagen, 01/01/1997
Source: orbit
Source-ID: 168709
Publication: Research - peer-review › Article in proceedings – Annual report year: 1997

Instrumental Analysis (Experimental Course): Course No. 2146

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern), Thale, E. I. (Intern), Andersen, J. E. T. (Intern)
Number of pages: 75
Publication date: 1997

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 168755
Publication: Research - peer-review › Book – Annual report year: 1997

Investigations into the Role of Modifiers for Entrapment of Hydrides in Flow Injection Hydride Generation Electrothermal Atomic Absorption Spectrometry as Exemplified for the Determination of Germanium

General information
State: Published
Organisations: Department of Chemistry
Lecture Notes for Course 2140 (Instrumental Analysis)

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Number of pages: 105
Publication date: 1997

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 168710
Publication: Research - peer-review › Book – Annual report year: 1997

The Threat Against the Education of Analytical Chemists

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Pages: 4
Publication date: 1997
Main Research Area: Technical/natural sciences

Publication information
Journal: Dansk Kemi
Volume: 78
Issue number: 4
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Web of Science (2007): Indexed yes
Web of Science (2004): Indexed yes
Original language: Danish
Source: orbit
Source-ID: 168707
Publication: Research › Journal article – Annual report year: 1997

Working Party on Analytical Chemistry 1996

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Pages: 38-42
Publication date: 1997
Main Research Area: Technical/natural sciences

Publication information
Journal: Dansk Kemi
Volume: 78
Issue number: 4
Ratings:
Book Review: Flow Injection Atomic Absorption Spectrometry (by Zhaolun Fang)

General information
State: Published
Organisations: Department of Chemistry
Authors: Hansen, E. H. (Intern)
Pages: 2023-2025
Publication date: 1996
Main Research Area: Technical/natural sciences

Publication information
Journal: Talanta
Volume: 43
Issue number: 12
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.162 SNIP 1.27 CiteScore 4.19
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.187 SNIP 1.327 CiteScore 3.99
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.201 SNIP 1.296 CiteScore 3.71
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.201 SNIP 1.399 CiteScore 3.74
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.421 SNIP 1.46 CiteScore 3.74
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.429 SNIP 1.518 CiteScore 3.91
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.456 SNIP 1.366
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.319 SNIP 1.338
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2007): SJR 1.428 SNIP 1.506
Determination of Ultra-trace Amounts of Arsenic(III) by Flow Injection Hydride Generation Atomic Absorption Spectrometry with On-line Preconcentration by Coprecipitation with Lanthanum Hydroxide or Hafnium Hydroxide

A time-based flow-injection (FI) procedure for the determination of ultra-trace amounts of inorganic arsenic(III) is described, which combines hydride generation atomic absorption spectrometry (HG-AAS) with on-line preconcentration of the analyte by inorganic coprecipitation-dissolution in a filterless knotted Microline reactor. The sample and coprecipitating agent are mixed on-line and merged with an ammonium buffer solution, which promotes a controllable and quantitative collection of the generated hydroxide on the inner walls of the knotted reactor incorporated into the FI-HG-AAS system. Subsequently the precipitate is eluted with 1 mol/l hydrochloric acid, allowing ensuing determination of the analyte via hydride generation. The preconcentration of As(III) was tested by coprecipitation with two different inorganic coprecipitating agents namely La(III) and Hf(IV). It was shown that As(III) is more effectively collected by lanthanum hydroxide than by hafnium hydroxide, the sensitivity achieved by the former being ca. 25% better. With optimal experimental conditions and with a sample consumption of 6.7 ml per assay, an enrichment factor of 32 was obtained at a sample frequency of 33 samples/h. The limit of detection (3s) was 0.003 µg/l and the precision (relative standard deviation) was 1.0% (n = 11) at the 0.1 µg/l level.

General information
State: Published
Organisations: Department of Chemistry, Division of Food Chemistry, National Food Institute, Department of Chemistry
Authors: Nielsen, S. (Intern), Sloth, J. J. (Intern), Hansen, E. H. (Intern)
Pages: 867-880
Publication date: 1996
Conference: Seventh International Conference on Flow Injection Analysis (ICFIA ’95), Seattle, WA, USA, 01/01/1995
Main Research Area: Technical/natural sciences

Publication information
Volume: 43
Issue number: 6
ISSN (Print): 0039-9140
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.162 SNIP 1.27 CiteScore 4.19
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.187 SNIP 1.327 CiteScore 3.99
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.201 SNIP 1.296 CiteScore 3.71
Determination of Ultra-Trace Amounts of Selenium(IV) by Flow Injection Hydride Generation Atomic Absorption Spectrometry with On-line Preconcentration by Co-precipitation with Lanthanum Hydroxide. Part II. On-line Addition of Coprecipitating Agent

A flow injection procedure for the determination of ultra-trace amounts of selenium(IV) is described, which combines hydride generation atomic absorption spectrometry (HGAAS) with on-line preconcentration of the analyte by co-precipitation-dissolution in a filterless knotted Microline reactor. Based on a previously published procedure that requires the off-line premixing of sample and co-precipitating agent, the present approach facilitates on-line addition of the co-precipitant to the time-based aspirated sample. The sample and the coprecipitating agent (lanthanum nitrate) are mixed on-line and merged with an ammonium buffer solution of pH 9.1, which promotes precipitation and quantitative collection on the inner walls of an incorporated knotted Microline reactor. The Se(IV) preconcentrated by coprecipitation with the generated lanthanum hydroxide precipitate is subsequently eluted with hydrochloric acid, allowing an ensuing determination via hydride generation. At different sample flow rates, i.e., 4.8, 6.4 and 8.8 ml/min, enrichment factors of 30, 40 and 46, respectively, were obtained at a sampling frequency of 33 samples/h. The detection limit (3σ) was 0.005 µg/l at a sample flow rate of 6.4 ml/min and the precision (relative standard deviation) was 0.5% (n = 11) at the 0.1 µg/l level.

General information
State: Published
Flow Injection Analysis: A Revolution in Modern Analytical Chemistry

Flow Injection and Atomic Absorption Spectrometry (FI-AAS) -
One of the advantages of the flow injection (FI) concept is that it is compatible with virtually all detection techniques. Being a versatile vehicle for enhancing the performance of the individual detection devices, the most spectacular results have possibly been obtained in conjunction with atomic absorption spectrometry (AAS). Initially with flame-AAS (fAAS) procedures, later for hydride generation (HG) techniques, and most recently in combination with electrothermal AAS (ETAAS). The common denominator for all these procedures is the inherently precise and strictly reproducible timing in FI from the point of sample injection/introduction to the point of detection. Hence, in FI-fAAS this feature allows not only to obtain improved repeatability but also improved accuracy, and because the wash to sample ratio is high it permits the handling of samples with elevated salt contents - which in conventional operation readily might lead to clogging of the burner. In FI-HG procedures it entails several advantages: Thus, via the generation of the gaseous hydride the analyte is effectively separated from the constituents of the matrix material. Furthermore, the rigorous and exact timing of FI in many instances makes it possible to exploit kinetic discrimination towards species which by their presence potentially might interfere in the hydride generation process or act as mediators for the degradation of the hydrides formed. And not the least, the FI-HG approach opens entirely new avenues for performing suitable on-line sample pretreatment and preconcentration procedures prior to the hydride generation process itself. In FI-ETAAS - which only recently has been explored at any appreciable extent - it promises to yield new and exciting possibilities for determining ultra-low concentrations of a number of (especially HG-forming) elements. In the words of the one of the authorities of AAS and foremost pioneers of FI-AAS - Professor Z. L. Fang, who is the author on two recently published monographs on this hyphenated technique - the impact of FI on AAS is "so dramatic" that it has brought "new vitality to a technique [AAS] which otherwise seemed to be confronted by a period of stagnancy". The communication demonstrates, by several practical examples, especially selected from works conducted in the author's own group, this new vitality.
Sequential Injection Determination of D-Glucose by Chemiluminescence Using an Open Tubular Immobilised Enzyme Reactor

A sequential injection analysis system is described that incorporates a nylon tubular reactor containing immobilised glucose oxidase, allowing determination of D-glucose by means of subsequent luminol chemiluminescence detection of the hydrogen peroxide generated in the enzymatic reaction. The operating parameters were optimised by fractional factorial screening and response surface modelling. The linear range of D-glucose determination was 30-600 μM, with a detection limit of 15 μM using a photodiode detector. The sampling frequency was 54 h⁻¹. Lower LOD (0.5 μM D-glucose) could be reached by using a PMT as the detector. Fermentation broth samples were determined and good recoveries were obtained.
Projects:

Method Development for Automated Analysis of Radionuclides

Risø National Laboratory for Sustainable Energy
Period: 15/03/2008 → 13/04/2011
Number of participants: 7
Phd Student:
Qiao, Jixin (Intern)
Supervisor:
Miró, Manuel (Ekstern)
Roos, Per (Intern)
Main Supervisor:
Hou, Xiaolin (Intern)
Examiner:
Nielsen, Sven Poul (Intern)
Hansen, Elo Harald (Intern)
Lehto, Jukka Kalevi (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

Development of methodologies for determination of trace-level concentrations of element by atomic spectrometry via on-line pretreatment procedures

Department of Chemistry
Number of participants: 7
Phd Student:
Long, Xiangbao (Intern)
Supervisor:
Andersen, Jens (Intern)
Miró, Manuel (Ekstern)
Main Supervisor:
Hansen, Elo Harald (Intern)
Examiner:
Heydorn, Kaj (Intern)
Karlberg, Bo Ingemar (Ekstern)
Larsen, Erik Huusfeldt (Intern)

**Financing sources**
- Source: Internal funding (public)
- Name of research programme: DTU-lønnet stipendie
- Project: PhD

**Microfabricated Devices for Advanced Cuerial Separations**

Department of Micro- and Nanotechnology  
Period: 15/11/1999 → 24/01/2003  
Number of participants: 6  
Phd Student:  
Petersen, Nickolaj Jacob (Intern)  
Supervisor:  
Telleman, Pieter (Intern)  
Main Supervisor:  
Kutter, Jörg Peter (Intern)  
Examiner:  
Hansen, Elo Harald (Intern)  
Verpoorte, Elisabeth M. J. (Ekstern)  

**Financing sources**
- Source: Internal funding (public)
- Name of research programme: Forskningsrådsfinansiering
- Project: PhD

**Exploiting flow injection/sequential injection on-line separation and preconcentration schemes for determination of ultra-trace levels of metals by means of ETAAS and ICPMS**

Department of Chemistry  
Period: 01/10/1999 → 06/12/2002  
Number of participants: 5  
Phd Student:  
Wang, Jianhua (Intern)  
Main Supervisor:  
Hansen, Elo Harald (Intern)  
Examiner:  
Andersen, Jens (Intern)  
Adams, Freddy (Ekstern)  
Larsen, Erik Huusfeldt (Intern)  

**Financing sources**
- Source: Internal funding (public)
- Name of research programme: DTU-lønnet stipendie
- Project: PhD

**Developement, optimisation, and application of ICP-SFMS methods for the measurements of isotope ratios**

Department of Chemistry  
Period: 01/04/1997 → 05/01/2000  
Number of participants: 3  
Phd Student:  
Sturup, Stefan (Intern)  
Main Supervisor:  
Hansen, Elo Harald (Intern)  
Examiner:  
Andersen, Jens (Intern)  

**Financing sources**
FiA on-line opkoncentreringsteknikker og specieringsprocedurer
Department of Chemistry
Period: 01/02/1997 → 09/11/2000
Number of participants: 3
Phd Student:
Nielsen, Steffen (Intern)
Main Supervisor:
Hansen, Elo Harald (Intern)
Examiner:
Mosbæk, Hans (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsstip.-SU, Eksp
Project: PhD

Statistiske metoder til vurdering af kontrol af kemiske referencematerialer
Department of Informatics and Mathematical Modeling
Period: 01/09/1995 → …
Number of participants: 4
Phd Student:
Schramm-Nielsen, Karina Edith (Intern)
Supervisor:
Hansen, Elo Harald (Intern)
Main Supervisor:
Spliid, Henrik (Intern)
Examiner:
Vølund, Aage (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-Su Stipendium, Eksperiment
Project: PhD

Implementation and automation of trace organic analysis in mobile laboratories
Department of Chemistry
Period: 01/02/1994 → 22/07/1997
Number of participants: 5
Phd Student:
Nilsson, Torben (Intern)
Main Supervisor:
Madsen, Jørgen Øgaard (Intern)
Examiner:
Grøn, Christian (Intern)
Hansen, Elo Harald (Intern)
Svensmark, Bo (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Anden Ef-Finansiering-SU
Project: PhD

Anvendelse af statistiske metoder i analytisk kemi.
**Uorganisk sporeelementanalyse med ICP/MS.**

Department of Chemistry  
Period: 01/04/1993 → 27/02/1997  
Number of participants: 4  
Phd Student:  
Behrens, Annette (Intern)  
Main Supervisor:  
Hansen, Elo Harald (Intern)  
Examiner:  
Haraldsson, Conny (Ekstern)  
Mosbæk, Hans (Intern)  

Financing sources  
Source: Internal funding (public)  
Name of research programme: Sektorministerium, Stip-SU  
Project: PhD

**Trace metal analysis in soil, waste water and drinking water by potentiometric stripping analysis (PSA) methods**  
The aim of this project is to obtain methods for differentiation between poisonous and non-poisonous metallic species in the environment. In contrast to conventional PSA, where the reoxidation of the prereduced/preconcentrated analytes in the mercury film of the working electrode is based on the use of mercury ions, this project is concerned on finding alternative means of oxidation thereby obviating the use of mercury ions and hence make the method more environmentally acceptable. This is much in demand, because the method as such is a simple, inexpensive and expedient approach for trace level determinations as compared to the more costly optical procedures commonly applied.

Department of Chemistry  
Department of Chemistry  
Period: 01/01/1993 → …  
Number of participants: 3  
Project participant:  
Andersen, Jens (Intern)  
Johansen, Inge Marie (Intern)  
Project Manager, organisational:  
Hansen, Elo Harald (Intern)  

**Målemetoder under kødfermentering**

Department of Biotechnology  
Period: 01/12/1992 → 27/02/1996  
Number of participants: 3  
Phd Student:
**Waade, Charlotte (Intern)**
Main Supervisor:
Zeuthen, Peter (Intern)
Examiner:
Hansen, Elo Harald (Intern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Program-stipendium
Project: PhD

**FIA and Chemometrics**
This project focuses on the use of scanning detectors (primarily optical) for exploiting the (theoretical) infinite time-dependant data in the matrix, which any FIA-concentration gradient inherently represents, supplemented by application of advanced mathematical and statistical methods to resolve the spectral information, e.g., for simultaneous determination of several components. Previous Ph.D-projects include selective determination of rare earth elements by means of ICP-MS (in cooperation with Research Center Risø), and multivariate methods for the assessment of fundamental quality parameters for frozen fish. Additionally, published results comprize applications to potentiometric stripping analysis (PSA) and FIA-speciation procedures.

Department of Chemistry

Period: 01/01/1985 → …
Number of participants: 2
Project participant:
Andersen, Jens (Intern)
Project Manager, organisational:
Hansen, Elo Harald (Intern)

**Flow Injection Trace Metal Determinations and Speciation Procedures**
These procedures are based on detection via atomic absorption spectrometry (AAS), that is, either flame-AAS, electrothermally heated AAS (ET-AAS), or hydride generation-AAS. Special emphasis is placed on designing on-line preconcentration techniques in order to reach the very low limits of detection required in modern environmental analyses and to obtain sufficient selectivity via separation of the measurand from interfering matrix constituents. The preconcentration techniques comprize the use of incorporated column reactors containing ion-exchangers, exploitation of on-line generation of non-polar complexes which subsequently are selectively extracted, or the use of filterless precipitation/coprecipitation, where the preconcentration in the latter instance is effected by adsorption on the inner wall of a knotted reactor and where the precipitate ensuingly is eluted by a discrete zone of eluent. The research activities in this field is currently (1999/2000) being supplemented with the acquisition of an Inductively Coupled Plasma Mass Spectrometry (ICP-MS) instrument, which promises to entail even lower limits of detection and enhanced selectivity of measurement.

Department of Chemistry

Period: 01/01/1985 → …
Number of participants: 3
Project participant:
Thale, Eva Illum (Intern)
Andersen, Jens (Intern)
Project Manager, organisational:
Hansen, Elo Harald (Intern)

**Financing sources**
Source: Unknown
Name of research programme: Ukendt
Amount: 1,115,000.00 Danish Kroner
Source: Unknown
Name of research programme: Ukendt
Amount: 190,000.00 Danish Kroner
Source: Unknown
Name of research programme: Ukendt
Kinetic FIA-descrimination procedures with the aim of determining transient/metastable species of specific analytically interesting characteristics

Several chemical reactions proceed through intermediary steps, some of which might entail the formation of species of analytically interesting characteristics (such as species of particularly high molar absorptivities as compared to the ultimately generated end-products). Due to its inherent exact and reproducible timing, FIA is a very attractive vehicle to use to detect such species - especially if side reactions entail the formation of coproducts that can give rise to signals at the measurements conditions used.

Department of Chemistry

Flow Injection Enzymatic Assays

This project is concerned at quantifying both substrates and enzyme activities, particularly with detection by optical means (UV/Vis, fluorometry, bio- and chemiluminescence), and including assays based on enzyme amplification schemes. Special emphasis is placed on devising generic systems, that is, FIA-systems which can be designed to serve as templates for a multitude of individual species.

Department of Chemistry

Analytical Chemistry with special emphasis on the use of Flow Injection Analysis

Development and application of methods and procedures based on Flow Injection Analysis (FIA) - whith analytical concept originally was developed by this group in the mid-70'es and about which over 10,000 papers since have been published world-wide in international scientific periodicals. This feat is not the least due to the adaptability of FIA to virtually any type of detection device. Current projects comprize: Enzymatic assays; Trace metal determinations and speciation procedures with detection by atomic absorption spectrometry (AAS) and inductively coupled plasma mass spectrometry (ICP-MS); Kinetic FIA-descrimination procedures with the aim of determining transient/metastable species of specific analytically interesting characteristics; Trace metal analysis in soil, waste water and drinking water by potentiometric stripping methods; and determinations based upon the combination of FIA and chemometrics. The individual projects are briefly described separately in the attached subprojects.
Department of Chemistry

Period: 01/01/1975 → …
Number of participants: 6

Project participant:
Andersen, Jens (Intern)
Behrens, Annette (Intern)
Bechmann, Iben Ellegaard (Intern)
Thale, Eva Illum (Intern)
Johansen, Inge Marie (Intern)

Project Manager, organisational:
Hansen, Elo Harald (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 47,392.00 Danish Kroner
Source: Unknown
Name of research programme: Ukendt
Amount: 30,000.00 Danish Kroner
Source: Unknown
Name of research programme: Ukendt
Amount: 76,239.00 Danish Kroner

Project