The Metrologist

Edition 5 June 2017

Reagecon

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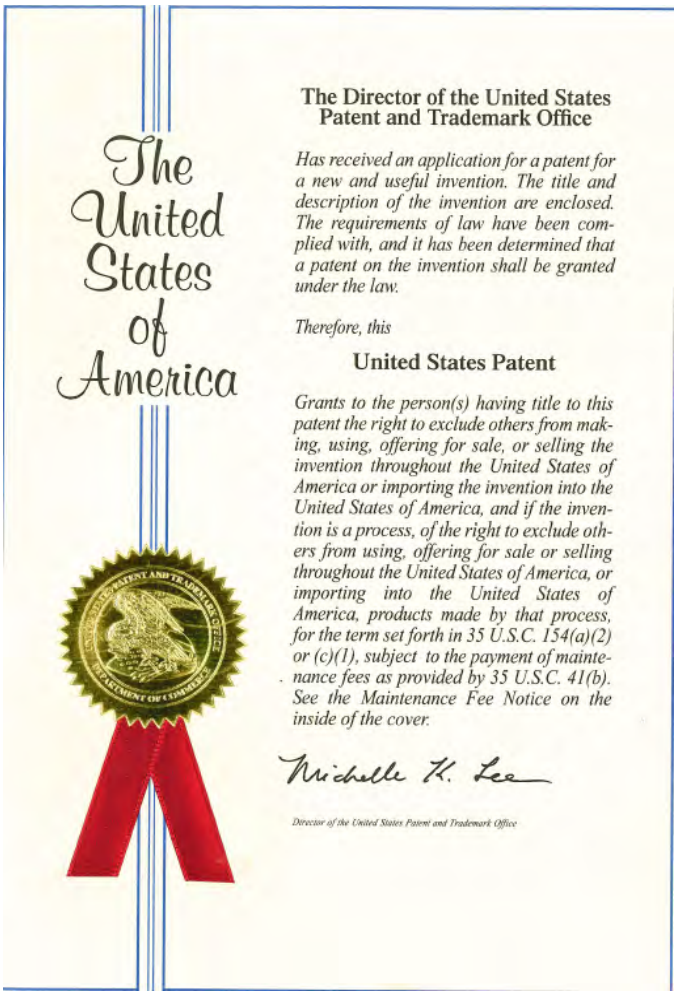


The United States of America

The Director of the United States Patent and Trademark Office

Has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

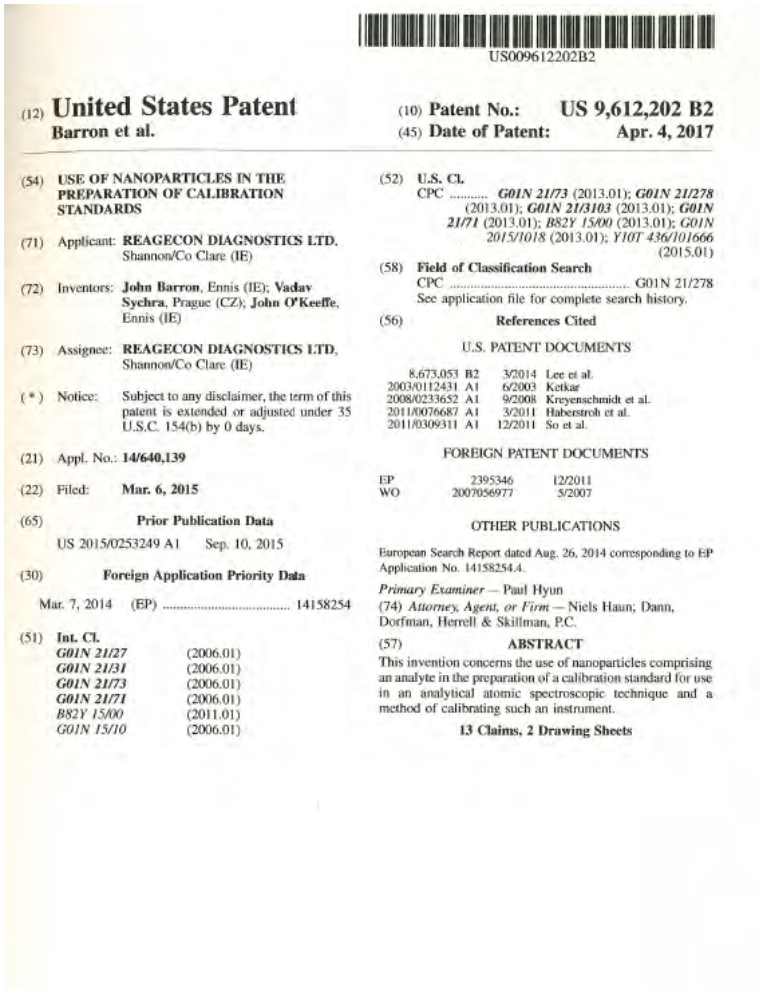
Therefore, this

United States Patent

Grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America, and if the invention is a process, of the right to exclude others from using, offering for sale or selling throughout the United States of America, or importing into the United States of America, products made by that process, for the term set forth in 35 U.S.C. 154(a)(2) or (c)(1), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b). See the Maintenance Fee Notice on the inside of the cover.

Michelle K. Lee

Director of the United States Patent and Trademark Office



US009612202B2

(12) **United States Patent**
Barron et al.

(10) **Patent No.: US 9,612,202 B2**
(45) **Date of Patent: Apr. 4, 2017**

(54) **USE OF NANOPARTICLES IN THE PREPARATION OF CALIBRATION STANDARDS**

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(73) Assignee: **REAGECON DIAGNOSTICS LTD**, Shannon/Co Clare (IE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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G01N 15/10	(2006.01)

(52) **U.S. Cl.**

CPC ***G01N 21/73*** (2013.01); ***G01N 21/278*** (2013.01); ***G01N 21/3103*** (2013.01); ***G01N 21/71*** (2013.01); *B82Y 15/00* (2013.01); *G01N 2015/1018* (2013.01); *Y10T 436/101666* (2015.01)

(58) **Field of Classification Search**

CPC G01N 21/278

See application file for complete search history.

(56) **References Cited**

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(74) *Attorney, Agent, or Firm* — Niels Haun; Dann, Dorfman, Herrell & Skillman, P.C.

(57) **ABSTRACT**

This invention concerns the use of nanoparticles comprising an analyte in the preparation of a calibration standard for use in an analytical atomic spectroscopic technique and a method of calibrating such an instrument.

13 Claims, 2 Drawing Sheets

'The Use of Nanoparticles in the Preparation of Calibration Standards' A recent United States Patent granted to Reagecon.

Dear Customers, Readers and Business Partners

Welcome to the latest edition of the Metrologist.

Our New Product Development (NPD) program continues to expand at a very rapid pace and we are delighted to now offer you, a very comprehensive range of On-line Analyser, Standards and Reagents. The various chemistries, types of instruments they are used on, the typical testing regime and variety of standards available from Reagecon are covered in summary in pages 23-26 of this edition of The Metrologist. A more comprehensive catalogue containing part numbers, product compatibility with manufacturers makes and models and packing options will be prepared shortly, available in both hardcopy format and on our website. The official listing of the full range will be released in October 2017. We hope that this offering will provide you with real choice and value. We believe this product range is a significantly better package than is presently available in the marketplace.

The quantitative measurement of cations and anions, is of huge significance in a wide and ever-growing range of industries. Detection limits, specificity, accuracy, precision and several other metrological parameters are of increasing importance to analysts. Reagecon has responded with a wide array of standard options suitable for spectroscopic and electrochemical analysis of cations and anions. The meticulous preparation, processing, calibration, verification and validation steps that we apply to standard preparation and manufacture is covered in detail in this edition of The Metrologist. These steps reflect the importance we attribute to this field of science and the information provided here, in addition to a wealth of other information and detail on Cation and Anion measurement, will be disseminated in our new textbook called "Spectroscopic and Electrochemical Measurement of Cations and Anions; Metrology, Calibration and Control." which will be published by Reagecon in October 2017. We believe the level of detail contained in this publication will be of use in your daily analysis and will guide you on sample management and also provide a complete product guide on the proper use of standards. The book will also contain details on XRF standards which will be part of a new offering from Reagecon in late 2017.

In addition to applied research, our Research and Development Department have engaged in a number of areas that are, or will be, subject to journal publication or patent protection. Once such area is 'The Use of Nanoparticles in the Preparation of Calibration Standards' which has been the subject of a number of patent awards including a recent United States Patent, the details of which are shown on the graphics on page 1. This area of futuristic research will also be covered in the textbook referred to above.

Finally, on behalf of all of my colleagues at Reagecon, we hope that the contents of this edition of The Metrologist and the forthcoming textbook will offer you benefit and value. I would like to formally thank you all for your support, customer feedback and encouragement.

John J Barron
Editor

Reagecon's Physical and Chemical Standards Compendium.

In the past few years substantial changes have occurred in the field of Analytical Chemistry. Stringent regulatory demands, combined with major economic implications and increased competitiveness, places necessity for validation on every analytical test performed, either in the laboratory or in the field. Not only must the correct result be obtained, but proof must also be provided of its fitness for purpose, validity and accuracy. Such proof must then be accessible, retrievable and presented in an easily understood format. Reagecon continues to respond to these challenges by presenting to its customers, an ever increasing range of highly specified, stable, traceable and certified standards.

The use of standards such as calibrators or control materials can greatly increase the possibility for the analyst to obtain the correct result and can provide definitive proof of the correctness of such a result from a technical perspective. Such materials can also be used for method validation, instrument qualification, verification and analyst qualification.

Since the beginning of 2011, we have developed a major pipeline of new products and in our 2016 Compendium, we now have a broader and more comprehensive range of physical and chemical standards than any other producer worldwide. We are privileged to be able to present these new ranges to you, (in excess of 8,000 product numbers). This is the largest range of physical and chemical standards ever presented in one publication.

We hope you find this compendium beneficial; that the products on offer match your technical specifications; represent value for money and that they will greatly enhance your ability to achieve valid and correct analytical results now and in the future. Many of the chapters and families of products contained within the compendium are introduced with detailed technical notes. The compendium can be viewed in full on our website www.reagecon.com and the following summarises the contents.

Organic Standards

- Volatile Organic Compound Standards (VOCs)
- Phenol Standards
- Polycyclic Aromatic Hydrocarbon Standards (PAHs)
- Pesticide Standards
- Azo Dye Metabolite Standards
- Fatty Acid Methyl Ester & Fatty Acid Ethyl Ester Standards (FAME & FAEEs)
- Nitrosamine Standards
- Polybrominated Biphenyl Standards (PBBs)
- Polybrominated Diphenyl Ethers (PBDE) & Other Flame Retardant Standards
- Polychlorinated Biphenyl Standards (PCBs)
- Phthalate Standards
- Semi Volatile Organic Compound Standards (SVOCs)
- PIANO, PONA & PNA Standards
- Petrochemical Standards

Total Organic Carbon/Total Inorganic Carbon Standards

- Premium Range
- Quality Range
- Instrument Specific Range

Electrochemistry Standards

- Conductivity Standards
- pH Buffer Solutions
- Electrode Care & Maintenance Solutions
- Redox Standards
- Turbidity Standards
- Chemical Oxygen Demand
- Ion Selective Electrode Standards & Ionic Strength Adjustors

Standards for Anion & Cation Analysis

- ICP-MS/ICP-OES Standards
- Ion Chromatography Standards
- Atomic Absorption Standards
- Flame Photometry Standards

Titration

- Analytical Volumetric Solutions & Indicator Solutions
- Total Acid Number/ Total Base Number Standards & Reagents

Physiochemical Standards

- Colour Standards
- Spectrophotometry Standards
- Melting Point Standards
- Density Standards - Premium Range
- Density Standards - Quality Range
- Viscosity Standards
- ISO Guide 34 Certified Reference Materials: Sucrose in Water Standards
- Brix Standards (Stabilised)
- Refractive Index Standards
- Osmolality Standards
- Cryoscope Standards

Standards & Solutions in Compliance to Pharmacopoeias

- United States Pharmacopoeia Solutions
- European Pharmacopoeia Solutions
- Buffered Eluents
- Dissolution Media - Concentrates
- Dissolution Media - Ready to use

Industry Specific Standards & Reagents

- Dairy Standards & Reagents
- Standards & Reagents for APHA, AWWA & WEF Test Methods
- Wine Standards & Reagents
- Soil Testing Standards & Reagents
- Pulp & Paper Standards & Reagents

General Laboratory Standards & Reagents

- Laboratory Water
- Cleaning Solutions
- Analyst Qualification Sets

CASE STUDY: Integrated System Technology Company in the United Kingdom

The Chief Chemist within this company with responsibility for a Chemical and Metallurgical Laboratory, has been working with Reagecon for six years. The laboratory provides critical support to the Manufacturing Division through the chemical analysis of the composition of plating solutions for process control purposes, as well as the analytical testing of process and waste waters/trade effluent.

X-Ray Fluorescence and Atomic Absorption techniques are used to analyse the various metals in use in the plating process solutions and waste water applications. These metal solution standards include compositions at grams per litre to replicate plating solutions and trace content levels at parts per million to replicate waste water/trade effluent applications.

The laboratory identified the requirement for bespoke standards to calibrate X Ray Fluorescence and Atomic Absorption instruments. Reagecon embarked on a partnership programme to work with this company to mutually develop these standards to the required specifications.

Reagecon's manufacturing techniques and quality systems provide a much higher level of accuracy than those that this company could have practically manufactured themselves.

Reagecon's Rigaku ZSX Primus II XRF Instrument

Reagecon's Dionex Ion Chromatograph with CD20 conductivity Detector, EG40 Eluent Generator, LC20 Chromatography Enclosure, GP40 Gradient Pump, AS50 Autosampler & Phenomenex TS-430 HPLC Column

Commenting on the relationship with Reagecon, this customer said: “Reagecon have provided an outstanding service to ourselves throughout the course of our relationship. Their Custom Made Solutions are critical to instrumentalise everything we do. The personnel from the account managers to the technical services chemists have provided a personable service that you don’t often find in industry today. We have used Reagecon’s Standards for 6 years including: Atomic Absorption, pH Buffers (NIST Traceable), ICP (Inorganic Spectroscopy Standards), plus a range of custom-blend liquid ICP/XRF.’

Reagecon’s standards gives them the confidence they need in delivering the required results. The traceability of the products ensures accuracy, flexibility of manufacture for the required custom blends, and competitive pricing.

Reagecon's Thermo Integrion Ion Chomatograph

Reagecon's Agilent Technologies 200 Series FAAS.

Ion Selective Electrode Standards & Ionic Strength Adjustors

Introduction

Ion Selective Electrodes, (ISEs) allow specific and quantitative measurement of a wide range of cations, anions and some dissolved gases. These ions can be measured directly like pH measurement, indirectly or by titrimetry. ISEs respond selectively to the relevant ion activity exactly like pH electrodes respond to hydrogen ion activity. Like pH electrodes, they require a suitable reference electrode, preferably a double junction system. They also require a pH or ion meter and a selection of filling solutions for the outer and inner chambers of the reference electrode. In some instances the reference and sensing electrodes may be combined into one unit.

Types of Measurement-Direct

Direct measurement is performed exactly like the measurement of pH. The electrode is calibrated using two concentrations of the relevant standard which are chosen to bracket the expected value of the sample. More than two calibration standards may be used for better linearity or more accurate measurement and a standard curve of mV reading versus concentration of various standards can be constructed.

However, the measurement technique deviates from pH in that both sample and standards require the addition of an Ionic Strength Adjustor (ISA). The addition of this solution confers the following benefits:

- The ionic strength of the adjustor is much higher than the ionic strength of the sample or standard so it keeps the ionic strength of both high, constant and similar and thus enables what is effectively activity measurement to be read as concentration.
- The ionic strength adjustor (which should never react with the sample or standard chemically) also keeps the pH value constant in some instances. This combined with high ionic strength and the chemistry of the ISA suppresses or eliminates interfering ions.
- The ISA when added to sample and standard eliminates any matrix, hysteresis or erroneous liquid junction potentials that might affect the accuracy of the test result.
- Calibration need only be performed occasionally or not at all, therefore only ISA needs to be added to the sample.
- The possibility of error due to a temperature co-efficient of variation between the sample and standard is largely eliminated.
- The ion concentration of solid samples can be measured.
- The range of types of ions measured and the versatility of the technique is greatly enhanced by careful and considered selection of the optimal indirect method. This is true, in particular, with standard or sample subtraction, where precipitation or complexation may be performed, or where the counter ion to that contained in the standard is measured.

Types of Measurement-Indirect

Standard Addition

Standard addition methods are widely employed where samples are measured infrequently as calibration is not required. A known volume of sample is measured by ISE and the potential recorded. A known volume of a standard of known concentration is then added into the sample and the resulting potential is measured. From both of these measurements the concentration of the sample can then be calculated.

Sample Addition

This is performed in a similar manner to standard addition except that a known volume of standard is first measured and to this a known volume of sample is added. This method is applicable to samples of high concentration of ion in solid water soluble samples.

Standard Subtraction

Using this method a known amount of a Standard Ion Solution (usually 10ml) is added to a known volume of sample (usually 100ml). The standard reacts with, precipitates or complexes the ion of interest, reducing its concentration in the sample quantitatively. This method extends the usefulness of an ISE above the upper concentration range of linear response and therefore eliminates the need for serial dilutions.

Sample Subtraction

A known volume of a sample is added to a known volume of standard solution. The sample species is totally precipitated or complexed by the standard species. Therefore the counter ion of the standard solution is the ion which is sensed. This method expands the application of ISEs to those ions which are not directly sensed by the ISE but which react with the ion which is sensed by the ISE. The method can also be applied to solid samples which will dissolve in the standard solution and be complexed or precipitated by it.

Indirect Methods offer many advantages to the analyst:

-The analysis is simplified as ionic strength adjuster need only be added to the sample and not a full set of standards

-Calibration need only be performed occasionally, as only the electrode slope needs to be known because electrode drift has no effect on performance of indirect methods.

-Where sample (or standard) temperature can vary, such as in field measurement, then indirect methods are more accurate provided that the added species is kept to a small volume relative to the sample to minimise temperature change.

-Solid samples can be determined by sample addition if the sample is water soluble.

-If it is known that the ion of interest is precipitated or complexed stoichionmetrically by an ion for which an ISE exists (e.g. SO_4 is precipitated by Ba or Pb), then the subtractive technique can be used.

Use of Controls

As with all analytical measurements, no test should be performed without the use of control material. The control should be treated in exactly the same way as the sample including the addition of ISA, thereby picking up any error in the measurement technique, whether it be due to the analyst, environment, meter, sensors or sample in line with the execution of good laboratory produce. Reagecons ISE standards, diluted to a suitable concentration, are particularly suitable for use as control material.

A selection of Ion Selective Standards and Ionic Strength adjustors available from Reagecon can be seen in Table 1.

Reagecon's Ion Selective Standards and Ionic Strength Adjustors

Product No.	Description
ISENH5	Ammonia 1000ppm as N
ISENH45	Ammonium 1000ppm as NH_4
ISEBA5	Barium 1000ppm
ISEBR5	Bromide 1000ppm
ISECD5	Cadmium 1000ppm
ISECA5	Calcium 1000ppm
ISECO5	Carbon Dioxide 1000ppm
ISECL5	Chloride 1000ppm
ISECU5	Copper 1000ppm
ISECN025	Cyanide 1000ppm
ISECN5	Cyanide 1000ppm
ISEF5	Fluoride 1000ppm
ISEI5	Iodide 1000ppm
ISEPB5	Lead 1000ppm
ISEMG5	Magnesium 1000ppm
ISEHG5	Mercury 1000ppm
ISEN5	Nitrate 1000ppm as NO_3
ISENO5	Nitrogen Oxide 1000ppm as NO_2
ISEPCL5	Perchlorate 1000ppm
ISEK5	Potassium 1000ppm
ISEAG5	Silver 1000ppm
ISENA5	Sodium 1000ppm
ISES5	Sulphide 1000ppm
ISESCO5	Sulphur Dioxide 1000ppm
ISESC5	Thiocyanate 1000ppm
ISEWH5	Water Hardness Standard 1000ppm $CaCO_3$

Product No	Description
ISANH5	Ammonia 10M NaOH
ISANH45	Ammonium 4M LiCl
ISABA5	Barium 4M LiCl
ISABR5	Bromide 5M $NaNO_3$
ISACD5	Cadmium 5M $NaNO_3$
ISACA5	Calcium 4M KCl
ISACO5	Carbon Dioxide Solution
ISACL5	Chloride 5M $NaNO_3$
ISACU5	Copper 5M $NaNO_3$
ISACN5	Cyanide 10M NaOH
TISAF5	Fluoride TISAB3
ISAI5	Iodide 5M $NaNO_3$
ISAPB5	Lead 2.5M $NaNO_3$
ISAMG5	Magnesium 4M KCl
ISAHG5	Mercury 5M $NaNO_3$
ISAN5	Nitrate 2M $(NH_4)2SO_4$
ISAPCL5	Perchlorate 2M $(NH_4)_2SO_4$
ISAK5	Potassium 5M NaCl
ISAAG5	Silver 5M $NaNO_3$
ISANA5	Sodium Based Standard
ISAS5	Sulphide 10M NaOH
ISASO5	Sulphur Dioxide 2M H_2SO_4
ISASC5	Thiocyanate 5M $NaNO_3$
ISAWH5	Water Hardness 4M KCl Solution

Table 1

Other Concentrations are available on request. All products listed above are supplied in 500ml bottles.

Atomic Absorption Standards

Reagecon manufacture an extensive range of aqueous AA Standards. These include standards for the measurement of the most common alkali and transition metals. There are two types of Atomic Absorption Spectrometry, (AAS). Flame Atomic Absorption Spectrometry, (FAAS) and Graphite Furnace Atomic Absorption Spectrometry (GFAAS).

In Flame Atomic Absorption Spectrometry, (FAAS) either an air/acetylene or a nitrous oxide/acetylene flame can be used to evaporate the solvent and dissociate the sample into its component atoms. When light from a hollow cathode lamp (selected based on the element to be determined) passes through the cloud of atoms, the atoms of interest absorb the light from the lamp. This is measured by a detector, and used to calculate the concentration of that element in the original sample. The use of a flame limits the excitation temperature reached by a sample to a maximum of approximately 2600°C (with the Nitrous Oxide / acetylene flame). For many elements this is not a problem. However, there are a number of refractory elements like V, Zr, Mo and B which do not perform well with a flame source. This is because the maximum temperature reached, even with the N_2O/ acetylene flame, is insufficient to break down compounds of these elements. As a result, flame AAS sensitivity for these elements is not as good as other elemental analysis techniques. FAAS is an inexpensive technique, is rapid for a few selected elements, however, it has poor sensitivity (high detection limits), is limited to single element determination each time and requires a large amount of sample. It has a narrow linear range.

Graphite Furnace Atomic Absorption Spectrometry (GFAAS) - This technique is essentially the same as FAAS, except the flame is replaced by a small, electrically heated graphite tube, or cuvette, which is heated to a temperature up to 3000°C to generate the cloud of atoms. The higher atom density and longer residence time in the tube improve furnace AAS detection limits by a factor of up to 1000x compared to flame AAS, down to the sub-ppb range. However, because of the temperature limitation and the use of graphite cuvettes, refractory element performance is still somewhat limited.
GFAAS is relatively inexpensive and requires small sample volume, it has excellent sensitivity (low detection limits) however it is also limited to single element determination and has a narrow linear range.

12 Important Facts about Reagecon's Atomic Absorption Standards

1. Use similar raw materials to those used in the manufacture of Reagecon's ICP-MS/ICP-OES Standards. This means using pure metals where possible of greater than 99.999% purity, or where not possible using metals of 99.995% purity or where not available, using metals or salts of 99.9% purity.
2. All products for Atomic Absorption are produced in class ISO7 (10,000) clean room conditions.
3. All Raw materials are assayed for purity by ICP-MS and titration prior to manufacture. This provides two layers of traceability.
4. Products are certified gravimetrically, Reagecon holds ISO 17025 accreditation for the calibration of laboratory balances.
5. All final products are assayed by titimetry and verified using an ICP-MS instrument or in the case of alkali metals by an AAS instrument.
6. All products traceable to a primary standard or certified reference material or in a lot of instances both of the above.
7. A wide range of customised options are available.
8. More element mixtures can be formulated and certified upon request.
9. Several matrix modifiers(10) and releasing agents (4) formulations available.
10. All standards are available at 1000 ppm and 10,000 ppm plus several additional concentrations.
11. Widest range available from any supplier.

For further details contact sales@reagecon.ie
Significant Additional Product Detail on Reagecon's Atomic Absorption Standards can be found in our Physical and Chemical Standards Compendium.

Flame Photometry Standards

1.0 Theory

The benefits of measuring electromagnetic radiation emitted by atoms subjected to flame excitation has been recognised for over 150 years in analytical chemistry. In the intervening period instrumentation capable of exploiting this principle has been developed, refined and commercialised by several companies using a number of technologies. Flame photometry is particularly suitable for measuring the concentration of Alkali and Alkaline Earth metals in several matrices by exploiting a characteristic of such metals whereby, their atoms reach an excited state at a lower temperature than most other metals.

The instrument operates on the principle that the metals are thermally dissociated into atoms and the electrons in some of these atoms are excited by the flame. When the excited atoms return to their normal state, they emit electromagnetic radiation which lies mainly in the visible region. The wavelengths of this radiation are easily isolated by an optical filter from those of most other elements and then converted to an electric signal. This signal is a direct function of the concentration of the particular metal in the sample, control or standard. The spectra produced are simple, free of interference and well suited to quantifiable measurement.

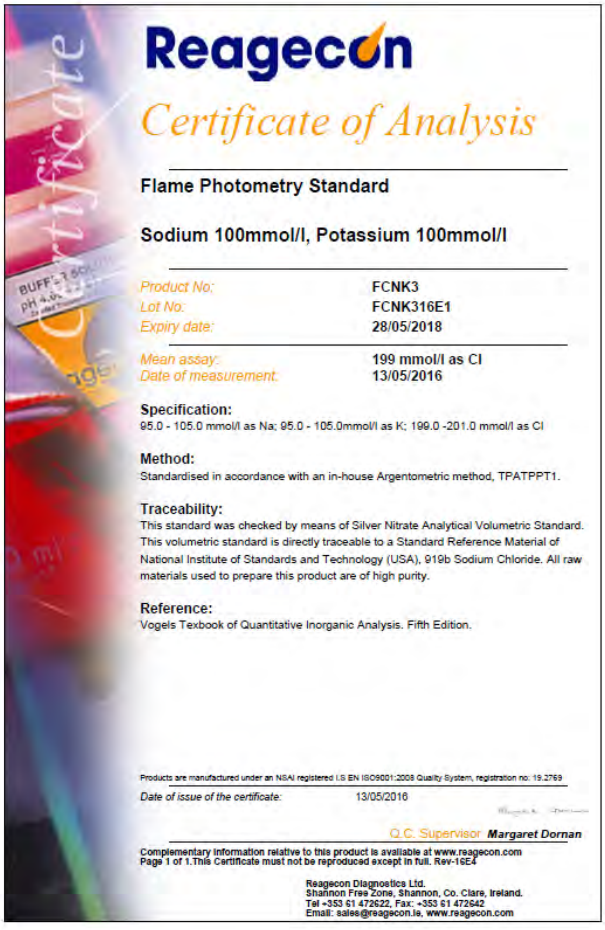
Flame Photometry Standards may be used to:

1) Calibrate the instrument in preparation for testing.

2) Control the entire testing process to include:
   - The flame photometer
   - Sample
   - Operator
   - Measuring environment

   Any of these four factors can influence the accuracy and precision of the analysis and give erroneous results.

3) Perform instrument qualification
4) Assist in method validation of a particular flame photometry technique



Reagecon

Certificate of Analysis

Flame Photometry Standard

Sodium 100mmol/l, Potassium 100mmol/l

Product No:	FCNK3
Lot No:	FCNK316E1
Expiry date:	28/05/2018
Mean assay:	199 mmol/l as Cl
Date of measurement:	13/05/2016

Specification:
95.0 - 105.0 mmol/l as Na; 95.0 - 105.0mmol/l as K; 199.0 -201.0 mmol/l as Cl

Method:
Standardised in accordance with an in-house Argentometric method, TPATPPT1.

Traceability:
This standard was checked by means of Silver Nitrate Analytical Volumetric Standard. This volumetric standard is directly traceable to a Standard Reference Material of National Institute of Standards and Technology (USA), 919b Sodium Chloride. All raw materials used to prepare this product are of high purity.

Reference:
Vogels Texbook of Quantitative Inorganic Analysis. Fifth Edition.

Products are manufactured under an NSAI registered I.S EN ISO9001:2008 Quality System, registration no: 19.2769

Date of issue of the certificate: 13/05/2016

Q.C. Supervisor *Margaret Dornan*

Complementary information relative to this product is available at www.reagecon.com
Page 1 of 1.This Certificate must not be reproduced except in full. Rev-16E4

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2.0 Applications

Flame Photometry is a valuable technique for the measurement of Sodium, Potassium and Calcium in all sample types in: Mineral Extraction, Oil Industry, Paper Industry, Pharmaceuticals, Soil Analysis, Utilities, Food & Beverage, Chemical Manufacture and Fertilisers.
It may also be used to determine:

- Alkalis in Cement
- Calcium in:
  - Beer
  - Biological Fluids Reagents Preparation
  - Biscuits
  - Fruit Juice
  - Milk.
- Lithium in Greases
- Potassium in:
  - Blood Serum
  - Fertilizers
  - Glass
  - Mixtures Containing Plant Derived ResinsPlant Extracts
  - Fruit Juice
  - Silicates ,Minerals & Ores
- Sodium in:
  - Fruit Juice
  - Silicates, Minerals & Ores
  - Blood Serum
  - Fuel
  - Grass
  - Pine Oil
  - Straw
  - Soils

3.0 Key features and Benefits of Reagecon's Flame Photometry Standards

- Single and multi-element solutions available
- Wide range of values and elements
- A very high accuracy supported by a certificate of analysis which can be downloaded online
- Products are non-hazardous, non-toxic and SDS (Safety Data Sheets) can also be downloaded
- All products manufactured and tested in a GLP (Good Laboratory Practice) environment.
- Reagecon's Single Element Standards for Industrial and Clinical Applications can be seen in Tables 2 & 3, and Multi Element Standards in Table 4.

Industrial Standards

Product No.	Description	Concentration	Pack Size
FIBA1	Barium	1,000ppm	500ml
FIBA3	Barium	3,000ppm	500ml
FIBA10M	Barium	10,000ppm	500ml
FICA1	Calcium	1,000ppm	500ml
FICA2	Calcium	2,000ppm	500ml
FICA10M	Calcium	10,000ppm	500ml
FICS1	Cesium	1,000ppm	500ml
FILI1	Lithium	1,000ppm	500ml
FILi10M	Lithium	10,000ppm	500ml
FINA1	Sodium	1,000ppm	500ml
FINA10M	Sodium	10,000ppm	500ml
FIK1	Potassium	1,000ppm	500ml
FIK10M	Potassium	10,000ppm	500ml
FISR1	Strontium	1,000ppm	500ml
FIRB1	Rubidium	1,000ppm	500ml

Table 2

Clinical Standards

Product No.	Description	Pack Size
FCNK3	Sodium 100mmol/l and Potassium 100 mmol/l	500ml
FCNK4	Sodium 120mmol/l and Potassium 2 mmol/l	500ml
FCNK5	Sodium 140mmol/l and Potassium 5 mmol/l	500ml
FCNK1	Sodium 160mmol/l and Potassium 8 mmol/l	500ml
FCNK2	Sodium 160mmol/l and Potassium 80 mmol/l	500ml
FCLI001	Lithium 1 mmol/l	500ml
FCNK6-M	Sodium 30mmol/l and Potassium 20mmol/l	100ml
FCNK6-S	Sodium 30mmol/l and Potassium 20 mmol/l	2ml
FCNK7-M	Sodium 60mmol/l and Potassium 40mmol/l	100ml
FCNK7-S	Sodium 60mmol/l and Potassium 40mmol/l	2ml
FCNK8-M	Sodium 90mmol/l and Potassium 60mmol/l	100ml
FCNK8-S	Sodium 90mmol/l and Potassium 60mmol/l	2ml
FCNK9-M	Sodium 120mmol/l and Potassium 80mmol/l	100ml
FCNK9-S	Sodium 120mmol/l and Potassium 80mmol/l	2ml
FCNK10-M	Sodium 150mmol/l and Potassium 100mmol/l	100ml
FCNK10-S	Sodium 150mmol/l and Potassium 100mmol/l	2ml
FCNK11-M	Sodium 180mmol/l and Potassium 120mmol/l	100ml
FCNK11-S	Sodium 180mmol/l and Potassium 120mmol/l	2ml
FCNK12-M	Sodium 210mmol/l and Potassium 140mmol/l	100ml
FCNK12-S	Sodium 210mmol/l and Potassium 140mmol/l	2ml

Table 3

Multi-Element Linearity Standards

Product No.	Description	Concentration	Pack Size
FPLE5		Low	500ml
	Barium	28.8ppm	
	Calcium	18.2ppm	
	Lithium	1.91ppm	
	Potassium	2.09ppm	
	Sodium	2.15ppm	
FPME5		Medium	500ml
	Barium	105ppm	
	Calcium	52.4ppm	
	Lithium	5.42ppm	
	Potassium	5.37ppm	
	Sodium	5.67ppm	
FPHE5		High	500ml
	Barium	510ppm	
	Calcium	112ppm	
	Lithium	10.0ppm	
	Potassium	11.4ppm	
	Sodium	11.3ppm	
FPHK3	Combination of FPLE5, FPME5 & FPHE5	As above	3 x 500ml

Table 4

Ion Chromatography Standards

1.0 Theory

Ion Chromatography (IC) allows for the separation of ionisable molecules on the basis of differences in charge properties. Its large sample-handling capacity, broad applicability (particularly to proteins and enzymes), moderate cost, powerful resolving ability, and ease of scale-up and automation have led to it becoming one of the most versatile and widely used of all liquid chromatography (LC) techniques. In cation exchange chromatography positively charged molecules are attracted to a negatively charged solid support. Conversely, in anion exchange chromatography, negatively charged molecules are attracted to a positively charged solid support. It uses the electrochemical charge as a means to separate ions in the liquid phase based on their charge. Anions (negatively charged ions) and cations (positively charged ions) are selectively eluted from a column by changing the ionic concentration of the mobile phase.

2.0 Applications

Ion Chromatography measures concentrations of ionic species by separating them based on their interaction with a resin on the element. Some typical applications of ion chromatography include:

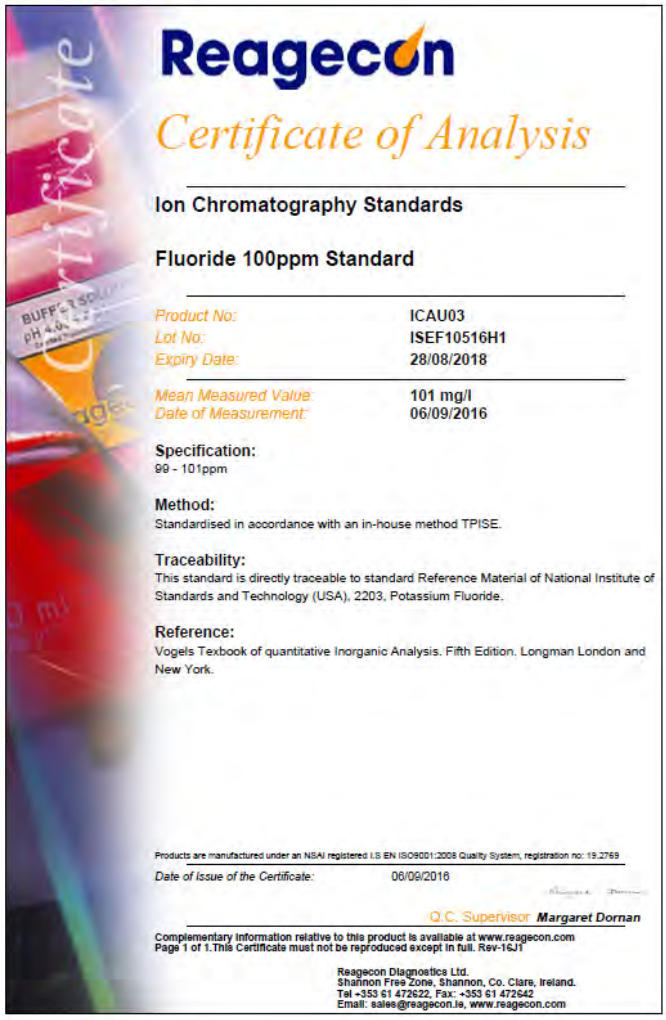
-Environmental analysis for ions such as bromide, fluoride, chloride, nitrate, phthalate etc.
-Anions and cations in drinking water and ultra trace analysis
-Drinking water analysis for pollution and other constituents
-Determination of water chemistries in aquatic ecosystems
-Determination of sugar and salt content in foods
-Widely used technique for isolation of select proteins in industry for protein purification

3.0 Key features and Benefits for Reagecon's Ion Chromatography Standards

- Each Standard is supplied with a Certificate of Analysis, stating traceability to NIST, certified value and expiration date.
- Prepared, tested, certified and verified to exacting standards
- As part of an additional Quality control check all elements are also analysed by ICP-MS
- All results are verified on state of the art chromatograph.
- Chromatograph is calibrated using high purity ISO Guide 34 accredited standards

4.0 Technical Information

Ion Chromatography has evolved into being a very sensitive and accurate technology, with widespread applicability to a lot of sample types and measurements. Reagecon has endeavoured to match the developments in this exciting scientific area, with the development of ion chromatography standards of very high quality. We now use the exact same methodologies to manufacture, test, certify and verify these standards, that are used for the production of ICP-MS/ ICP-OES Standards, and are discussed in detail on pages 18-22 of this document, except for verification of the cations and anions , which is carried on a state of the art ion chromatograph, rather than an ICP-MS.



Reagecon

Certificate of Analysis

Ion Chromatography Standards

Fluoride 100ppm Standard

Product No:	ICAU03
Lot No:	ISEF10516H1
Expiry Date:	28/08/2018
Mean Measured Value:	101 mg/l
Date of Measurement:	06/09/2016

Specification:
99 - 101ppm

Method:
Standardised in accordance with an in-house method TPISE.

Traceability:
This standard is directly traceable to standard Reference Material of National Institute of Standards and Technology (USA), 2203, Potassium Fluoride.

Reference:
Vogels Texbook of quantitative Inorganic Analysis. Fifth Edition. Longman London and New York.

Products are manufactured under an NSAI registered I.S EN ISO9001:2008 Quality System, registration no: 19.2769

Date of Issue of the Certificate: 06/09/2016

Q.C. Supervisor *Margaret Dornan*

Complementary information relative to this product is available at www.reagecon.com
Page 1 of 1.This Certificate must not be reproduced except in full. Rev-15J1

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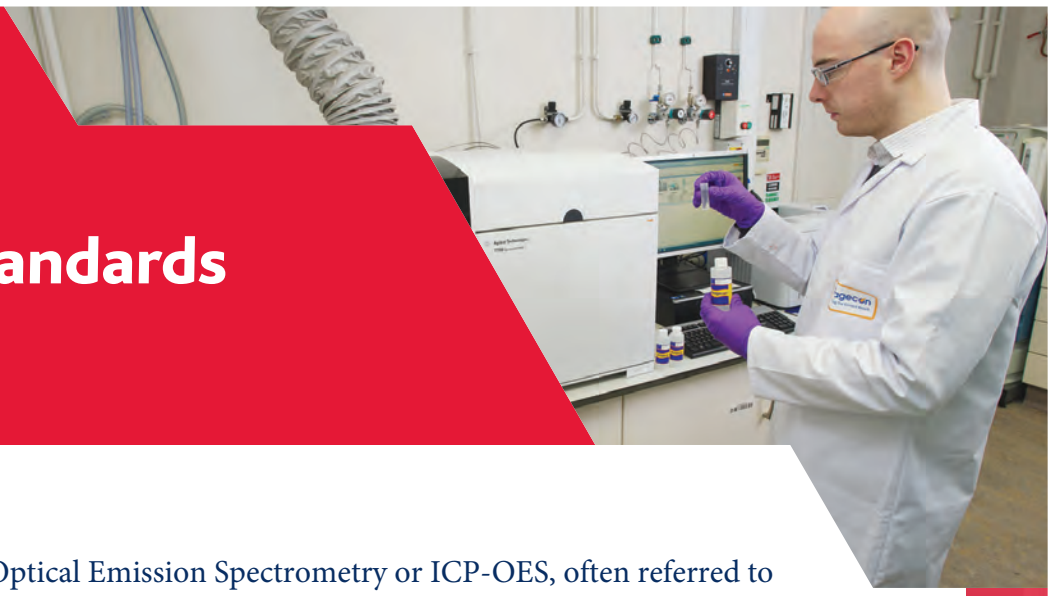
ICP-MS/ ICP-OES Standards



1.0 Theory

Inductively Coupled Plasma Optical Emission Spectrometry or ICP-OES, often referred to simply as ICP, is a multi-element analysis technique that uses an inductively coupled plasma source to dissociate the sample into its constituent atoms or ions, exciting them to a level where they emit light of a characteristic wavelength. A detector measures the intensity of the emitted light, and calculates the concentration of that particular element in the sample. When undergoing ICP analysis, the sample experiences temperatures as high as 10,000oC, where even the most refractory elements are atomized with high efficiency. As a result, detection limits for these elements can be orders of magnitude lower with ICP than with FAAS techniques, typically at the 1-10 parts-per-billion level. There are two different types of ICP analyser, radial and axial. In the traditional radial configuration, the plasma source is viewed from the side, across the narrow emitting central channel of the plasma. Many newer systems view the emitting channel horizontally along its length; this is known as the axial method. Axial viewing increases the path length and reduces the plasma background signal, resulting in detection limits as much as 5-10x lower than with the radial configuration.

Inductively Coupled Plasma Mass Spectrometry or ICP-MS is a multi-element technique that also uses an ICP plasma source to dissociate the sample into its constituent atoms or ions. However, in this case, the ions themselves are detected, rather than the light that they emit. The ions are extracted from the plasma and passed into the mass spectrometer, where they are separated based on their atomic mass-to-charge ratio by a quadruple or magnetic sector spectrometer. The high number of ions produced, combined with very low backgrounds, provides the best detection limits available for most elements, normally in the parts-per trillion range. It is important to remember that detection limits can be no better than lab cleanliness allows. Good Laboratory Practise and housekeeping is critical for good results using this technique. In some cases the technique is performed in a clean room environment. The use of high quality standards is imperative in these highly sensitive techniques and all of Reagecon's ICP-MS/ICP-OES standards are produced in a Clean Room (ISO7) environment.

2.0 Technical Information on Reagecon's ICP-MS/ICP-OES standards

2.1 Controlled Environment

Reagecon's standards are manufactured in a highly controlled clean room environment using:

- High purity starting materials
- Ultra-pure water, specially treated for Mass Spectroscopy Standards
- High purity matrix materials
- Pre-leached and pre-cleaned bottles

2.2 Elemental Metallic Impurities

All Reagecon Standards are manufactured from the purest available raw materials. At least thirty-three starting materials are metals of > 99.999% purity. Several others are at least 99.995% pure. Most of the remaining metals or salts of metals are at least 99.99% pure. The level of impurities are quantified using ICP-MS and are measured and reported both on the starting materials and on the finished product. All of Reagecon's ICP-MS standards are manufactured in a Class 10,000 (ISO 7) clean room environment.

2.3 Raw Material Control

All metal raw materials are assayed by titration and ICP-MS prior to manufacture. Separate CRM's are used to control or calibrate the titration and ICP-MS respectively. This dual process enables the assays to be cross-checked against each other, provides two layers of traceability (see 2.4) and quantifies the combined level of impurities in the starting material. The product is then manufactured gravimetrically using the mass balance approach: 100% - sum of all impurities (w/w).

The assay of the final product is certified using the gravimetric result corrected for density. Prior to bottling, the finished product is again tested and verified using an ICP-MS instrument calibrated with appropriate CRM's.

2.4 Traceability

The content of the starting material for each single element or multi-element standard is established by titration. The resulting analysis is directly traceable to a relevant NIST standard where available. All of the resulting uncertainties of measurement are calculated according to EURACHEM/CITAC guidelines and reported as expanded uncertainties at the 95% confidence level. Reagecon have applied for ISO 17025 accreditation for several classes of titrimetric analysis relevant to the assay of Raw Materials, for the manufacture of ICP-MS and ICP-OES standards.

2.5 Final Assay and Result

Each batch of Reagecon's finalised ICP-MS standards are subjected to an assay on the instrument prior to bottling. This assay verifies the target element assay and verifies that the level of impurities have not changed significantly during the manufacturing process. The results are then reported and certified in mg/Kg and mg/L on the basis of weight and the density measurement of the standard. All of the volumetric, titrimetric and gravimetric functions are carried out under a highly regulated temperature regime, using equipment calibrated by Reagecon's engineers. Reagecon holds ISO 17025 accreditation for temperature calibration in the range of -196 to +1200°C (INAB ref: 265C). The density measurements are also highly temperature dependent and are carried out in Reagecon's specialised Density Laboratory. Reagecon is ISO 17025 Accredited, for density measurement using an Oscillating U-Tube Method in accordance with the ASTM D4052-09 method. The company is an extensive producer of density standards.

2.6 Certification

Reagecon's ICP-MS and ICP-OES Standards are prepared gravimetrically on a weight/weight basis from the purest available raw materials on the market. Both solute and solvent are weighed on balances calibrated by Reagecon's engineers using OIML traceable weights. Reagecon holds ISO 17025 accreditation for calibration of laboratory balances (INAB ref: 265C). The resulting Balance Certificate of Calibration is issued in accordance with the requirements of ISO/IEC 17025.9

3.0 Uses of Reagecon's ICP-MS/ICP-OES Standards

3.1 Tuning Standards (Qualification)

ICP-MS Tuning solutions contain elements that cover the mass range of the instrument. The Tuning Solution's role is to "Tune" the Hardware of the instrument to ensure that it is running correctly. Tuning Solutions verify that the resolution and mass calibration of the instrument are within the required specification. This analysis is for performing Operational Qualification (OQ) and relates only to the instrument performance. A Tuning Solution must be run every time the plasma is lit before any analysis can take place. A typical Tuning Solution typically contains the following elements: Lithium (Mass 7), Cobalt (59), Yttrium (89), Cerium (140) and Thallium (205).

3.2 Calibration Standards

ICP-MS Calibration standards are used to establish a calibration curve using the ICP-MS software. The unknown samples are then run, and the signal intensities are compared to the calibration curve to determine the concentration of the unknown. The calibration standards and samples are prepared in the same way.

Reagecon's Agilent ICP-MS Instrument

3.3 Internal Standards

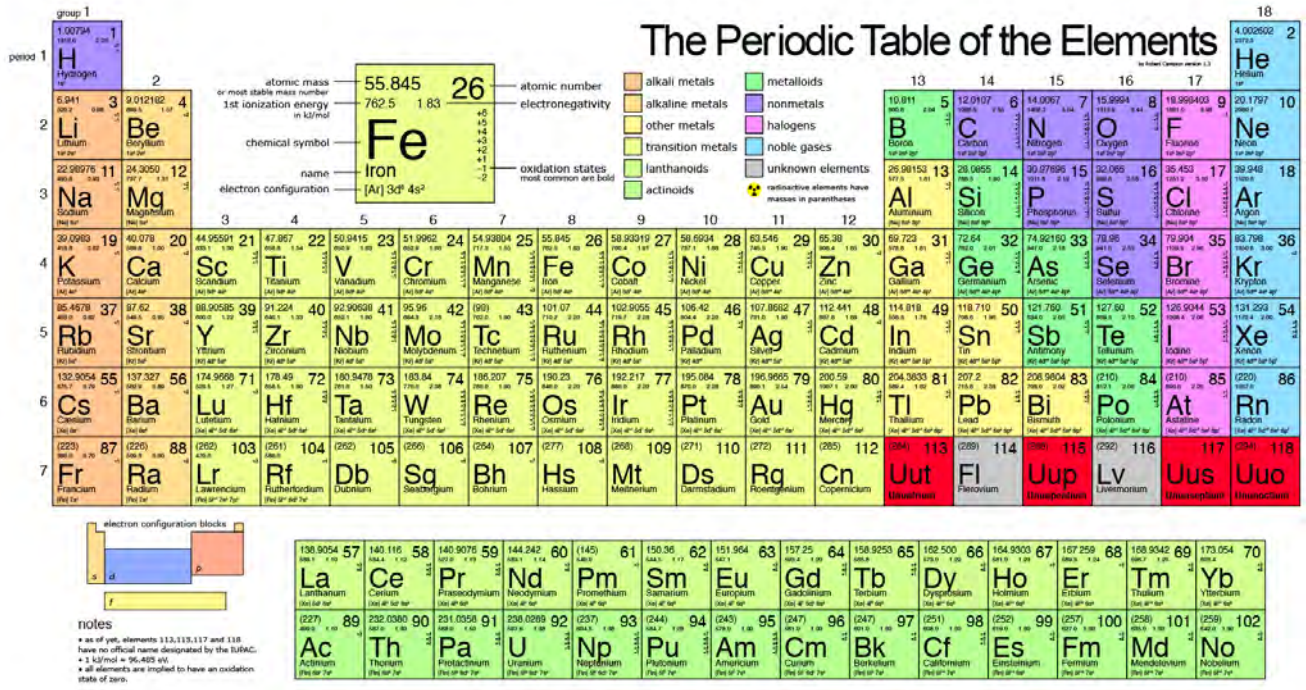
Internal standards are routinely used with inductively coupled plasma mass spectrometry (ICP-MS) to minimize the impact of signal instability. ICP-MS Internal Standards typically contain a number of elements spread out across the mass range e.g. Lithium (Mass 6), Scandium (45), Germanium (72), Yttrium (89), Rhodium (103), Indium (115), Terbium (159) and Bismuth (208). These elements are not usually found naturally. Careful study of the matrix effect in ICP-MS showed that, in all cases studied, the magnitude of the signal suppression or enhancement depends in a regular way on the mass number. To correct for non-spectral interferences and to obtain optimal precision and accuracy, the internal standard should be selected as close in mass number as possible to that of the analyte element(s). When a number of elements over a considerable mass range are to be determined, several internal standards have to be used. E.g. if Potassium (Mass 39) and Vanadium (Mass 51) are to be measured by ICP-MS, Scandium (Mass 45) would be a suitable internal standard. Also, if Thallium (Mass 204) and Lead (Mass 207) are to be measured by ICP-MS, Bismuth (Mass 208) would be a suitable internal standard.

3.4 Control Standards

To quality control the entire testing process including: instrument, environment, sample and analyst competence.

3.5 These high quality standards are also extensively used to perform:

-Method Validation
-Analyst Qualification
-Instrument Qualification (IQ,OQ,PQ,MQ)
-Proficiency testing



Standards and Reagents for On-Line Analysers

Over the last two years, Reagecon has focused very heavily on New Product Development (NPD). This work has included the development of a complete suite of products for use on On-Line Analysers. Full details of our offering can be seen in our publication 'Reagents and Standards for On-Line Analysers' or on our website www.reagecon.com. A brief synopsis of the products can be seen on the following page (page 24).

These products will be produced by a highly accredited producer. These accreditations include a cluster of physical accreditations unique in the world of metrology that include:

- Density
- Viscosity
- Weighing
- Temperature
- Volume
- Extensive and complete regulatory compliance

Extensive manufacturing capability for aqueous and non aqueous products that include:

-Batch sizes from 10ml to 6000 litres
-Products produced either using automated or manual technology
-Product packs from 0.1ml up to 1000 litres in size
-Cold chain management
-Environmental containment (including cleanroom manufacturing)
-Ex rated manufacturing and storage capability

Packaging Solutions

Reagecon has substantial expertise in the selection and supply of correct packaging for all the Physical and Chemical Standards we manufacture. Packaging includes the container, cap and closure type, boxes to present, protect and store the products, shipping containers to allow safe, secure and compliant transit by combinations of road, sea and air, including cold chain transportation if necessary. The selection of packaging takes account, not only of the physical containment of the product, but also the container materials used, their compatibility with the products contained, culminating in negative impact from the container materials on the product performance. All packaging offered must comply with our stringent in house quality criteria. These criteria include leak testing according to IATA Dangerous Goods regulations, container composition compatibility with chemicals used, UN approved containers, UN approved shipping cartons and all Health and Safety and handling compliance.

From a supply chain and logistics perspective, we can offer you the following:

-Customised options - a large range of customised products
-Flexibility - we will quote you for small annual quantities of product
-Standard freight costs - to UK, Europe, Middle East and India
-Savings - we can save you significant expense on transatlantic freight costs

We believe our offering is unique and that by using all or most of the components, we can enable you to add real additional value to your On-Line analysis. As already mentioned a list of the parameters that can be measured using Reagecon's On-line Standards and Reagents can be seen on page 24, The types of Standards and Reagents offered and the techniques and instruments used to quality control and certify the products are presented on pages 25 & 26.

Chemical Capabilities

Process Analyser Parameters

Reagecon manufactures reagents and calibration standards for Process Analysers for a growing portfolio of parameters, just some of which are detailed below:

- Acidity
- Alkalinity
- Aluminium
- Antimony
- Arsenic
- Cadmium
- Calcium
- Chloride
- Chlorine (Free & Total)
- Chromium
- COD
- Conductivity
- Copper
- Cyanide
- Fluoride
- Hardness
- Hydrazine
- Iron (Total, Iron II & Iron III)
- Lead
- Manganese
- Mercury
- Nickel
- Nitrate
- Nitrite
- Nitrogen (Total)
- ORP (Redox)
- Peroxide
- pH
- Phenol

- Phosphate (Total & Ortho)
- Refractive Index
- Silica
- Sodium
- Sulphate
- Sulphite
- Suspended Solids
- Spectrophotometry
- TAN (Total Acid Number)
- TBN (Total Base Number)
- Tin
- TOC / TIC
- Turbidity
- TDS
- Zinc

Process Analyser Technology & Methodologies covered by Reagecon's On-Line offering

Process Analyser Measurement Techniques

Reagecon manufacturing capabilities are aligned with the complete set of chemicals required for operation of Process Analysers, including the following:

- **Colourimetric / Spectrophotometric Analysers**
  - Reagents
  - Calibrations Standards
  - Cleaning Solutions
  - Analyser Qualification Sets

- **Ion Selective Electrode & pH Analysers**
  - Calibration Standards
  - Ionic Strength Adjuster (ISA) Reagents
  - Electrolytes
  - Electrode Cleaning, Care & Maintenance Solutions
  - Analyser Qualification Sets

- **Titrimetric Analysers**
  - Titrants
  - Titration Solvents
  - Electrode Calibration Standards
  - Electrolytes & Electrode Cleaning Solutions
  - Analyser Qualification Sets

- **Direct Measurement Analysers (Conductivity, ORP (Redox), Suspended Solids, Turbidity)**
  - Calibration Standards
  - Cleaning Solutions
  - Analyser Qualification Sets

- **Ion Chromatography Analysers**
  - Eluents (Concentrates & Ready to Use)
  - Calibration Standards
  - Analyser Qualification Sets

- **TOC / TIC Analysers**
  - Acidification Reagents
  - Oxidation Reagents
  - Calibration Standards
  - Analyser Qualification Sets

As analysis increasingly transfers from being laboratory-based to being process-based then the demands on the quality of process analytical measurements is increasing. All Process Analyser sample measurements are stated as a numerical analyte concentration and a concentration unit. It is only valid to quote the relevant measurement unit if there is a direct link to its definition, which can only be established through the use of Standards with metrological traceability. Reagecon ensures that this requirement is satisfied by rigorous analysis of all of its Process Analyser Calibration and Control Standards to provide metrological traceability to the SI units and to assign their certified values.

Reagecon's Quality Control for Process Analysers Reagents is performed using appropriate techniques from our extensive analytical capabilities to ensure that every batch of each individual reagent is within the customer agreed specification. Examples of these Analytical Capabilities are presented on page 26.

Techniques & Instruments Employed within Reagecon for Testing & Quality Control

- Process Analysers for Water Purity:
  - -Silica, Conductivity, TOC
- Process Analysers for Product Testing:
  - -Including Aluminium, Ammonium, Colour, Iron, Manganese, Phosphate & Silica
- Auto-titrators
  - -Aqueous (acidimetric, redox, conductometric)
  - -Non-aqueous (acidimetric, TAN, TBN)
  - -Karl Fisher (volumetric & coulometric)
- Spectrophotometers
  - -Hunter Solid / Liquid
  - -Shimadzu
  - -Chemical Oxygen Demand (COD)
- Turbidimeters
- pH meter & Potentiometer
- Conductometers
- Biological Oxygen Demand (BOD) Assay Unit
- Ion Chromatography (IC)
- Flame Atomic Absorption Spectroscopy (FAAS)
- Induced Coupling Plasma-Mass Spectroscopy (ICP-MS)
- Total Organic Carbon Analysers:
  - -Membrane Exclusion
  - -Carbon Oxidation
- Cryoscope
- Coulometer
- Fourier Transform Infrared Spectroscope (FTIR)
- Gas Chromatography (GC)
  - -Flame Ionisation Detection (GC-FID)
  - -Mass Spectroscopy (GC-MS)
- Liquid Chromatography
  - -Mass Spectroscopy (HPLC-MS)
  - -Ultra Violet Detection
  - -Preparative
  - -Reverse Phase
  - -uHPLC
- Refractometer
- Polarimeter
- Osmometer
- Differential Scanning Calorimeter
- Melting Point apparatus
- X-ray fluorescence spectroscope (WD-XRF)
- Elemental Analyser (CHNOS)
- Thermo-gravimetric Analyser (TGA)

- Bingham Pycnometry
- Vibrational Densitometer
- Rotational Viscometer
- Ubbelöhde Master Viscometer
- Ex-rated Solvent Facility
- Radley Combinational Chemistry Synthesiser
- Rotary Evaporators
- ISO 7 Class (Class 10,000) Cleanroom

Ion Chromatography Standards

These standards are prepared, tested, certified and verified.All results are verified on a state of the art Ion Chromatograph, which is calibrated using high purity ISO Guide 34 accredited standards, similar in concentration to the products offered. Reagecon have an extensive product offering:

- Cation Standards – 91 single element standards
- Anion Standards – 100 single element standards
- Multi-element Standards – 111 off the shelf
- Also tested on ICP-MS as another quality check, where possible.

Flame Photometry Standards

Reagecon offer both Single and Multi element flame photometry Standards and a wide range of values and elements.
These standards offer a very high accuracy supported by a certificate of analysis.
These Products are non hazardous, non toxic.
All standards are manufactured and tested in a GLP (Good Laboratory Practice) environment.

Atomic Absorption Standards

Reagecon manufacture an extensive range of aqueous Atomic Absorption Standards. These include standards for the measurement of the most common alkali and transition metals.
Reagecon also manufacture Matrix Modifier solutions and Releasing agents for Atomic Absorption.

Reagecon have been manufacturing Inorganic Standards, Controls and Calibrators for Spectroscopy for almost two decades. Our customer base in over 80 countries is testament of our efforts to be leaders in a changing field where LODs and % purity are becoming ever more demanding.

Inorganic Standards from Reagecon

ICP-MS / ICP-OES Standards

Reagecon offer more options than any competitor.

Single Elements

- 70 single elements offered in over 900 variant concentrations, matrices and pack sizes.
- 33 HNO_3 only
- 14 HNO_3 or HCl
- 9 have HF singly or with HNO3
- 7 HCl only
- 3 H_2O only
- Small no Ammonium Hydroxide (2) or H_2SO_4 (1)

Multi Elements

- Approx. 235 mixtures catalogued
- 33 elements -> 2 elements
- Customised options
- Other Concentrations

Reagecon's standards are manufactured in a highly controlled Class 10,000 cleanroom environment using :

- High Purity starting materials
- Ultra-Pure water
- High Purity matrix materials
- Pre-leached and pre-cleaned bottles
- All Metal Raw Materials are assayed by titration and ICP-MS prior to manufacture.
- Separate CRMs are used to control or calibrate the titration and ICP-MS respectively.
- This provides two layers of traceability and quantifies the combined level of impurities in the starting material.
- The product is manufactured gravimetrically using the mass balance approach: 100% - sum of all impurities (w/w)
- Reagecon's ICP-MS and ICP-OES standards are prepared gravimetrically on a weight / weight basis from the purest available raw materials on the market
- Solute and Solvent are weighed on balances calibrated by Reagecon's engineers using OIML traceable weights. Reagecon holds ISO 17025 accreditation for calibration of laboratory balances.
- The assay of the final product is certifeid using the gravimetric result corrected for density.
- Prior to bottling, the finished product is again tested and verified.

Ion Selective Electrode (ISE) Standards & Ionic Strength Adjustor (ISA) Solutions

Ion Selective Electrodes, (ISEs) allow specific and quantitative measurement of a wide range of cations, anions and some dissolved gases. These ions can be measured directly like pH measurement, indirectly (see below) or by titrimetry. ISEs respond selectively to the relevant ion activity exactly like pH electrodes respond to hydrogen ion activity. Our ISE standards and ISA's are an important part of our offering. The range of standards is extensive, accurate,traceable and produced to have minimal uncertainty of measurement.

They can be used for:

- Calibration
- Instrument Qualification
- Control
- Method Validation

Both ISE standards or ISA reagents can be customised for individual customer requirements and can be supplied in bulk quantities for process or online applications.

Reagecon Staff Events and Initiatives

As part of Reagecon's commitment to employee wellbeing we are participating in an ongoing workplace wellbeing program,which aims to improve employee health through the promotion of better nutrition and physical activity. We had a Physiotherapist and Dietician on site at the end of March doing bite size sessions on posture, stretching, nutrition.

Dr. Anne Griffin BSc PhD Dietician & Brendan Hill BSc G.S.R Physiotherapist pictured left to right with our HR Manager Vicky Howard at Reagecon for Workplace Well-Being day.

Reagecon staff pictured supporting Daffodil Day for the Irish Cancer Society.

Finbarr Murray from Reagecon pictured at our stand in Arablab which was held in March this year.

Reagecon's Bernard Gleeson at Arablab pictured with the Editor from Sri Lanken Scientist Publication.

Reagecon

Delivering The Correct Result

Your Next Metrologist will feature:

- A wide selection of part number and packaging options for Reagecon's On-Line Analyser Standards and Reagents.
- The launch of our new XRF Standards Range.
- A detailed profile of our new Solvent purification, distillation , drying and mixing facility.
- A series of technical notes on XRF.
- Company news and updates
- Scientific papers on the effects of Temperature on pH and Conductivity.
- Technical information on our new Textbook "Spectroscopic and Electrochemical Measurement of Cations and Anions; Metrology, Calibration and Control."

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