GLASS EXPANSION
Quality By Design

Trident CT™ In-Line Reagent Additions Kit

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Internal standards (IS) are often used in ICP optical and mass spectrometry to correct for matrix-based interferences and improve measurement stability.[1] Similarly, an ionization buffer can be utilized for axial view ICPs to suppress the ionization effects of easily ionizable elements (EIE). When dealing with a large number of samples, this process can be very time consuming. Other concerns are the risk of contamination and the accuracy of volumetric addition.

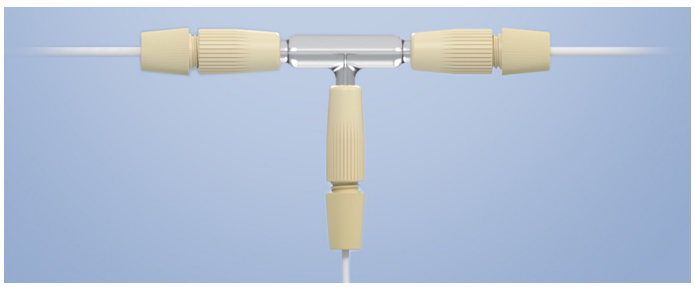
A common alternative to volumetric or gravimetric addition of the IS or ionization buffer is to add them in-line using the peristaltic pump and a mixing tee. Glass Expansion developed the Trident In-Line Reagent Additions Kit in 2004 to provide a simple, easy and error-free way to continuously add IS or ionization buffers in ICP spectrometry. The Trident quickly became an ICP industry standard for in-line addition, and we are now pleased to release the Trident CT™ In-Line Reagent Additions Kit.

Introduction

The Trident CT mixing tee is based on the industry-proven design of the Trident, but with the addition of Glass Expansion's ConstantTorque™ (CT) technology to provide a simple-to-use, leak-free connection for both the internal standard and sample, every time.

The heart of the Trident CT In-Line Reagent Additions Kit is the new CT mixing chamber (Figure 1). It is designed with zero dead volume CT ratchet style ¼-28 fittings on the sample and IS inlets, in addition to the outlet to the nebulizer. The use of inert, metal-free, ratchet fittings provides simple-to-use, leak-free, zero dead volume connections for the internal standard and sample, every time.

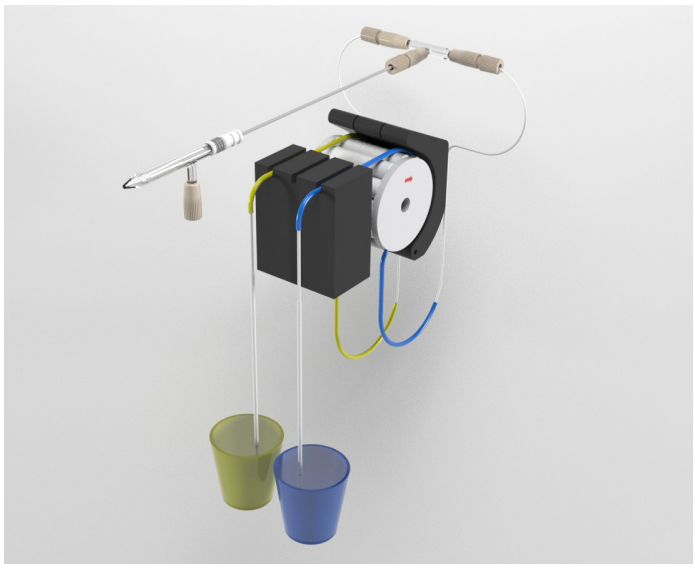
Figure 1. Trident CT glass mixing chamber, P/N 60-703-1119.



With other mixing chambers, worn or incorrectly fitted connections can leak, injecting a stream of air bubbles into the nebulizer flow, which can degrade short-term analytical precision (%RSD). By using CT ratchet style fittings, the Trident CT eliminates air leaks, optimizing analytical performance.

Like the previous design, the Trident CT provides a complete solution for a simple, easy and error-free way to continuously add IS or ionization buffers in ICP spectrometry. The Trident CT In-Line Reagent Additions Kit is completely modular so that damaged or lost components can easily be replaced. A schematic of the Trident CT is shown in Figure 2 (peristaltic pump shown for reference only, not included).

Figure 2. Trident CT In-Line Reagent Additions Kit, P/N 60-703-1179.



The Trident CT In-Line Reagent Additions Kit (Components are listed in Table 1), includes several options to accommodate a variety of nebulizer designs and capillary tubing sizes, providing a universal solution for in-line addition. For example, a Glass Expansion nebulizer can be secured to the outlet of the Trident CT mixing chamber by using the UniFit or EzyFit connector (depending on the nebulizer model) in combination with the ¼-28 CT fitting and the 1/16th inch ferrule. Figure 2 shows the UniFit connector being used to connect a Glass Expansion DC nebulizer to the Trident CT mixing chamber. To accommodate non-Glass Expansion nebulizer designs, the ¼-28 CT fitting combined with the 1/16th inch or 1.3 mm ferrule can be used to connect the nebulizer capillary tubing directly to the Trident CT.

Table 1. Trident CT In-Line Reagent Additions Kit (P/N 60-703-1179) Components

Part Number	In-Line Reagent Additions Kit
60-703-1179	Trident CT In-Line Reagent Additions Kit (Complete)
Part Number	**In-Line Reagent Additions Kit Contents**
60-808-1187	Internal Standard Sample Probe
70-803-0748	Ferrule 1.3mm (PKT. 10)
70-803-0749	Ferrule 1/16 (PKT. 10)
70-803-1350	Ratchet Connector
60-703-1119	Mixing Chamber
70-803-1870	Connector Tube with 1/4-28 fitting 0.25mm x 700mm (PKT. 3)
70-803-1871	Connector Tube with 1/4-28 fitting 0.5mm x 700mm (PKT. 3)
EZT-16-50-300	EzyFit Sample Tube 1/16 OD X 0.50mm ID X 300mm (PKT. 10)
NFT-16-50-300	UniFit Sample Tube 1/16 OD X 0.50mm ID X 300mm (PKT. 10)

Note: *1 piece only is supplied with 70-803-0748, 70-803-0749, 70-803-1871, 70-803-1870, NFT-16-50-300 & EZT-16-50-300 as part of the Trident CT Internal Standard Kit.*

Experimental

An Agilent™ 5100 ICP-OES was used to compare the performance of the original Trident and new Trident CT, in addition to a comparison of volumetric IS addition to the precision achieved using in-line addition with the Trident. The ICP experimental conditions used for these comparisons are listed in Table 2. A 2% HNO_3 solution for the blank, a 10 ppm Y in 2% HNO_3 for internal standard and a 1 ppm As, Se, Cr, Cu, Mn, Mg, Ni, Na and K in 2% HNO_3 for calibration standards and sample were used for the sensitivity and precision comparisons.

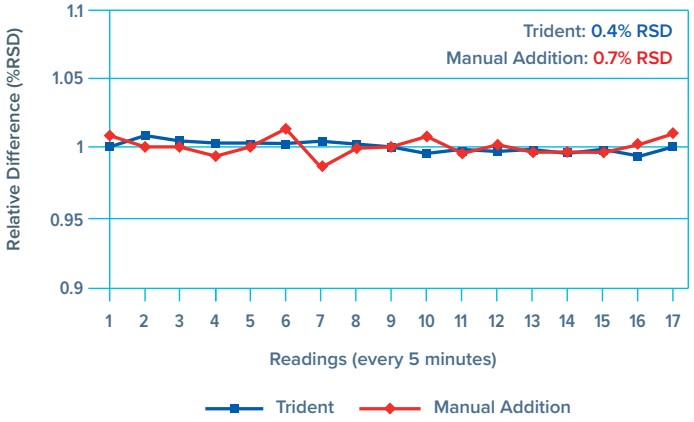
Table 2. Agilent™ 5100 ICP Experimental Conditions

Experimental Parameter	Setting
RF power	1.2 kW
Nebulizer gas flow rate	0.7 L/min
Plasma gas flow rate	12 L/min
Auxiliary gas flow rate	1.0 L/min
Read time and number of replicates	3 sec and 5 replicates
Number of samples	10 for average sensitivity and precision
Viewing mode	Axial
Sample pump tubing	Black-black (0.76 mm ID) (P/N 0.76-BLK-F)
Internal standard tubing	Orange-yellow (0.51 mm ID) (P/N 0.51-OY-F)
Pump rate	12 rpm
Nebulizer	1 mL/min SeaSpray (P/N A13-07-USS1)
Spray Chamber	Twister with Helix CT (P/N 20-809-9199HE)
Torch	D-Torch with quartz outer tube (P/N 30-808-3560)
Injector ID	1.8 mm (P/N 31-808-3576)

Results

A comparison of the IS stability and precision achieved with and without the Trident is shown in Figure 3. The stability of IS signal with the Trident closely matches the sample set that was manually spiked with IS. Over a period of 85 minutes, an IS signal precision of 0.4% RSD is achieved with the Trident compared to 0.7% where the IS was manually added. These results show that performance of in-line addition with the Trident is at least as precise as manual addition.

Figure 3. Comparison of long-term stability of in-line addition versus manual addition of IS.



A comparison of the relative signal intensity and IS precision (%RSD) achieved with the new Trident CT and original Trident is shown in Figures 4a and 4b, respectively. Both sensitivity and precision results indicate no significant differences. The 14-line average sensitivity advantage for the new Trident CT compared to the original Trident was 1 %, whereas the average IS precision obtained with both the Trident CT and original Trident was 0.7 %. These test results were important to confirm the new Trident CT design matched the performance of the industry standard, original Trident design. With identical analytical performance, the new Trident CT simply offers a design to improve the reliability of proper installation and eliminate air leaks due to worn or incorrectly installed fittings.

Figure 4a. Relative analyte intensity obtained with the new Trident CT versus original Trident.

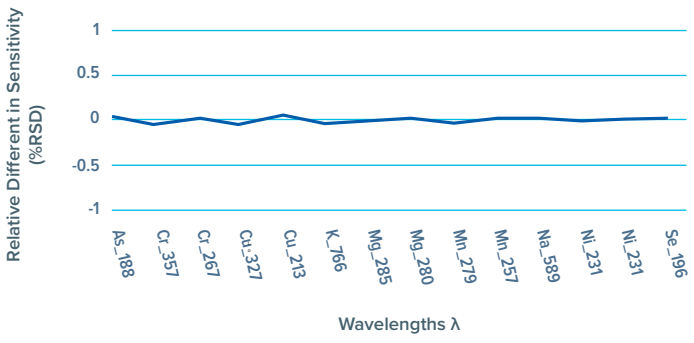
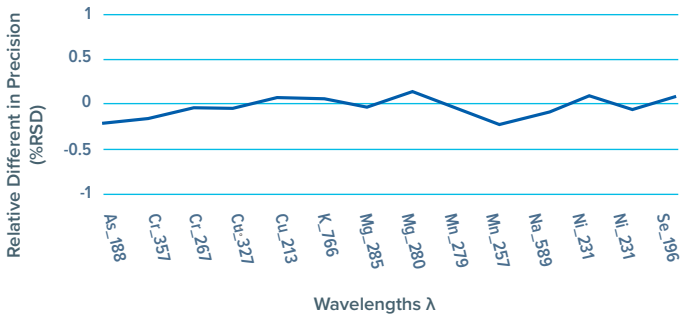


Figure 4b. Relative IS precision (%RSD) obtained with Trident CT versus original Trident.



Since in-line addition with the Trident relies, in part, on the stability of the IS uptake rate via the peristaltic pump, it is important to check the condition of peristaltic pump tubing and tension of the clamp. The TruFlo™ real-time sample monitor[2] is a very useful tool to diagnose any problems associated with sample tubing or the nebulizer. Pump tubing wear can be slowed by lubricating the pump rollers with the EzyGlide cloth (P/N 70-EZG-CLOTH). This improves precision, reduces drift and extends the period between recalibrations.

Glass Expansion also offers a complete range of contour flared-end pump tubing, making it easy to connect capillary tubing to small-ID pump tubing. Our contour flared-end pump tubing is available in a range of sizes and materials to suit all applications.

Self-aspiration is an alternative delivery method to the more common peristaltic pump. In some cases, ICP-MS laboratories choose self-aspiration for improved precision by eliminating the pulsations from the peristaltic pump that are more pronounced at very low uptake rates. The Trident CT, when paired with a Glass Expansion concentric nebulizer, can self-aspirate both the sample and IS, providing a means of in-line addition of an IS via self-aspiration. Glass Expansion also offers a complete line of high-quality PTFE encapsulated carbon fibre autosampler probes that can be directly connected to the Trident CT mixing chamber via a zero dead volume connection providing a stable and consistent sample uptake. Previous results[3] showed that the IS stability obtained using the Trident and manual addition is indistinguishable when using self-aspiration.

Conclusion

The results presented in this report indicate that there are no significant differences in the sensitivity or precision achieved with the new Trident CT and original Trident design. The stability and precision of in-line addition with the Trident CT also match the performance of manual addition. The alternative of in-line addition with the Trident CT drastically reduces sample preparation time, in addition to lowering the risk of contamination and error. The design improvement of the Trident CT eliminates the chance of worn or incorrectly fitted connections that can leak and inject air bubbles into the nebulizer flow, which can degrade short-term analytical precision (%RSD).

The Trident CT In-Line Reagent Additions Kit provides the ICP community with a new industry standard for in-line addition of an IS or ionization buffer with simple-to-use, leak-free, zero dead volume ratchet connections.

References

1. Robert Thomas, “Practical Guide to ICP-MS – A Tutorial for Beginners” 2nd Edition 2008.
2. Glass Expansion TruFlo™ Real-Time Sample Monitor, http://www.geicp.com/cgi-bin/site/wrapper.pl?c1=Products_accessories_truflo_sample_monitor
3. Glass Expansion October 2015 Newsletter, https://www.geicp.com/site/GE_Newsletter/Oct_2015/pubData/source/GE%20Newsletter%20Oct%202015.pdf