A Dedicated Dialogue

How to Improve ICP Performance and Operation

Jerry Dulude, President, Glass Expansion, Inc.

ICP offers greater speed, precision and sensitivity compared to atomic absorption techniques. Sample introduction system is the most cruicial component. Spectroscopy spoke with Jerry Dulude, President of Glass Expansion, about recent advances in the sample introduction systems that enable users to meet ever-tighter analytical specifications.

Spectroscopy: What sample introduction innovations have been introduced that help to lower the limits of detection?

DULUDE: In the late 1980s, Glass Expansion pioneered the combination of a concentric glass nebulizer with a cyclonic spray chamber. This development, along with some spectrometry modifications, helped Thermo Scientific develop an ICP optical spectrometer called the 61E Trace. This instrument was capable of hitting the demanding limits of the United States Contract Laboratory Program for the difficult elements of arsenic, selenium, lead and thallium, which up until that time were only done by graphite furnace AA. The was quite a coup for them and the instrument sold very heavily into the environmental market.

That combination of a concentric glass nebulizer with a cyclonic spray chamber has become the standard for most ICP optical and mass spectrometers.

More recently, Glass Expansion developed a syringe-based sample introduction system called The Assist, which in combination with flow injection technology, can be used to reduce carryover and speed analysis. Since the syringe drives eliminate the short-term pulsations of the peristaltic pump, The Assist has been shown to significantly lower detection limits, particularly for ICP mass spectrometry, which uses a rapid scanning detector.

Spectroscopy: One concern shared by both researchers and technicians is the reproducibility of sample introduction components so that method parameters remain constant even after changing out a component. What has been done to address this concern?

DULUDE: First of all, you need to have very low manufacturing tolerances for all the parts that you manufacture. And you need a design that is capable of being manufactured with very tight tolerances. It's not as easy as it might seem.

Take the concentric glass nebulizer. Glass Expansion did not introduce this design, but we improved upon the concept. By definition, the concentric glass nebulizer has a small ID liquid channel inside a nebulizer body, so the liquid is drawn out by the Venturi effect at the confluence of the two channels at the tip.

Other manufacturers heat glass capillaries and draw them out to the desired thickness and internal diameter. It is very difficult to accurately control the tolerances along the entire length of the drawn capillary. Glass Expansion developed capillary technology to use thick-walled constant bore glass tubing and machine the outside diameter to the proper shape. This approach allows us to achieve high nebulizer-to-nebulizer reproducibility. Although not recommended, an analyst could now interrupt an analysis, change the nebulizer and resume analysis without the need to re-standardize.

We took a similar approach with our line of ICP-MS cones. We built a complete metal machining factory with four CNC machines and an electron beam welder so that we could achieve the highest degree of accuracy and reproducibility possible.

Spectroscopy: Given that ICP technicians have different levels of experience and training, how can installation and optimization of sample introduction components be facilitated?

DULUDE: Glass Expansion has introduced a number of innovations to facilitate installation and optimization. Let me give you some examples.

First, our helix O-ring free nebulizer fitting solves a number of challenges. The operator no longer has to deal with O-rings bonding to the nebulizer and risking breakage of the nebulizer. The helix screw is simply rotated counterclockwise for nebulizer installation or removal and then clockwise to lock it in place. There is no depth adjustment that has to be done, because the helix is designed so that the nebulizer is pushed in all the way to the stop. Also, there is no need for the difficult task of O-ring replacement, which can be quite onerous.

Second, we developed a liquid flow meter specifically for ICP called the TruFlo, that allows the operator to monitor the sample flow in real-time. This makes setting the pressure on the peristaltic pump less subjective and easier to optimize. It also tells the operator, during a run, when the flow has deviated out of a preset range so that problems can be corrected immediately.

Lastly, sometimes it's necessary to chill a spray chamber in order to analyze certain very volatile samples. This had been accomplished using a jacketed spray chamber with an external floor-mounted chiller connected via long cumbersome tubing. Glass Expansion took this technology to the next level with the IsoMist programmable temperature spray chamber. It's a compact self-contained unit, mounted right in the sample introduction area. It can be controlled via Bluetooth communication to operate anywhere from -25 to +80°C.

Spectroscopy: And what can be done to improve or reduce maintenance of the sample introduction system?

DULUDE: Proper maintenance is very important to achieve top performance of an ICP and to keep costs at a minimum. One of the hardest hit components in the sample introduction area is the quartz torch. Quartz, at very high temperatures, devitrifies when it comes into contact with salts which are present in the sample. Particularly high salt samples can destroy an ICP torch completely in only a few weeks. So we're talking about a fair amount of expense with very nasty samples.

Glass Expansion developed an all-ceramic D torch to address this challenge. The demountable outer tube is made of ceramic and the intermediate tube is made of alumina. When fitted with a demountable alumina injector, the torch is completely quartz free. This torch is going to last for years, even when used to analyze samples such as brines.

Nebulizers can also suffer from exposure to difficult samples. Glass Expansion recently introduced an in-line sample filter to trap large particles before they reach the nebulizer. If the nebulizer does experience a total or partial clog, the popular Eluo nebulizer cleaning tool can be used to easily and safely clean it.

Accessories such as the Niagara Plus and The Assist cut in half the amount of time that sample introduction components come in contact with the sample. So you can double the amount of samples run with a particular nebulizer, torch, or set of cones before maintenance is necessary.

Spectroscopy: With all of these recent improvements, what do you see as opportunities to further improve the sample introduction system of an ICP?

DULUDE: Glass Expansion is constantly working on new designs of nebulizers, spray chambers, torches and interface cones. We're seeing a trend towards smaller samples and smaller spectrometers. We offer nebulizers that are designed to run at uptake rates as low as 10 µL per minute. One of the advantages is that there is negligible waste. More rugged designs are going to be needed for field operating ICP systems, so we may see a trend away from glass for all of the sample introduction components.

Also, the interface of the sample introduction system of the ICP spectrometer with the output of a separation instrument, such as a liquid or gas chromatograph, demands customized components for optimum performance. We are not just a manufacturing company, we have a research lab and scientists in our Australian facility and are constantly investigating new ways to improve life for the ICP analyst.