GLASS EXPANSION
Quality By Design

Helix CT™ ICP Spray Chamber with ConstantTorque Technology Provides Consistent Day-to-Day Analytical Performance

Abstract

Glass Expansion revolutionized spray chamber design for the ICP-OES and ICP-MS analyst by introducing cyclonic spray chambers. Prior to the Glass Expansion Tracey™ cyclonic spray chamber, Scott-style spray chambers were the standard option provided with your ICP. The design of Glass Expansion's cyclonic spray chambers helps the ICP analyst achieve sensitivity gains, reduced washout times, and reduced matrix effects not possible with other designs.

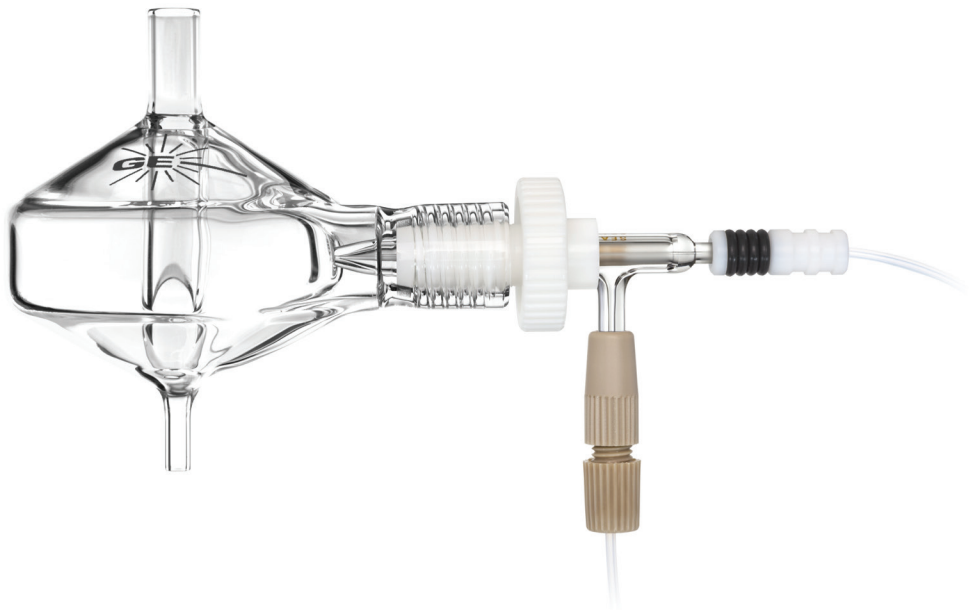
This article will provide a summary of Glass Expansion's unique cyclonic spray chamber features and describe the advantages of the new Helix CT™ ICP spray chamber with ConstantTorque™ technology.

Introduction

Traditionally, ICP-OES and ICP-MS sample introduction systems have relied on o-rings to form a gas-tight seal between the nebulizer and spray chamber. There are several drawbacks with an o-ring seal, such as:

- Potential for contamination due to dead volume around the o-ring seal
- Chemical resistivity of strong acids and organic solvents
- The o-rings are difficult to replace, often requiring tools
- Bonding to the nebulizer can result in breakage

Figure 1: Characteristics of Glass Expansion's Cyclonic Glass Spray Chamber



The evolution of Glass Expansion cyclonic spray design, specifically the advantages of the o-ring free Helix nebulizer-spray chamber interface were summarized in a 2014 article.1 In addition to the Helix interface, the benefits of each Glass Expansion cyclonic spray chamber model are detailed,1 making it easy for the ICP analyst to select the optimum spray chamber to suit their application needs. Glass Expansion is now pleased to introduce the new Helix CT (ConstantTorque) spray chamber, which provides a constant, reproducible, inert, gas-tight seal between the nebulizer and spray chamber (TwisterTM with Helix CT shown in Figure 1).

The main feature of the Helix CT spray chamber is a new Helix locking screw with built-in torque control mechanism that allows for a consistent seal of the PTFE ferrule against the nebulizer – making it impossible to overtighten or undertighten while ensuring a gas-tight seal each and every time. A new PressFit PTFE ferrule provides a chemically inert seal around the nebulizer, which is immune to strong acids and organic solvents routinely used in ICP sample preparation (Figure 2). The new Helix CT spray chamber by Glass Expansion, therefore, eliminates all the drawbacks of the o-ring nebulizer seal, while improving user safety by preventing broken nebulizers.

Figure 2. Helix CT Interface with nebulizer

The new Helix CT nebulizer interface is also simple to use:

- Fully insert the nebulizer into the Helix CT interface, until the nebulizer side-arm comes into contact with the moulded-in positive stop.
- Hand-tighten the Helix CT locking screw until the ConstantTorque mechanism clicks, indicating a secure, gas-tight seal.

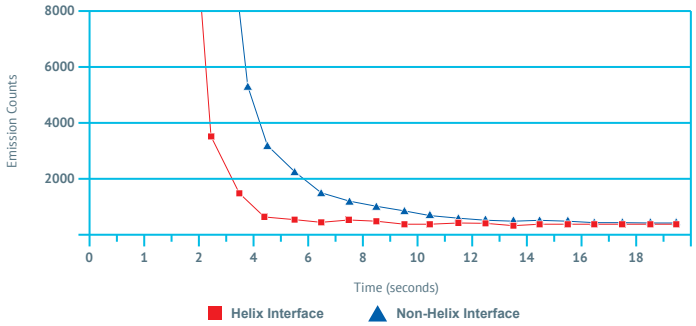
Experimental

An Agilent 5100 simultaneous dual view ICP-OES was used in combination with the SeaSpray DirectConnect (DC) nebulizer and Twister spray chamber with Helix CT to evaluate washout performance, in addition to highlighting the effects of nebulizer depth and torque applied to the nebulizer seal.

Results

The Helix CT is the only nebulizer-spray chamber interface that significantly reduces the dead volume around the nebulizer. This unique design minimizes washout time with highly concentrated samples, reducing sample-to-sample carryover and improving sample throughput. Figure 3 compares the time required to washout a 10ppm Molybdenum standard with the Helix CT interface and a “Brand-X” spray chamber with an o-ring interface. The results show that with the Helix nebulizer interface a 10ppm standard can be washed out in as little as 4 seconds, whereas “Brand-X” takes 16 seconds. One can expect this time to significantly increase for more troublesome or “sticky” elements that are more prone to carryover issues.

Figure 3. 10 ppm Mo washout comparison between Helix and non-Helix spray chambers



Glass Expansion’s new Helix CT design maintains the positive stop of the original Helix to ensure that the nebulizer is inserted to the correct and optimum depth within the spray chamber so that both ion and atom lines give optimum sensitivities under wide range of conditions.

The effect of a nebulizer depth relative to the aerosol impact zone inside a spray chamber was investigated by using radially measured background, atom and ion line intensities as well as the spectroscopically determined Mg ratios and Fe-excitation temperatures. The analytes studied were As (I), Cu (I), Cu (II), Mg (I), Mg (II), Mn (I), Mn (II), Se (I), Na (I) and K (I).

Figure 4. Mn (I) and Mn (II) sensitivities as a function of nebulizer gas flow rate for 2 different HALC positions, and 3 and 9mm nebulizer depths.

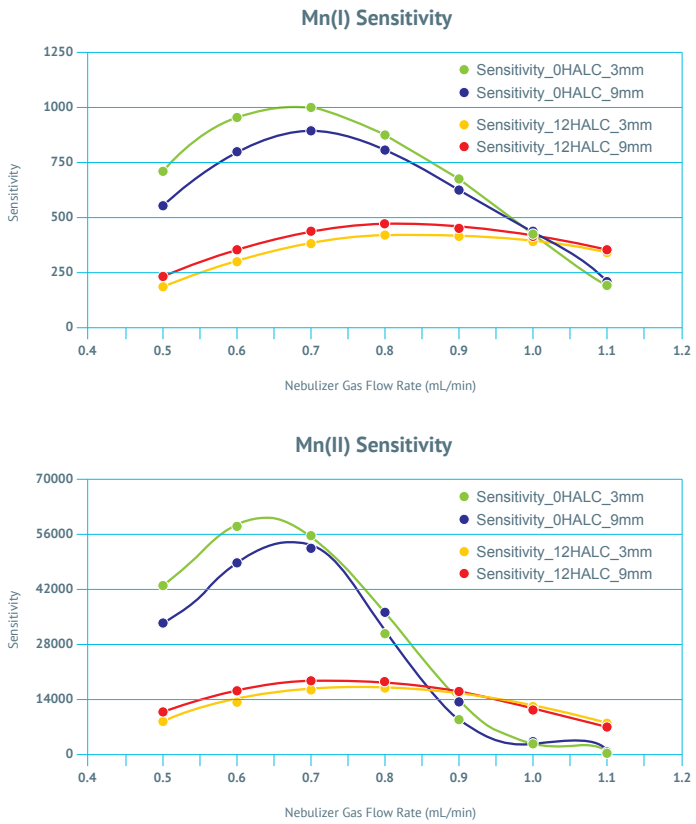
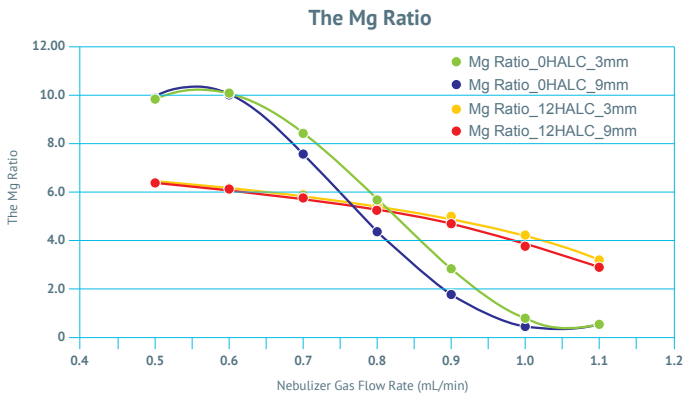


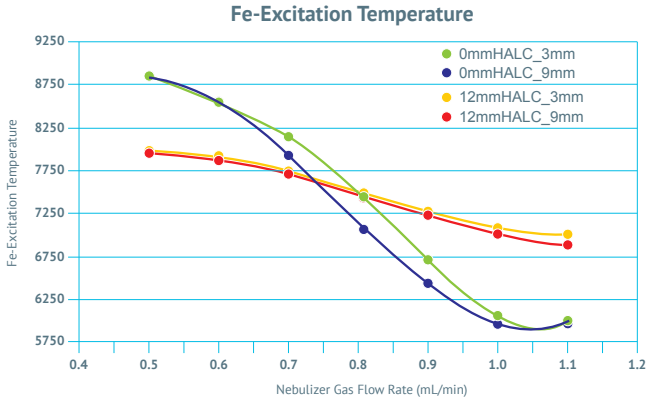
Figure 4 highlights the effect of nebulizer depth on Mn (I) and Mn (II) sensitivities as a function of nebulizer gas flow rate for two different height above the load coil (HALC) positions and two different nebulizer depths (3mm: closer to the aerosol impact zone and 9mm: away from the aerosol impact zone).

For the atom line, the highest sensitivity difference is noted at the lowest nebulizer gas flow rate when the nebulizer is moved away from the aerosol impact zone relative to the closest position studied. For the ion line, increases in sensitivity difference at lower nebulizer gas flow rate changes to decreases at higher nebulizer gas flow rate when the nebulizer is moved away from the aerosol impact zone. There is a crossover point clearly visible at 0mm HALC at approximately 0.7L/min nebulizer gas flow rate.

Figure 5 depicts the Mg ratio and Fe excitation temperature as a function of nebulizer gas flow rate. The results presented in Figure 5 indicate that both the Mg ratio and Fe excitation temperature show no significant difference at lower nebulizer gas flow rate whether a nebulizer is inserted closer or away from the aerosol impact zone inside the spray chamber. However, when the nebulizer gas flow rate is above about 0.7L/min and viewed closer to the load coil, the Mg ratio and Fe-Excitation temperature for the 9mm nebulizer depth are lower than that of the 3mm nebulizer depth. Therefore, the Mg ratio and Fe excitation temperature results indicate lower plasma temperatures when the nebulizer is moved away from the aerosol impact zone at higher nebulizer gas flow rates.

Figure 5. The Mg ratio and Fe-Excitation temperature as a function of nebulizer gas flow rate for 2 different HALC positions, and 3 and 9mm nebulizer depths.



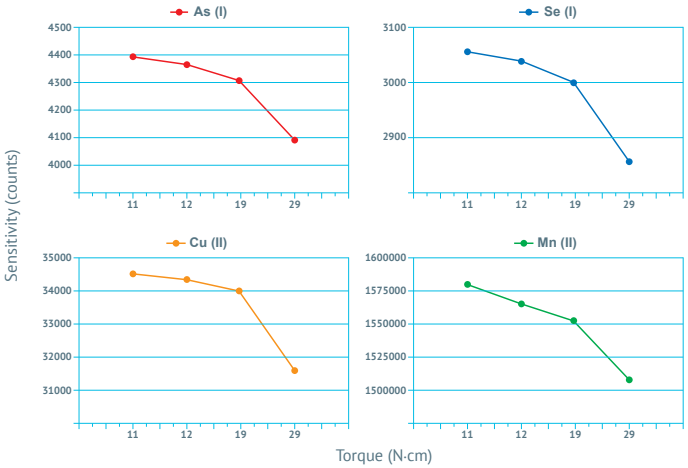


Therefore, the increase in sensitivity for both atom and ion lines can be attributed to the increase analyte loading to plasma when the nebulizer is inserted away from the aerosol impact zone and decrease sensitivity for ion lines can be attributed to the plasma cooling due to the increase nebulizer gas flow rates and water loading to plasma.

In order to address the above highlighted challenges, Glass Expansion's new Helix CT design maintains the correct and optimum nebulizer depth within the spray chamber so that both ion and atom lines give optimum sensitivities under wide range of experimental conditions.

In addition to nebulizer depth, the torque applied to the nebulizer seal is also critical. The data shown in Figure 6 highlights the effects of torque applied to the nebulizer seal versus the observed sensitivity. The applied torque was increased incrementally from 11 N·cm to 29 N·cm. As the torque applied to the nebulizer seal increases, the sensitivity decreased on average by 5%, with greatest difference being 8% (Cu (II)). The new Helix CT locking screw is set to the optimum torque and will seal the PressFit PTFE ferrule against the nebulizer to the same torque each day. This allows the ICP analyst to achieve the same nebulizer performance every day.

Figure 6. Helix CT interface sensitivity vs. torque



Conclusions

The results from our study show how dead volume around the nebulizer seal can affect washout efficiency, and ICP sensitivity is affected by both nebulizer depth within the spray chamber and the torque applied to the nebulizer seal. If consistent performance is crucial to your ICP laboratory, the new Helix CT spray chamber is your solution. The Helix CT spray chamber provides unparalleled, reproducible day-to-day ICP analytical performance.

Glass Expansion will now equip all of its glass, PFA, and PTFE spray chambers with the new Helix CT interface. However, if you already have a Helix spray chamber, you can easily upgrade to the Helix CT interface. The new Helix CT locking screw and PressFit PTFE ferrule are fully compatible with all Glass Expansion Helix style spray chambers. Achieving consistent day-to-day analytical performance in your ICP laboratory is just a click away with the new Helix CT cyclonic spray chamber, learn more at www.geicp.com/HelixCT and upgrade your ICP today.

References

1. Glass Expansion October 2014 Newsletter, "ICP Spray Chamber Update."

http://www.geicp.com/site/GE_Newsletter/GE_Newsletter_October_2014/pubData/source/GE0283%20GE%20Newsletter%20October%202014.pdf