GLASS EXPANSION
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Improving Washout and Efficiency in High-Throughput ICP-MS Testing Laboratory

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Introduction

- One of the major challenges an ICP laboratory faces is the excessive washout time required for methods analyzing samples containing high levels of elements, such as B and Hg, that tend to “stick” around in the sample introduction system.
- These “sticky” elements frequently require multiple rinse blanks following these samples to flush the system back down to reporting limits, and in some cases down to method or even instrument detection limits.
- If there is an inadequate amount of rinse time, these high concentration samples can frequently require a lab to rerun or flag samples analyzed after a sample containing high levels of elements like B.
- In this webinar, we will review the design of Glass Expansion’s high-performance Peltier Cooled Cyclonic Spray Chamber, or PCC Kit.
- We will explore the efficient and rapid washout of boron from the sample introduction system of an Agilent 7900 ICP-MS using the PCC Kit.
- Specifically, we will evaluate washout data collected using a real-world sample containing >4 ppm of B to compare the washout efficiency of the Scott-Style spray chamber versus the PCC Kit at a high-throughput environmental laboratory.

Rapid Washout of Boron Using Glass Expansion's Peltier Cooled Cyclonic (PCC) Spray Chamber on Agilent® 7900 ICP-MS

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Author: Randy Mercurio

Abstract

This application note explores the efficient and rapid washout of boron (B) from the sample introduction system of Agilent's 7900 Inductively Coupled Plasma Mass Spectrometer (ICP-MS) instrument using Glass Expansion's Peltier Cooled Cyclonic (PCC) spray chamber. The combination of these technologies enhances analytical performance by minimizing memory effects and improving signal stability, particularly in the analysis of trace levels of boron in complex, real-world sample matrices.

Introduction

Boron analysis poses challenges using ICP-MS due to its tendency to form memory effects and interfere with subsequent analyses. This occurs when residual boron from previous samples adheres to the spray chamber walls, leading to carryover and inaccurate measurements in following samples. Along with a few other elements, such as Hg, Pb and Sb, B is notorious for causing memory effects. Sometimes, even relatively advanced ICP-MS instrumentation can struggle to meet basic QC requirements when it comes to analyzing challenging elements like these in real-world samples. For example, when analyzing for boron using the standard Scott style spray chamber, washout times can be extensive. This is primarily attributed to the large surface area of the Scott-style spray chamber, where the time needed to sufficiently get boron levels to an acceptable level can take valuable analysis time. Whether analyzing difficult real-world samples with high boron content, or if low detection limits are hindering efficient rinse out times requiring repeated rinse blank analyses, Glass Expansion's Peltier Cooled Cyclonic Spray Chamber (PCC) Kit outfitted with a quartz spray chamber can quickly get boron down to acceptable levels in rinse blanks. Glass Expansion's Tracey™ cyclonic spray chamber design provides the best sensitivity, reproducibility and lowest memory effects. Additionally, the Helix Constant Torque (CT) locking screw and seal creates an optimal nebulizer interface that significantly reduces dead volume around the nebulizer, assisting the rapid washout.

PCC Spray Chamber Design

The PCC spray chamber by Glass Expansion is a high-performance accessory designed to replace standard Scott style spray chambers on ICP-MS instruments. It features a unique cyclonic design that creates a centrifugal force within the chamber. This force helps minimize the residence time of sample aerosols, reducing their interaction with the chamber walls and consequently, lowering memory effects. Furthermore, the PCC Kit incorporates Peltier cooling technology, which actively cools the spray chamber, further reducing aerosol dwell time and enhancing washout efficiency. It offers several advantages over the standard Scott-style spray chamber, particularly when analyzing troublesome elements like B.

Figure 1. PCC Kit (P/N [KT-1212Q](#)) Installed on Agilent® 7900 ICP-MS.

Scan to read the Application Note:

Introducing the Revolutionary PCC™ Kit

Enables the switch from a standard Scott style… to Glass Expansion's Tracey™ Cyclonic Spray Chamber

Scott Style
Spray Chamber

Tracey™
Spray Chamber

Key Advantages of the PCC™ Kit Spray Chamber

1. Cyclonic Spray Chamber:

- Glass Expansion's cyclonic spray chamber design along with the Helix "CT" Constant Torque Nebulizer Interface, minimizes washout time, optimizes nebulizer sensitivity, and ensures consistent day-to-day performance.

2. Interchangeable Materials:

- The PCC Kit allows easy interchangeability between different spray chamber materials:
  - Borosilicate Glass: Cost-effective option for routine analyses not requiring low-level boron measurements.
  - Quartz: Required for precise low-level boron detection.
  - PFA: Ideal for applications with a hydrofluoric acid matrix and ultra-trace ICP-MS analyses (paired optimally with Glass Expansion's DuraMist™ DC or OpalMist™ DC Nebulizer).
  - The Tracey PFA spray chamber interior features the proprietary Stediflow surface treatment, improving wettability and efficient drainage.

3. Fast and Simple Installation:

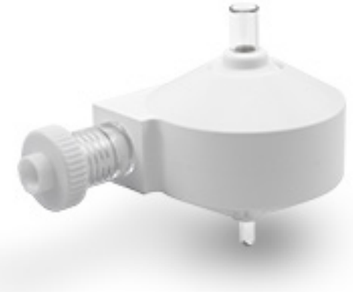
- The PCC Kit connects directly to the existing electronics and water-cooling system.
- A convenient mounting bracket ensures swift installation on the Agilent® ICP-MS systems.

4. Jet Vortex Interface (JVI™) – Aerosol Filtration:

- Compatible with your existing method settings for HMI or UHMI (7850/7900/8900).

Glass Tracey™ Spray Chamber with Helix CT

P/N 21-809-4368



Quartz Tracey™ Spray Chamber with Helix CT

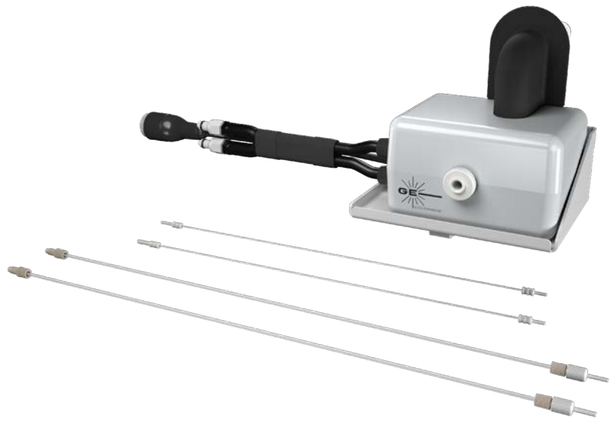
P/N 21-809-4448

PFA Tracey™ Spray Chamber with Helix CT

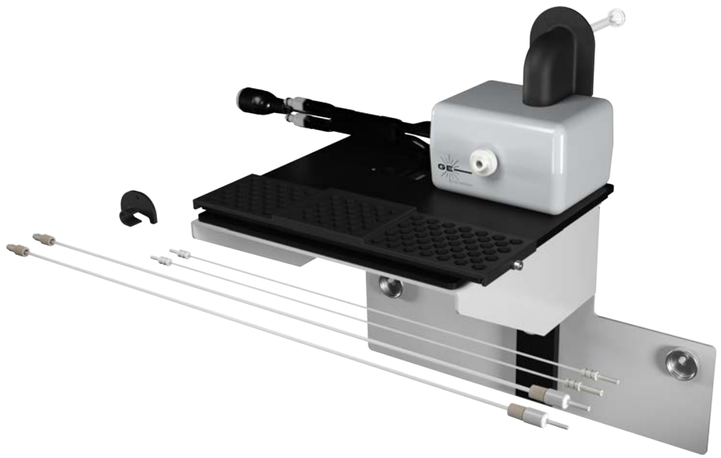
P/N 21-809-2985

PCC™ Kit Models

PCC™ Quartz Spray Chamber for Agilent® 7850, 7900, 8900, (P/N KT-1116Q)*



PCC™ Quartz Spray Chamber for Agilent® 7850, 7900, 8900 with Actuator Mount (P/N KT-1212Q)*

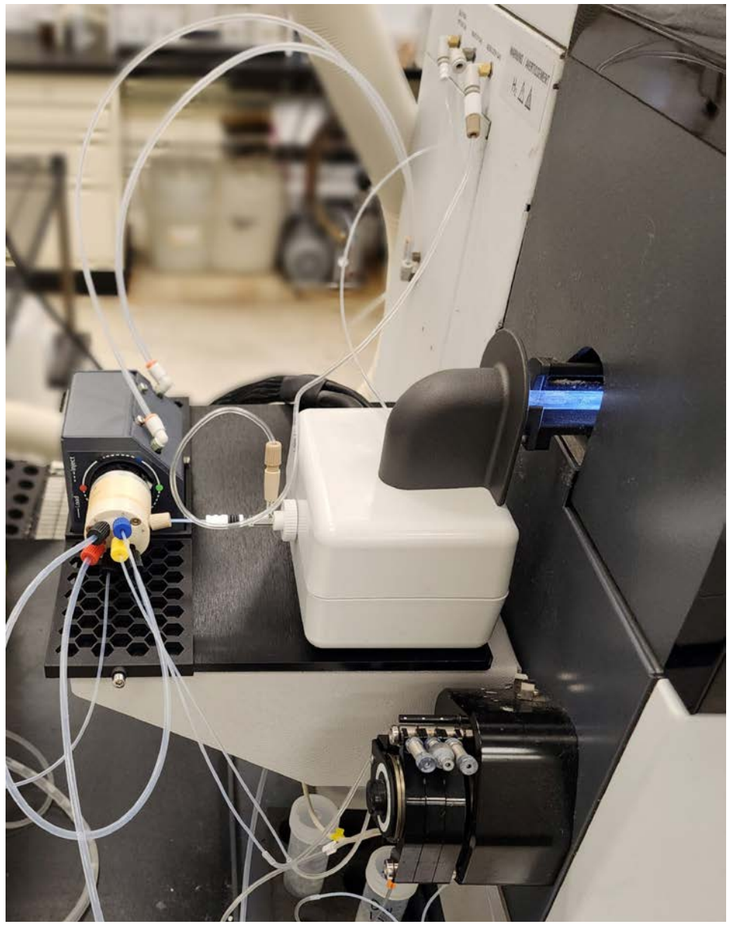


PCC™ Quartz Spray Chamber for Agilent® 7700, 7800, 8800, (P/N KT-1206Q)*

- All of these PCC™ Kit models can accommodate Glass, Quartz or PFA spray chambers
- KT-1116 and KT-1206 are compatible with other brands of OEM switching valves.
- KT-1212Q designed specifically to accommodate Agilent® switching valve.

New PCC™ Kit (P/N KT-1212Q)

- Compatible with Agilent® 7850/7900/8900
- Compatible with Agilent® HMI or UHMI conditions.
- Compatible with Agilent® AVS/ADS2/ISIS-3.
- Interfaces direct to the existing electronics and water cooling system of the Agilent® ICP-MS.
- A convenient mounting bracket allows for fast and simple installation while reducing the nebulizer path length.
- Minimizes washout time with highly concentrated samples and troublesome elements, such as B, Hg, Pb and Sb; compared to the standard Scott-style spray chamber.



Customer Comments

- For our particular application this PCC kit was a great improvement. On specific cases that required four (or more) blank runs to bring the boron level to baseline now we can do it two or one blank run. This allowed us to **increase sample throughput by about 50%**. — Specialty Chemical Manufacturer - USA

Jet Vortex Interface (JVI™) – Aerosol Filtration

A patent pending, novel design, providing highly efficient Aerosol Filtration. Simple and straightforward installation, the JVI works in conjunction with the existing “Make-Up” or “Dilution/Auxiliary” gas option of your ICP-MS.

Benefits

- Compatible with your existing method settings for HMI and UHMI (7850/7900/8900).
- Chemically inert, made from Teflon® (PTFE).
- Secure connection to gas supply, spray chamber and transfer tube.
- Improved life of torch & interface cones.
- Reduce build-up on injector & interface cones.
- More robust plasma conditions.

JVI™

High Matrix Applications – PCC Kit and Elegra™ Argon Humidifier

Elegra™ Argon Humidifier – Maximize Your Up-time

- Common practice to humidify nebulizer gas to prevent salt build up on nebulizer and injector.
- Two-channel configuration humidifies nebulizer and option/dilution gas simultaneously.
- Reduce salt build-up on interface cones.
- Improved signal stability, facilitates long, uninterrupted run times.
- Simple to use and maintain.
- Compatible with standard Scott-type and PCC Kit, bracket included for Agilent® ICP-MS (P/N 70-803-1273).

Elegra Dual Humidifier

Elegra Flyer

Nebulizer Selection - Agilent® ICP-MS - PCC Kit

MicroMist™ DC – ICP-MS Industry Standard

- Agilent® ICP-MS standard nebulizer
- Calibrated for use with UHMI
- High transport efficiency
- For aqueous or organic solutions without HF, low-flow applications or samples with limited volume
- Up to 15% TDS

OpalMist™ DC – Best for High Purity

- High purity PFA
- Resistant to HF and aggressive solvents
- Great choice for semiconductors, geological and soil/sediment with HF.
- Best precision and % Oxide Ratio (lowest sensitivity)
- Up to 15% TDS

SeaSpray™ DC – Best all-around Performance

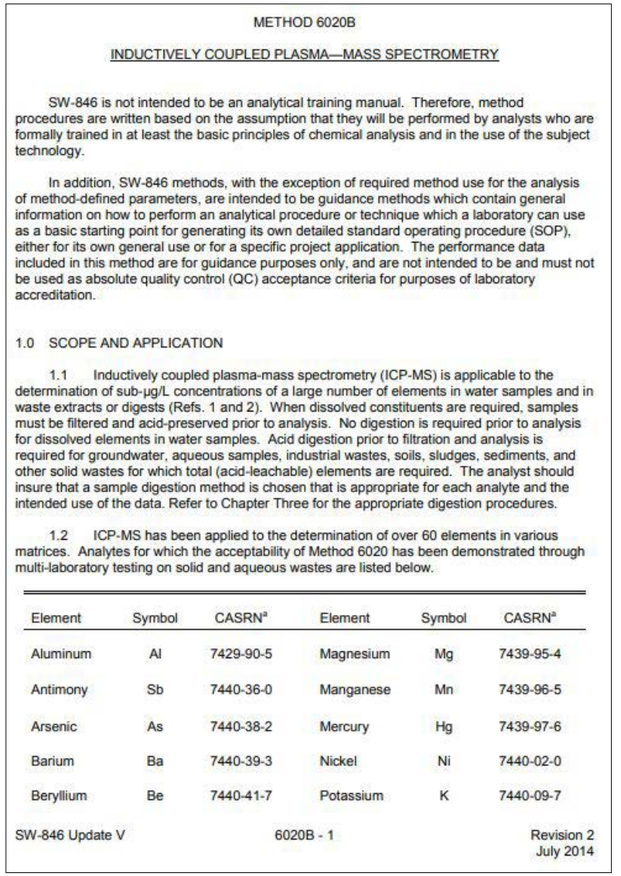
- Greater sensitivity
- Great choice for aqueous or organic solutions without HF: brines & salts, soils, plants, food & beverage, chemicals, animal feed, fertilizers, clinical, forensics, drinking, ground & surface waters, wastewater, mineral isotopes, petrochemicals
- Up to 20% TDS

DuraMist™ DC – Best for Higher TDS

- PEEK – completely inert construction
- Great choice for aqueous solutions with <5% HF, brines, seawater, and mining
- Up to 30% TDS

Customer Success Story

- A high-throughput environmental laboratory analyzing particularly difficult samples with high boron concentrations was looking for a solution to their excessive rinse out times to ensure quality data and improve their sample throughput.
- The lab was using an Agilent® 7900 ICP-MS with the standard Scott-style spray chamber, ISIS-3 switching valve, and SPS 4 Autosampler.
- Standard Agilent Performance Reports were analyzed after instruments were warmed up for thermal stability of the interface.
- This lab was operating under EPA Methods 200.8 and 6020, so each day after the instrument performance reports were analyzed they also analyzed an EPA Tune Check Report for H_2 and He modes to ensure the operating conditions of the nebulizer and JVI gas flows met these method criteria, which are different from the instrument performance reports.
- A challenging, real-world, aqueous sample from a remediation site, containing 4.3 mg/L of boron was used to collect washout analysis data, comparing the Scott and PCC Kit, by running 10 consecutive rinse blanks after the sample was analyzed.



METHOD 6020B

INDUCTIVELY COUPLED PLASMA—MASS SPECTROMETRY

SW-846 is not intended to be an analytical training manual. Therefore, method procedures are written based on the assumption that they will be performed by analysts who are formally trained in at least the basic principles of chemical analysis and in the use of the subject technology.

In addition, SW-846 methods, with the exception of required method use for the analysis of method-defined parameters, are intended to be guidance methods which contain general information on how to perform an analytical procedure or technique which a laboratory can use as a basic starting point for generating its own detailed standard operating procedure (SOP), either for its own general use or for a specific project application. The performance data included in this method are for guidance purposes only, and are not intended to be and must not be used as absolute quality control (QC) acceptance criteria for purposes of laboratory accreditation.

1.0 SCOPE AND APPLICATION

1.1 Inductively coupled plasma-mass spectrometry (ICP-MS) is applicable to the determination of sub-µg/L concentrations of a large number of elements in water samples and in waste extracts or digests (Refs. 1 and 2). When dissolved constituents are required, samples must be filtered and acid-preserved prior to analysis. No digestion is required prior to analysis for dissolved elements in water samples. Acid digestion prior to filtration and analysis is required for groundwater, aqueous samples, industrial wastes, soils, sludges, sediments, and other solid wastes for which total (acid-leachable) elements are required. The analyst should insure that a sample digestion method is chosen that is appropriate for each analyte and the intended use of the data. Refer to Chapter Three for the appropriate digestion procedures.

1.2 ICP-MS has been applied to the determination of over 60 elements in various matrices. Analytes for which the acceptability of Method 6020 has been demonstrated through multi-laboratory testing on solid and aqueous wastes are listed below.

Element	Symbol	CASRN[a]	Element	Symbol	CASRN[a]
Aluminum	Al	7429-90-5	Magnesium	Mg	7439-95-4
Antimony	Sb	7440-36-0	Manganese	Mn	7439-96-5
Arsenic	As	7440-38-2	Mercury	Hg	7439-97-6
Barium	Ba	7440-39-3	Nickel	Ni	7440-02-0
Beryllium	Be	7440-41-7	Potassium	K	7440-09-7

SW-846 Update V 6020B - 1 Revision 2 July 2014

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Autotune Performance Report

Instrument Performance Report (n=15)		
Average Nebulizer Gas Flow (L/min) = 1.038		
JVI Dilution Gas Flow (L/min) = 0.00		
H_2 & He Gas Flows (mL/min) = 0.00		
Mass	**Sensitivity (cps)**	**RSD%**
^{7}Li	6385	2.481
^{89}Y	30735	2.223
^{205}Tl	21436	2.447
Oxide 156CeO/Ce140 (<1.8%)	1.301	
Doubly Charged (<2.5%)	1.297	

H_2 Mode EPA Method Performance Report

US EPA 200.8/6020 Tune Check Report [H2] (n=16)		
Nebulizer Gas Flow (L/min) = 0.85		
JVI Dilution Gas Flow (L/min) = 0.15		
H_2 Gas Flow (mL/min) = 3.5		
Mass	**Sensitivity (cps)**	**RSD%**
^{9}Be	972	1.497
^{24}Mg	11245	2.083
^{25}Mg	1609	2.207
^{26}Mg	1982	1.974
^{59}Co	25236	0.899
^{115}In	84931	0.735
^{206}Pb	17030	0.871
^{207}Pb	14342	0.898
^{208}Pb	35324	0.868

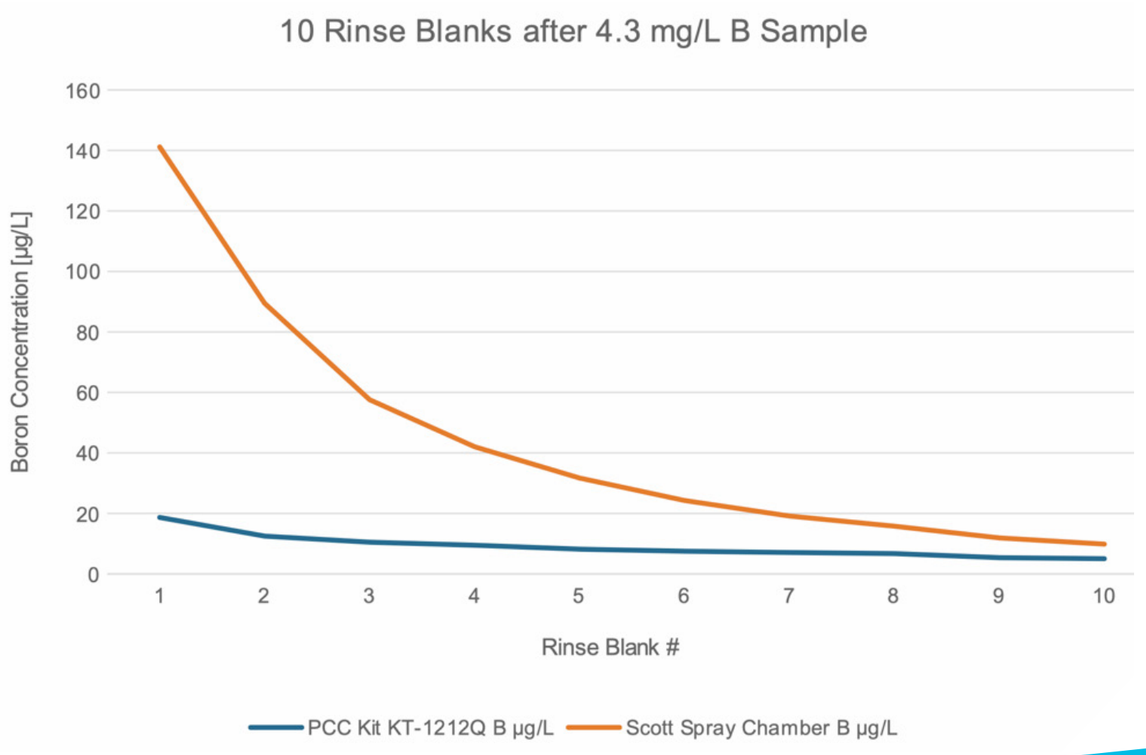
He Mode EPA Method Tune Check Report

US EPA 200.8/6020 Tune Check Report [He] (n=16)		
Nebulizer Gas Flow (L/min) = 0.85		
JVI Dilution Gas Flow (L/min) = 0.15		
He Gas Flow (mL/min) = 4.5		
Mass	**Sensitivity (cps)**	**RSD%**
^{9}Be	87	2.615
^{24}Mg	1266	1.486
^{25}Mg	184	2.021
^{26}Mg	232	1.962
^{59}Co	20333	1.333
^{115}In	24991	1.464
^{206}Pb	11164	1.370
^{207}Pb	9399	1.357
^{208}Pb	23286	1.361

B Washout after 4.3 mg/L Sample

	PCC Kit (KT-1212Q)		Scott Style Spray Chamber	
	11 B [H2]		**11 B [H2]**	
Time Stamp	**Conc. [ppb]**	Type	**Conc. [ppb]**	Time Stamp
7:35 PM	4294.897	Sample	4376.533	2:49 PM
7:38 PM	18.655	Blank 1	141.146	2:52 PM
7:41 PM	12.491	Blank 2	89.449	2:55 PM
7:44 PM	10.483	Blank 3	57.566	2:58 PM
7:47 PM	**9.49**	Blank 4	42.028	3:01 PM
7:50 PM	8.183	Blank 5	31.679	3:04 PM
7:53 PM	7.505	Blank 6	24.263	3:08 PM
7:57 PM	7.083	Blank 7	19.126	3:11 PM
8:00 PM	6.706	Blank 8	15.771	3:14 PM
8:03 PM	5.366	Blank 9	11.902	3:17 PM
8:06 PM	5.026	Blank 10	**9.851**	3:20 PM

✓ In this example, a **61% improvement** in B washout time, resulted in a much higher throughput and much lower potential for any carryover.



Summary of Key PCC™ Kit Benefits

- **Faster Washout Times:** Compared to traditional Scott-style spray chambers, the PCC™ significantly reduces washout times for “sticky” elements such as boron and mercury.
- **More Efficient Workflow:** Less reruns from unanticipated carryover or poor RSDs.
- **Improved Signal Stability:** Reduced memory effects lead to more consistent and accurate boron measurements, and longer analysis times with less analytical drift.
- **Higher Quality Data:** Less data flags on instrument blanks, method blanks, duplicates, dilutions, and other QA/QC samples.
- **Increased Sample Throughput:** Faster uptake and washout times enable shorter total sample acquisition times, thereby increasing sample throughput.

Want a FREE review of your Sample Introduction System?

Please contact your local Glass Expansion office by email (Asia Pacific: enquiries@geicp.com, Americas: geusa@geicp.com, Europe: gegmbh@geicp.com) to:

- Optimize your sample introduction system components.
- Take advantage of this PCC Kit.
- Identify other performance enhancing accessories available for your ICP.
- Discuss any sample introduction challenges.
- Explore ways to reduce operating costs.
- Obtain quotes.

Thank You

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