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Nomenclature, Symbols, Units and their Usage in Spectrochemical
Analysis – XIII

TERMS RELATED TO CHEMICAL VAPOUR GENERATION

(IUPAC Recommendations 1992)

Prepared for publication by

T. A. M. URE¹, L. R. P. BUTLER², B. V. L'VOV³, I. RUBESKA⁴ and R. STURGEON⁵

¹Department of Pure and Applied Chemistry, University of Strathclyde, Glasgow G1 1XL, UK

²Spectro Analytical Instruments, PO Box 17063, Groenkloof, 0227, RSA

³Department of Analytical Chemistry, Polytechnical Institute, SU-195251, St. Petersburg (Leningrad), USSR

⁴c/o UNDP, PO Box 345, Vientiane, Laos

⁵Division of Chemistry, National Research Council of Canada, Ottawa, Ontario K1A 0R9, Canada

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Nomenclature, symbols, units and their usage in spectrochemical analysis – XIII. Terms related to chemical vapour generation (IUPAC Recommendations 1992)

ABSTRACT

The terms required for the description of chemical vapour generating systems and processes used for the introduction of sample material in optical atomic spectrometry are prescribed. The terms include those relevant to the generation of volatile halides, mercury vapour and the halogens for determination by such spectrochemical techniques. The terminology recommended embraces the gas flow systems involved and the sampling and excitation sources used, in particular, with hydride generation techniques. An index of terms is included.

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- Introduction
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- 1.3 Flow systems for mercury
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INTRODUCTION

A series of documents dealing with nomenclature, symbols and units used in spectrochemical analysis is issued by IUPAC.

Part I (Pure Appl. Chem., 30, 653-679 (1972)) and Part II (Pure Appl. Chem., 45, 99-103, (1976)) are concerned mainly with general recommendations in the field of emission spectrochemical analysis. Part III (Pure Appl. Chem., 45, 105-123 (1976)) deals with the nomenclature of analytical flame spectroscopy and associated procedures. Part IV (Pure Appl. Chem., 52, 2541-2552 (1980)) concerns X-ray emission (and fluorescence) spectroscopy. Part V (Pure Appl. Chem., 57, 1453-1490 (1985)) deals with the classification and description of radiation sources. Part VI (Pure Appl. Chem., 56, 221-245 (1984)) covers molecular luminescence spectroscopy. Part VII (Pure Appl. Chem., 60, 1449-1460 (1988)) is concerned with molecular absorption spectroscopy (UV/VIS). Part VIII (Pure Appl. Chem., 63, 735-746, 1991), proposes a new nomenclature system for X-ray spectroscopy. Part IX deals with instrumentation for the dispersion and isolation of optical spectra and Part X (Pure Appl. Chem. 60, 1461-1472 (1988)) is concerned with the preparation of materials for analytical spectroscopy. Part XI, in preparation, deals with radiation detectors. This report, Part XIII, deals with the techniques of chemical vapour generation used in optical atomic spectrometry to introduce the sample into a sampling or excitation source (See Part V of this series).

1.1 CHEMICAL VAPOUR GENERATION SYSTEMS

In chemical vapour generation the analyte is separated from the sample matrix by the generation of gaseous species as a result of a chemical reaction. This technique has received its widest application in atomic absorption spectrometry (AAS) in the forms of cold vapour AAS (CVAAS) for the determination of mercury and hydride generation AAS (HGAAS) for elements forming gaseous covalent hydrides (As, Bi, Ge, In, Pb, Sb, Se, Sn and Te). Chemical vapour generation is also used in combination with optical emission and atomic fluorescence spectrometry. Carbonyl generation, halogen generation and the

generation of other volatile species have so far only been used rather exceptionally in spectrochemical analysis. The gaseous species generated, is introduced, usually with a stream of purge gas, into a sampling source for measurement by AAS or atomic fluorescence spectrometry (AFS) or into an excitation source such as an inductively coupled plasma (ICP) for measurement by optical emission spectrometry (OES). This document is mainly concerned with its application in AAS but analogous terms can readily be coined for other applications.

The vapour-generating assembly, including gas flow controls and means for the addition of reactants used for the production of the volatile species, is the hydride generator, mercury-vapour generator, or other generator.

If specified volumes of the sample and reactant solutions are mixed at the beginning of the measuring process the generation proceeds in a batch mode. In a continuous mode the blank, the reference or the sample solutions are added successively to a continuous flow of the reactant.

In the continuous mode the volatile species formed is liberated from the reacting solution spontaneously in a phase separator. In the batch mode liberation takes place in the generator vessel and is accelerated by stirring, agitation or by passing a purge gas through the solution. The purge gas may be hydrogen in hydride generation or air in mercury generation, or it may be an inert gas such as N_2 or Ar.

1.2 GAS FLOW SYSTEMS

In a direct transfer system the purge gas transports the analyte directly to the sampling or excitation sources. In a collection system the analyte is carried to a collecting device called the collector which may be an amalgamator for mercury, a cold trap for some of the more stable hydrides, an absorbing solution in which the analyte is absorbed by some chemical reaction, an electrothermal atomizer, or a reservoir.

Collection systems may be used as concentrators, in order to lower the limits of detection. This is achieved if the analyte is released during a shorter time period, the release time, than, the collection time. a collector may also be used simply to make the vapour generation and the measurement independent in time and space or to separate interfering species. In this case vapour generation with analyte collection is equivalent to a separation technique, the collector then becoming the actual analytical sample (See Part X, Section 3.4).

1.3 FLOW-SYSTEMS FOR MERCURY

For mercury released directly as atomic vapour, different direct transfer systems have been used. In an open dynamic system the liberated analyte is transported by a carrier gas through the sampling or excitation source and swept away. To eliminate the effects caused by the kinetics of reduction and liberation of mercury, equilibrium between the gas and liquid phases may first be established before mercury is swept through the sampling or excitation source.

In an (open) static system the equilibrated gaseous phase is forced into the absorption cell by displacement, e.g. by water. During measurement the gaseous phase is thus static.

In a closed system the analyte and carrier gas are circulated through the absorption cell and the generator vessel until equilibrium between the liquid and gaseous phases is established.

1.4 SAMPLING AND EXCITATION SOURCES USED WITH HYDRIDE GENERATION TECHNIQUES

For OES and AFS measurements a conventional plasma source such as an ICP or a microwave induced plasma is generally used. the flames used for AFS or AAS measurements are usually specialised types such as the hydrogen diffusion flame or the inert gas-hydrogen diffusion flame (See also Part III) which have lower background absorbance and exhibit less quenching than premixed hydrocarbon flames yet have high atomization efficiency for hydrides.

For AAS measurements the electrically- or flame-heated silica tube furnace is most often used. Flame-heated silica tubes are generally T-shaped with one inlet arm at the centre and two outlets. Electrically heated tubes may have both ends closed by optical windows and be provided with an inlet and outlet arm near the ends.

In a flame-in-tube atomizer hydrogen, used as carrier gas, is partially combusted in the inlet arm of a T-shaped tube furnace by introducing a limited amount of oxygen or air. Hydrides can also be collected and atomized in graphite tube or other electrothermal atomizers (See Part XII).

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