The “Top 5” Mass-ive Problems with Element-ary Solutions

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President

Glass Expansion, Inc.

CEM

Mastering Trace Metals Analysis

GLASS EXPANSION

Quality By Design

www.geicp.com

Who is Glass Expansion?

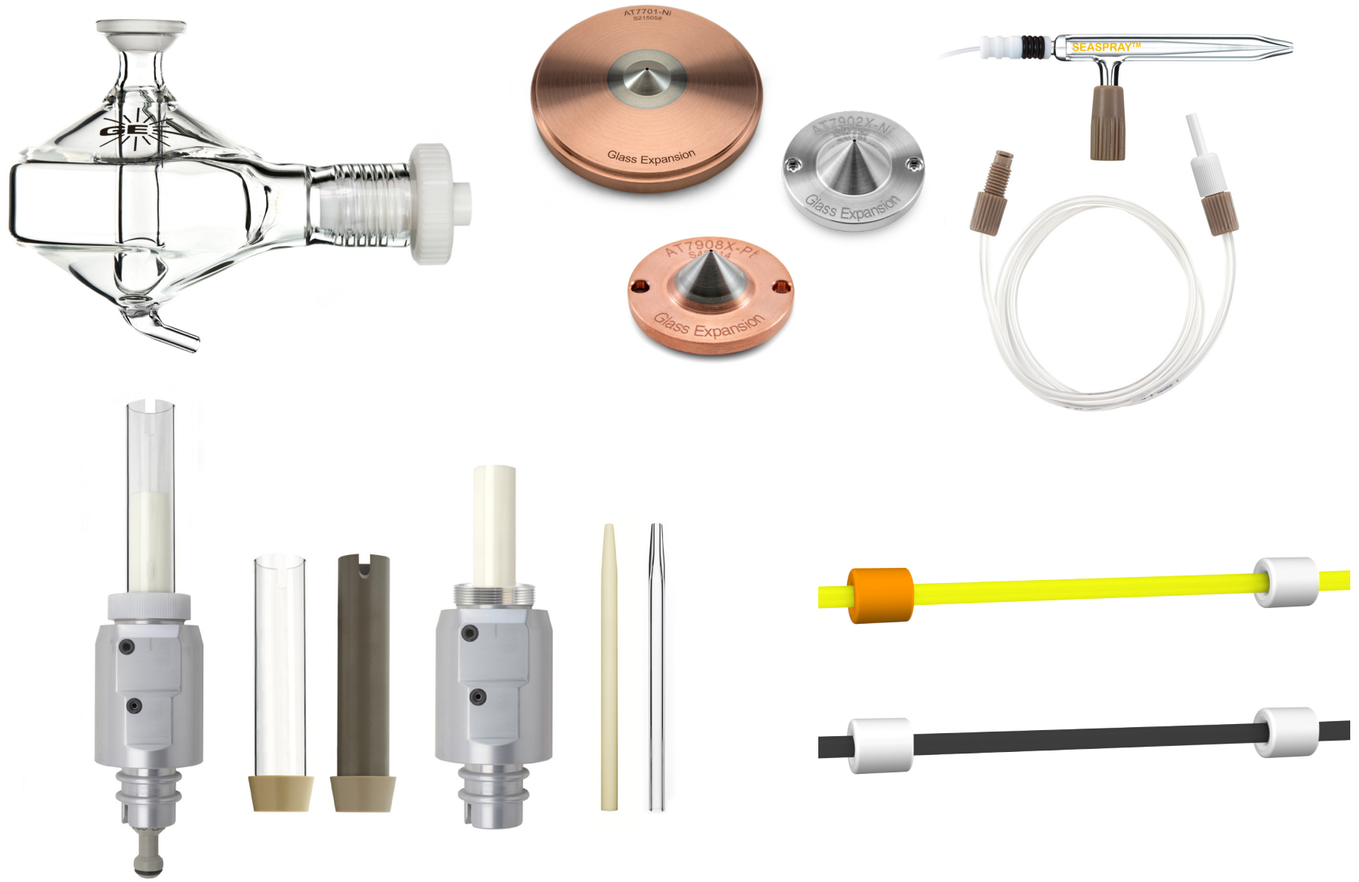
Glass Expansion is a unique group of enthusiastic people who on a daily basis, work on new frontiers of science and technology.

- Formed in 1985
- **World leaders in sample introduction components for ICP-OES and ICP-MS focused on:**
  - Quality by design
  - Value
  - Analytical performance
  - Better usability
- OEM to every major ICP-OES and ICP-MS manufacturer
- Approximately 100 staff
- Locations Worldwide (Australia, United States and Germany)

Email us at: **geusa@geicp.com**

Products Offered

- Autosampler Probes
- Pump Tubing
- Nebulizers
- Spray Chambers
- Torches
- Cones
- RF Coils
- Fittings, Connectors, & Adaptors
- Performance Enhancing Accessories



Manufacturers Supported

- Agilent Technologies®
- Analytik Jena
- GBC Scientific
- Hitachi
- Horiba
- Nu Instruments
- PerkinElmer®
- Shimadzu®
- SPECTRO (Ametek)
- Standard BioTools™ (Fluidigm)
- Teledyne CETAC
- Teledyne Leeman
- Thermo Fisher Scientific™

Support and Customer Service

Information for the ICP user:

- Application Notes
- E-News
- Catalogues
- Product Flyers
- Website
- Product care advice
- Operating instructions
- Videos
- Warranty

Cone Resource Guide

- **Guidance on cone selection**
  - Advantages of different cone raw materials
  - Selection based on matrix and performance
- **Tips on Care and Maintenance**
- **Organized by ICP-MS Model**
  - Cross-reference OEM product numbers
  - ***Click here to view the Cone Resource Guide***

Common Problems: "Real World" Samples

Perfect samples are nice—but they do not exist in the "real world":

- Clogged nebulizers and injectors
- Torch devitrification
- Destabilization of plasma
- Increased oxide formation
- Long washout times / carryover
- Long stabilization times
- Signal suppression
- Signal drift
- Poor precision (RSDs)
- Carbon build-up
  - » Orifice occlusion
  - » Signal drift
  - » Carbon-based polyatomic interferences

Common Problems: "Real World" Samples

Perfect samples are nice—but they do not exist in the "real world":

Take Home Note:

99% of analytical problems occur within the sample introduction configuration and can be traced back to a few common causes

#5

Abnormal Nebulizer Backpressure

#5

Abnormal Nebulizer Backpressure

It's good practice to record or take note of your nebulizer backpressure after the instrument has warmed up and use this as a benchmark while the instrument is running.

An abnormally high or low backpressure indicates a problem that needs to be addressed.

1L/min

Part Number: A13-1-UM04

Product: MicroMist DC Nebulizer 0.4mL/min

0.7L/min

Part Number: A31-07-USS2

Product: SeaSpray DC Nebulizer 2mL/min

Glass Expansion nebulizers are designed to operate at 40 psi (275 kPa) when set to their specified gas flow

Low Backpressure

Typically coupled with a loss in sensitivity, this can indicate a gas leak. Check the tubing and connections at both the instrument and nebulizer.

Direct Connect (DC) fittings, with built-in torque control, are the most secure and easiest to replace. The large, soft-walled tubing prevents kinks and fatiguing often associated with rigid capillary tubing.

Glass Expansion DC Gas Lines

Manufacturer	Model	P/N Prefix	Gas Line Included
Agilent®	4100, 4200	MP11-	70-803-0969
Agilent®	Vista, 700-ES	A11-	70-803-0969
Agilent®	7700, 7800, 7900, 8800, 8900	A13-	70-803-1105
Agilent®	5100, 5110, 5800, 5900	A13-	70-803-1105
Analytik Jena®	ICP-OES	A13-	70-803-1105
Analytik Jena ®	ICP-MS	A61-	70-803-2002
Analytik Jena ®	ICP-OES	A13-	70-803-1105
Horiba ® Jobin Yvon	All Models	A13-	70-803-1105
Leeman	All Models	A11-	70-803-0969
Nu Instruments	ICP-MS	A51-	70-803-1858
Nu Instruments	TOF-ICP-MS	A52-	70-803-2044
PerkinElmer ®	Optima, PE Avio	A21-	70-803-1070
PerkinElmer®	Elan, NexION 300/350	A22-	70-803-1049
PerkinElmer®	NexION 1000, 1100, 2000, 2200, 5000	A23-	70-803-1449
Radom	MICAP® OES™ 1000	A70-	70-803-2054
Shimadzu®	All Models	A41-	70-803-1311
Spectro™	All Models	A21-	70-803-1070
Standard BioTools™ (Fluidigm)	Helios	A21-	70-803-1070
Thermo Scientific™	PRO, 6000/7000, MX Series, Q/RQ/TQ, X-Series & Neoma	A31-	70-803-1105
Thermo Scientific™	Neptune	A11-	70-803-0969


P/N 70-803-0969


P/N 70-803-2002


P/N 70-803-1105


P/N 70-803-2044


P/N 70-803-1070


P/N 70-803-2054


P/N 70-803-1049


P/N 70-803-1858


P/N 70-803-1449


P/N 70-803-1311

High Backpressure

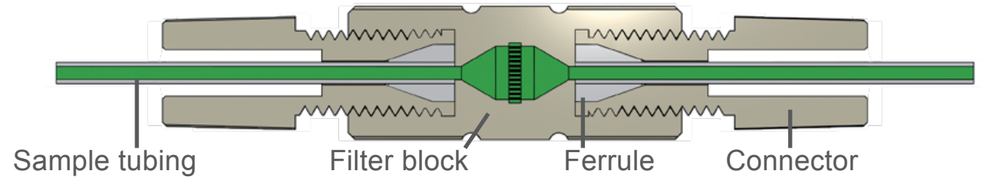
A high backpressure typically indicates a blocked or clogged nebulizer

1. **The nebulizer should be cleaned using appropriate procedures**

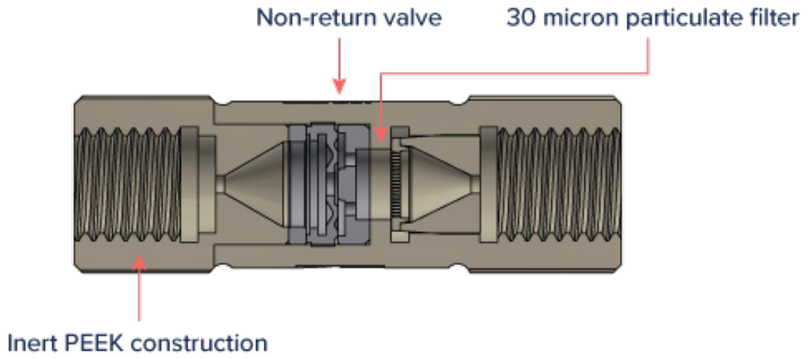
   • The Eluo device is recommended for all GE nebulizers

2. Determine the cause of the blockage (e.g., salts or particulates) and take preventative action

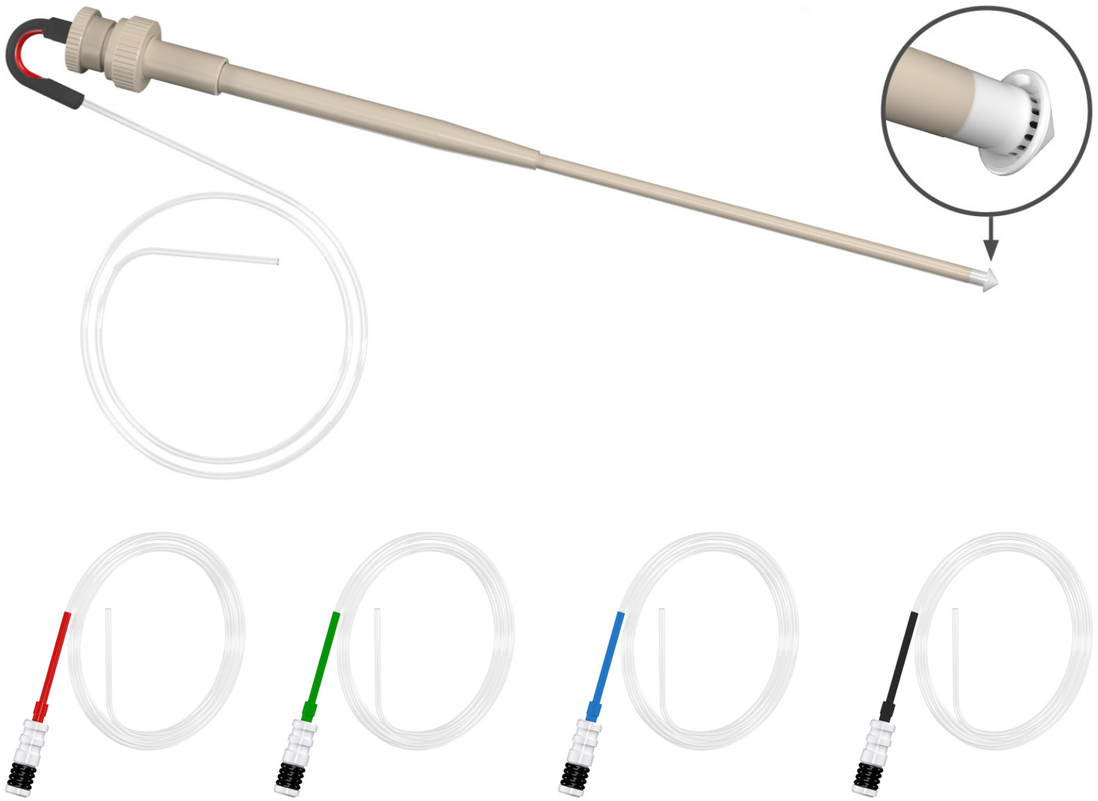
The **Guardian In-Line Sample Filter** installs directly onto the sample uptake or probe tubing. It contains a 120 µm PEEK filter that is designed to trap any large particulates that are taken up into the sample stream before they have a chance to reach and subsequently block or damage the nebulizer. The filter is reusable and can be backflushed with the **Eluo** and appropriate adapter.



The **Guardian In-Line Non-Return Gas Filter** prevents acidified sample or rinse solution from syphoning into the instrument gas box. It also contains a 30 µm PolyComb filter to protect the nebulizer from particulates in the instrument gas supply.

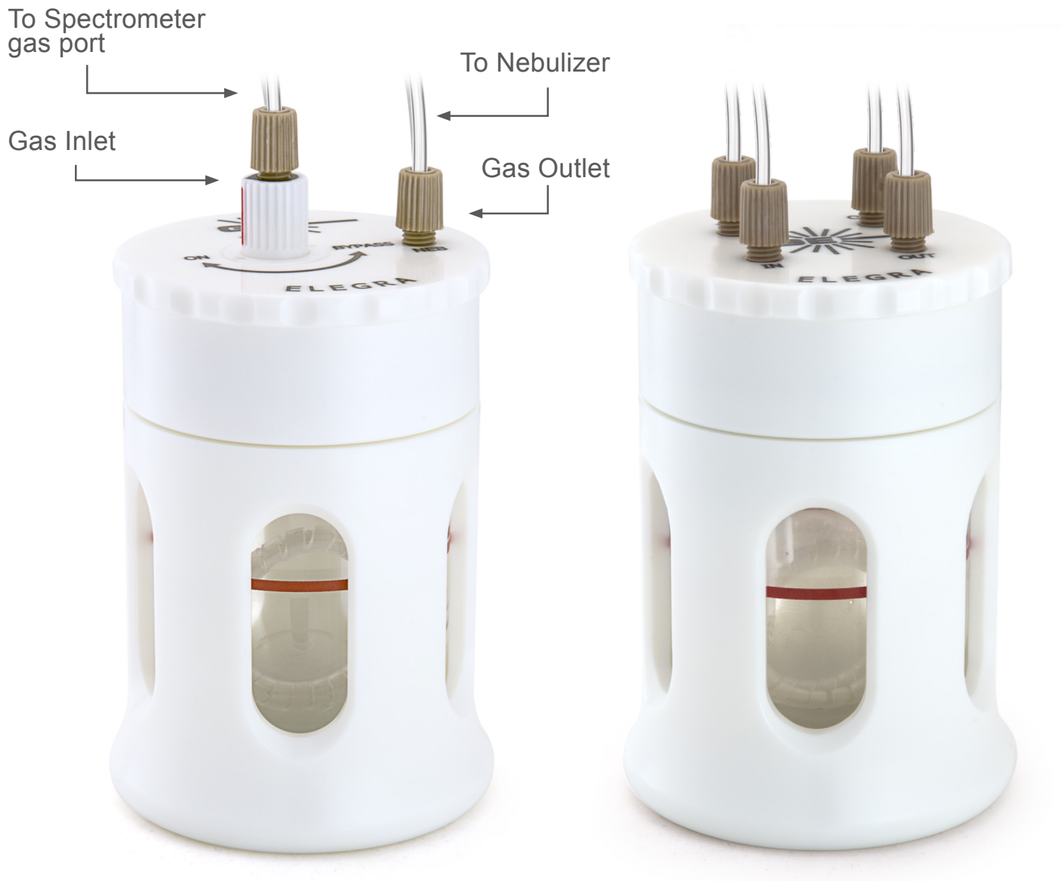


The **Guardian Autosampler Probe** is a new product from Glass Expansion that combines drip-resistance with a built-in filter tip. It is completely inert, with ceramic, PEEK, and PTFE construction.



- Robust (ceramic) tip prevents crushed and damaged tips due to misalignment
- Drip-resistant design prevents cross-contamination of samples, especially with oils
- Built-in particle filter holds back particulates from blocking the sample line

A carrier gas humidifier, such as the **Elegra Argon Humidifier** from Glass Expansion, is recommended for samples containing high amounts of total dissolved solids (TDS), as there is an increased likelihood of salt deposits forming at the tip of the nebulizer and injector which can result in significant analytical drift in or even an extinguished plasma.



#4

Inconsistent or Low Sample Uptake Rate

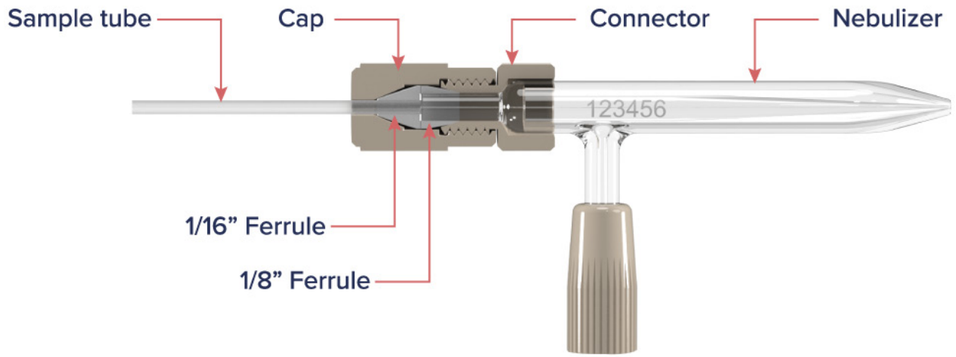
Just like with the nebulizer backpressure, it's good practice to monitor the sample uptake rate to ensure the correct or expected value.

A change in uptake rate can indicate a nebulizer or tubing blockage, worn pump tubing, or incorrect pump tension.

After checking for nebulizer issues covered in the previous slides, use the **Sample Uptake Calculator** on the Glass Expansion website to calculate the expected flow rate. Some ICP software also contains this feature.

The benchmark value should then be measured with new or recently-cleaned sample introduction components.

The **Nexus™ Universal Connection Kit** is a one-size-fits-all nebulizer connection kit which enables you to use any of Glass Expansion's industry- leading concentric nebulizers* with the sample introduction configuration of your choice, including switching valves, chromatographs (LC, HPLC, IC, etc.), and other high-performance accessories.



- **Switching Valves:** Simple and reliable custom-length connections to all high-throughput valve or syringe-drive systems
- **Speciation Analysis:** Zero-dead-volume and secure, high-pressure connection for hyphenated techniques, such as LC-ICP-MS, HPLC-ICP-MS, IC-ICP-MS, and FFF-ICP-MS
- **High-Efficiency Sample Introduction System (HE-SIS):** Connect to Glass Expansion's HE-SIS, which provides up to 95% transport efficiency for a variety of applications
- **High-Precision Analysis:** Create a high-pressure seal when performing self-aspiration for the most stable sample uptake and delivery

Poor precision (RSDs) or sensitivity can be symptoms of worn pump tubing. Be sure to replace pump tubing as frequently as necessary and ensure the correct pump tubing is used for your sample matrix.

Chemical Resistance Chart

Important note on service life, temperature, compatibility and chemical resistance:
The data provided in the tables are advisory values and not guaranteed. In all cases customers should conduct tests to ensure compatability with their chemicals and processes.

We recommend:
Place the tubing in the medium to be used for a period of 48 hours. After this time, examine the tubing for signs of swelling, softening or hardening. A judgement can then be made as to the likely suitability of the tubing.

Legend
X = **Satisfactory**
O = **Use only after testing**
U = **Unsatisfactory**
- = **No data available**

Medium	PVC	Silicone	Viton	PVC Solva	Santo-prene
Acetaldehyde	U	X	U	X	X
Acetates (low mol. wt.)	U	O	U	X	X
Acetic acid (<5%)	X	X	X	X	X
Acetic acid (>5%)	X	U	O	X	X
Acetic anhydride	O	O	U	X	U
Acetone	U	X	U	U	U
Acetyl bromide	U	-	-	X	-
Acetyl chloride	U	-	-	X	-
Air	X	X	X	X	X
Alcohols	X	X	X	X	-
Aliphatic hydrocarbons	X	O	U	U	-
Aluminium chloride	X	O	X	X	-
Aluminium sulfate	X	X	X	X	X
Alums	X	-	X	X	-
Ammonia (gas-liquid)	O	X	U	X	X
Ammonium acetate	X	-	-	X	-
Ammonium carbonate	X	-	-	X	-
Ammonium chloride	X	-	X	X	-
Ammonium hydroxide	O	X	X	X	X
Ammonium nitrate	X	O	-	X	-
Ammonium phosphate	X	X	-	X	-
Ammonium sulfate	X	X	X	X	X
Amyl acetate	U	U	U	U	U
Amyl alcohol	X	U	X	U	X
Amyl chloride	O	U	X	U	-
Aniline	O	U	O	X	X
Aniline hydrochloride	O	U	X	X	-
Animal oils	U	O	X	X	X
Antimony salts	X	-	O	X	-
Aqua regia	U	-	O	X	U
Aromatic hydrocarbons	U	O	X	U	-
Arsenic salts	X	-	X	X	X
Barium salts	X	X	X	X	X

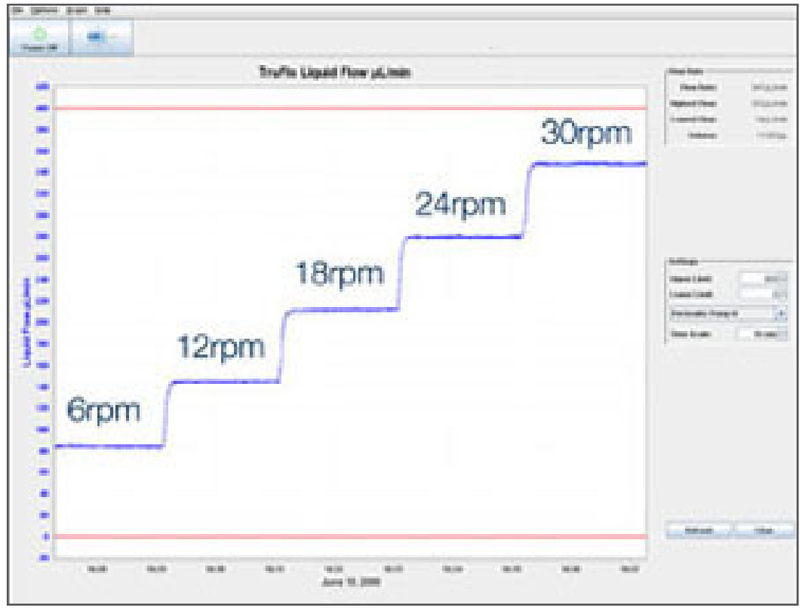
Medium	PVC	Silicone	Viton	PVC Solva	Santo-prene
Benzaldehyde	U	U	U	U	X
Benzene	O	U	X	U	U
Benzene sulfonic acid	O	-	X	X	-
Benzoic acid	X	O	X	U	U
Benzyl alcohol	X	-	X	U	X
Bleaching liquors	X	O	X	X	X
Boric acid	X	X	X	X	X
Bromine	X	U	X	X	U
Butane	O	U	X	U	U
Butanol	X	O	X	-	-
Butyl acetate	U	-	U	U	U
Butyric acid	U	-	O	X	X
Calcium salts	X	O	X	X	X
Carbon bisulfide	U	-	X	U	-
Carbon dioxide	X	O	X	X	X
Carbon tetrachloride	O	U	X	X	U
Chloracetic acid	U	-	U	X	U
Chlorbenzene	U	-	X	U	U
Chlorine (wet)	O	U	X	X	U
Chlorine (dry)	O	U	U	X	U
Chloroform	O	U	X	U	U
Chlorsulfonic acid	O	U	U	X	U
Chromatic acid	X	U	X	-	X
Chromium salts	X	-	-	X	X
Copper salts	X	X	X	X	X
Cresol	O	X	X	U	U
Cyclohexanone	U	U	X	U	U
Essential oils	O	-	-	X	X
Ethers	O	U	O	U	U
Ethyl acetate	U	O	U	U	U
Ethyl alcohol	O	O	X	X	X

Medium	PVC	Silicone	Viton	PVC Solva	Santo-prene
Ethyl bromide	U	-	X	X	-
Ethyl chloride	U	U	X	X	U
Ethylamine	U	-	U	X	-
Ethylene chlorohydrin	U	U	X	X	U
Ethylene di-chloride	U	U	X	X	U
Ethylene glycol	X	X	X	X	X
Fatty acids	O	O	X	X	-
Ferric chloride	X	O	X	X	-
Ferric sulfate	X	O	X	X	X
Ferrous chloride	X	O	X	X	-
Ferrous sulfate	X	O	X	X	-
Fluoborate salts	X	-	-	X	X
Fluoboric acid	X	-	-	X	X
Fluo-silicic acid	X	-	-	X	X
Formaldehyde	X	O	U	X	X
Formic acid	X	O	U	X	X
Freon	U	U	O	U	U
Gasoline (non-aromatic)	U	U	X	U	U
Gasoline (high aromatic)	U	U	X	U	-
Glucose	X	X	X	X	X
Glue	X	-	X	X	-
Glycerine	X	X	X	X	X
Hydriodic acid	X	-	X	X	-
Hydro-bromic-acid	X	U	X	X	X
Hydrochloric acid (dil.)	X	U	X	X	X
Hydrochl. acid (med. conc.)	X	U	X	X	X
Hydrochloric (conc.)	O	U	X	X	X
Hydrocyanic acid	X	U	X	X	X
Hydrofluoric acid	O	U	X	X	O
Hydrogen peroxide (dil.)	X	X	X	X	U

Example of a chemical compatibility chart for peristaltic pump tubing

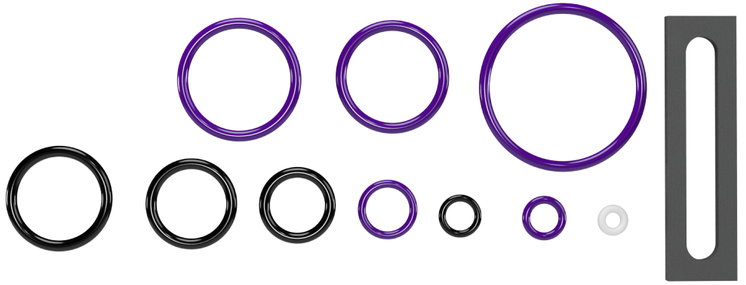
The **EzyGlide Cloth** another simple but useful product that can be used to lubricate pump rollers. This lubrication reduces pump tubing wear to increase the service life of pump tubing.

For precise analyses and complete diagnostic control, the **TruFlo Sample Monitor** actively monitors sample uptake rate, as well as enabling you to set optimal pump tension, allowing you to always know the actual rate of sample uptake to your nebulizer. It provides continuous, real-time flow measurement and will sound an alarm if the uptake rate falls outside of the pre-determined range.



#3

Not “Seal”-ing the Deal



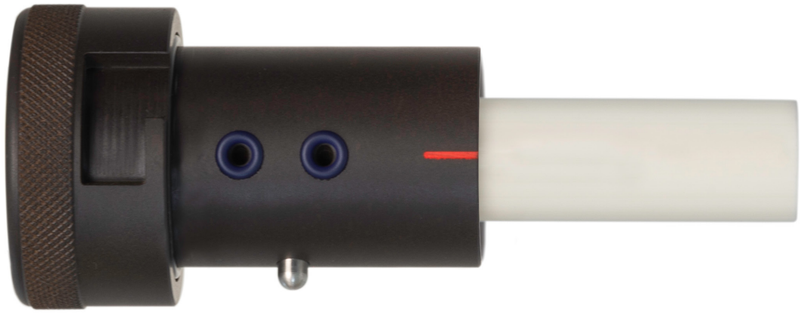
Worn or damaged gaskets, O-rings, seals, and ferrules are often a “hidden” problem, as they are commonly neglected not routinely inspected

- If a graphite gasket is used with your sampler cone, it should be replaced **every time** the cone is removed and either replaced or simply cleaned and re-installed. The gasket is designed to deform and make up any irregularities in the mating surface of the sampler cone

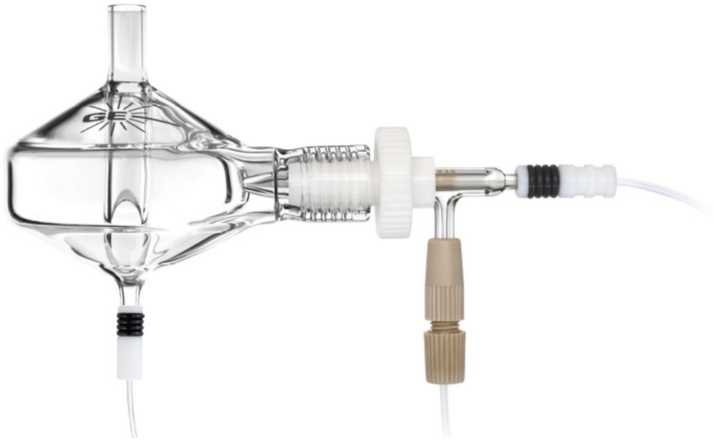
- Not doing so can lead to loss of sensitivity and vacuum, as well as premature cone failure due to inefficient cooling, as well as other analytical effects

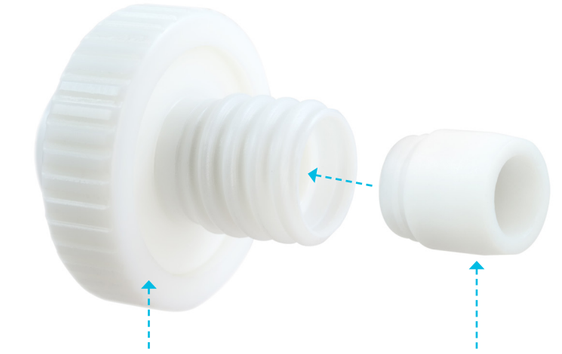
- Some torch designs contain multiple O-rings, which are often a point of failure, resulting in gas leaks and either plasma instability or an inability to ignite the plasma

- Demountable torch designs often use a ferrule to seat the injector. This can become worn or deformed over time as the injector is replaced or removed for cleaning and reinstalled, as well as simply resulting from exposure to the harsh conditions within the plasma stand

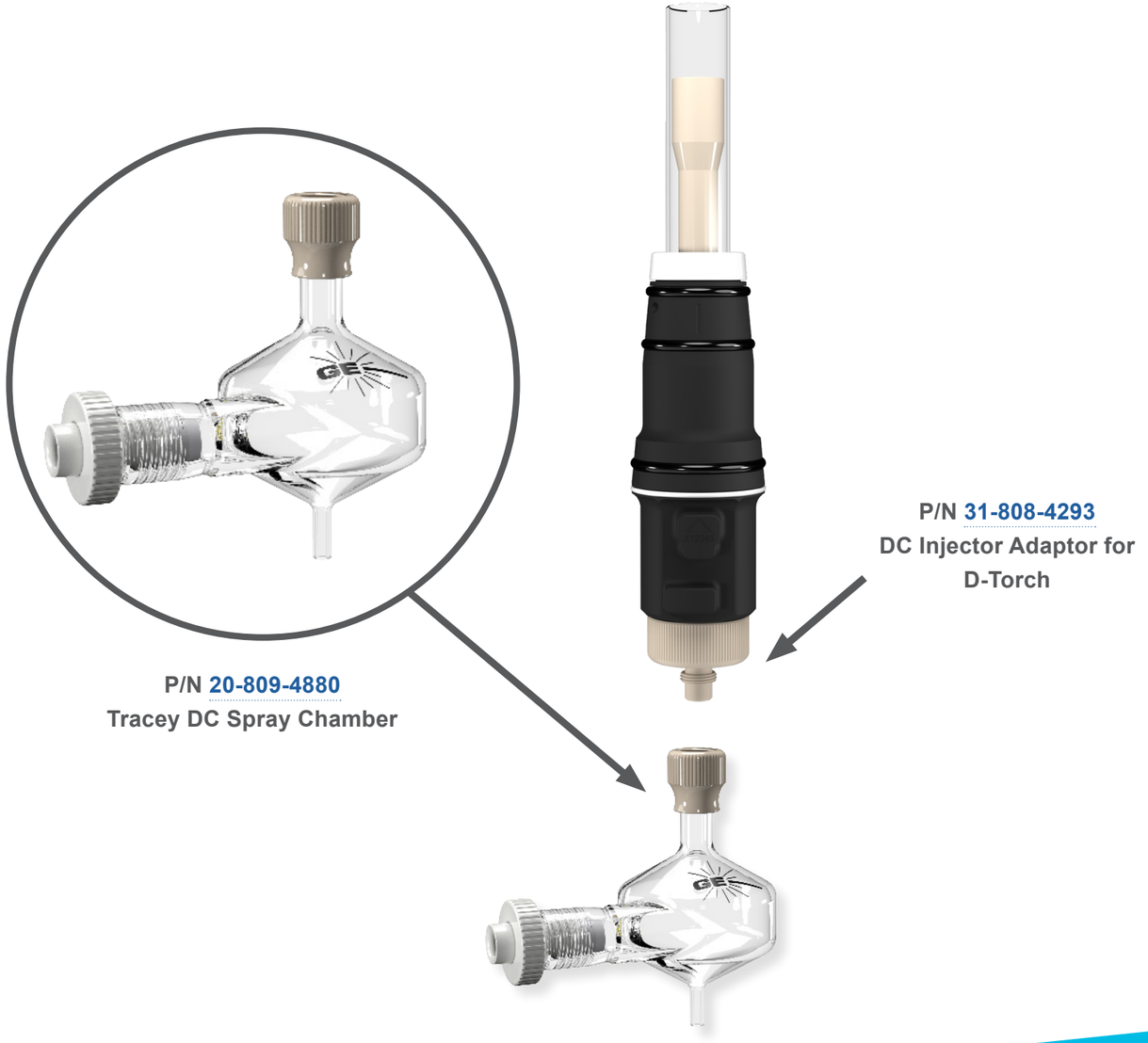


- Some spray chambers still use an O-ring seal for the nebulizer, which leads to multiple problems, such as prolonged washout, sample carryover, inefficient sealing, and loss of sensitivity
- They will also fatigue over time as a result of exposure to the analytical environment and acid content, which can result in physical damage to the nebulizer
- All Glass Expansion spray chambers come standard with the **Helix CT**, which eliminates the aforementioned problems associated with O-rings. The seal is a consumable and should be replaced as needed





For the most secure connection from the spray chamber to the torch, the **Direct Connect (DC) Spray Chamber** is a new product from Glass Expansion that eliminates ball joint clamps, which rust over time. The DC fitting guarantees perfect alignment each and every time, as well as a secure connection that eliminates gas leaks, providing improved precision and better transport efficiency.



#2

Premature Torch Failure

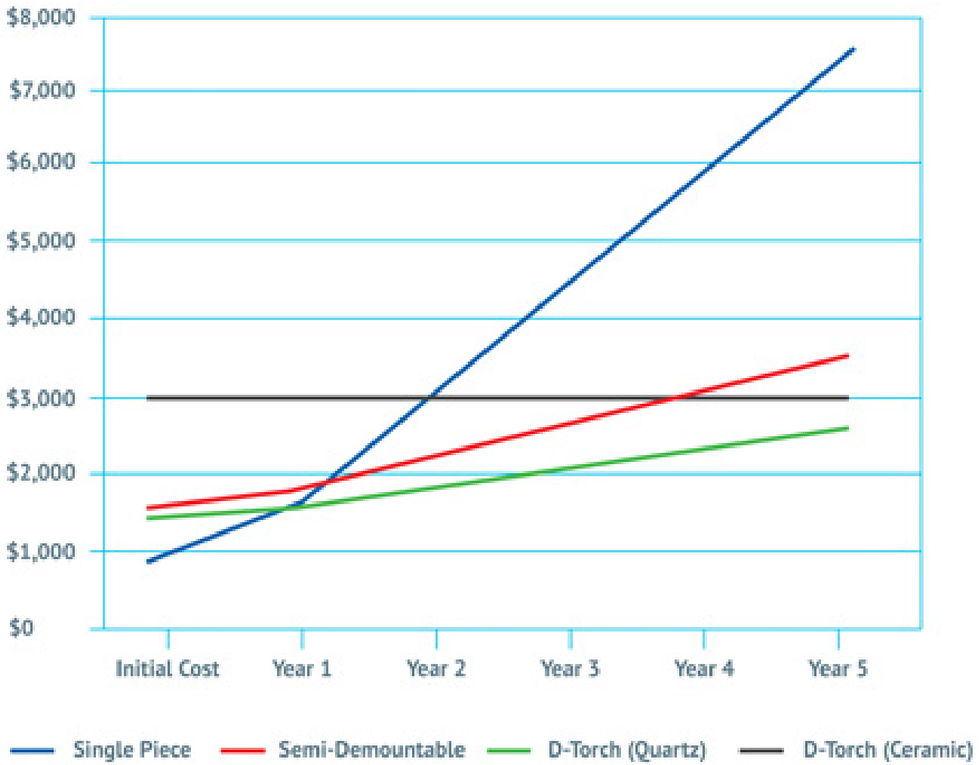
Torch failure can be a result of gas leaks, a damaged or mis-aligned RF coil, or simply suboptimal torch selection.

Aggressive sample matrices are a challenge, and most "real-world samples" analyzed by ICP laboratories contain considerable concentrations of TDS, including soils, sludges, wastewater, brines, high acid digests, and fusions. Analyzing these types of samples can pose a number of challenges for the ICP analyst, including increased frequency of torch replacement due to shortened torch life.

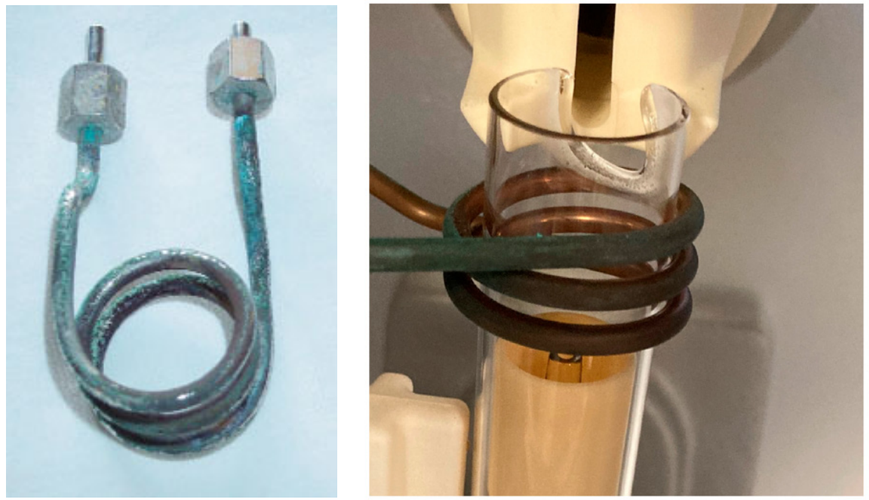
Demountable torches, such as the **D-Torch** from Glass Expansion, are quickly becoming the torch of choice for ICP users, in order to overcome the problems and costs associated with the traditional single-piece torch.

- Replaceable outer tubes or tube sets decrease the replacement cost compared to a single-piece torch
- Torches which have a ceramic inner tube, such as the **D-Torch**, decrease this cost even further, as the ceramic inner tube is fused with the base, allowing for only the outer tube needing to be replaced
- Optional ceramic outer tubes will not devitrify like quartz and can last the lifetime of the instrument
- Injectors are individually replaceable, which not only further leads to decreased costs, but also allow for one torch to be used for many different applications

Comparative Torch Ownership Costs



The RF coil is also a common source of torch failure, as it is often—and mistakenly—not viewed as part of the sample introduction system

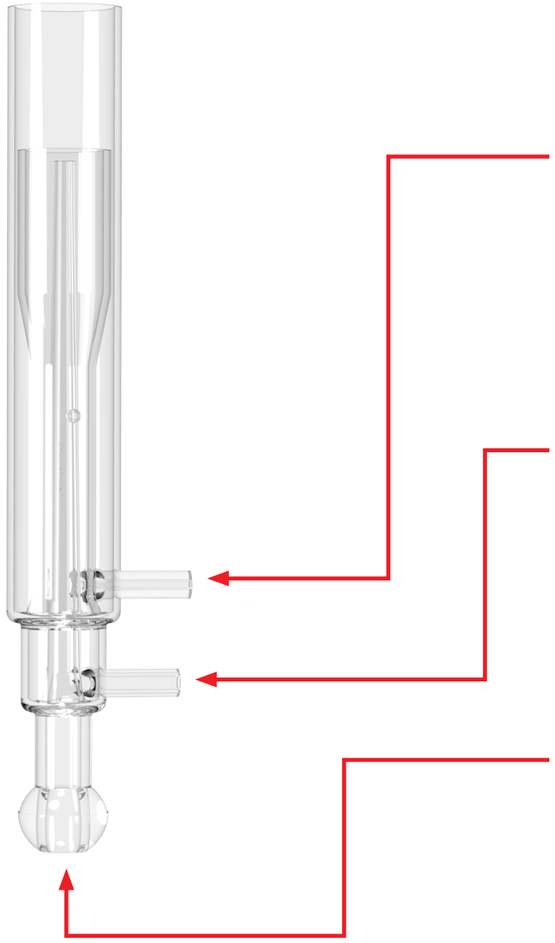


Damaged RF Coil

- Damaged or corroded RF coils result in decreased plasma efficiency, requiring a greater strain to be placed on the RF generator. Changing corroded coils increases energy transfer, resulting in a more robust plasma and generally higher analytical intensities
- Misaligned or misshaped RF coils result in hotspots on the torch, leading to premature melting
- RF coil material is also an important consideration. Copper, Gold, and Silver each offer their own benefits

Lastly, gas leaks from poor connections or seals will lead to premature torch failure.

To help understand why, it's helpful review the purposes of the gases used in an ICP torch:



Plasma (Coolant) Gas flows through the outer channel and acts a heat barrier between the inner and outer tubes. It also entrains the plasma, ensuring the sample is introduced into the right area for optimal atomization and ionization

Auxiliary Gas flows through the inner channel and controls the "lift" of the plasma off the bottom of the injector. It helps regulate the plasma temperature and energy distribution, as well as assisting in positioning the sample within the plasma to ensure optimal atomization and ionization

Carrier Gas flows through the nebulizer to the injector to both transport the sample and, at the tip of the injector, punch a hole through the plasma

Even though the optimal gas flows may be set correctly within the instrument software, poor or fatigued connections will cause leaks that interfere with the correct flows

GazFit connectors provide a more reliable attachment of argon tubing without adhesion to the sidearms

Injector ferrules and O-rings, as previously mentioned, should be routinely inspected and replaced to ensure proper gas flows through the torch

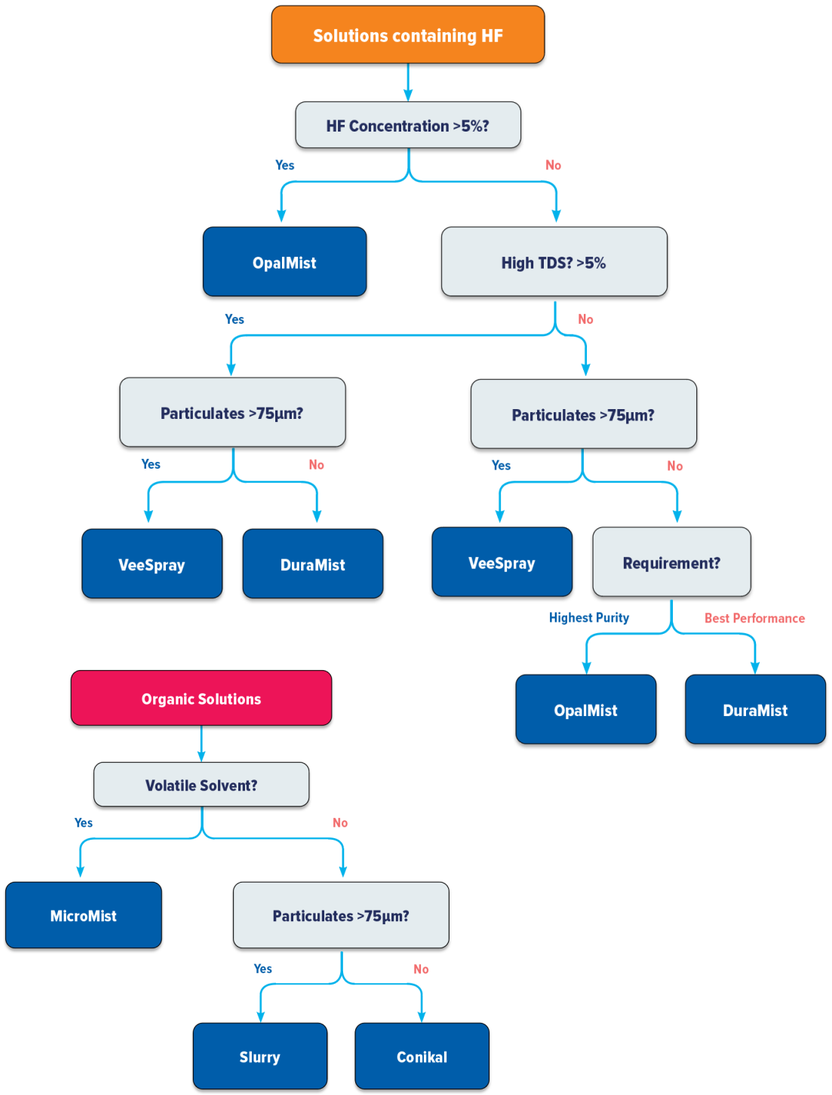
#1

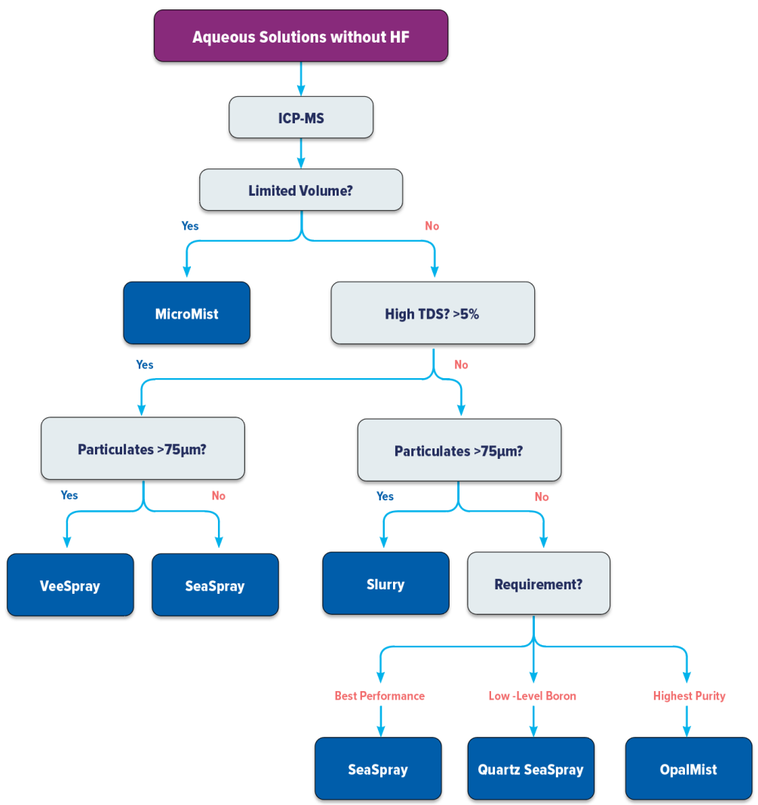
Not Optimizing your Sample Introduction System!

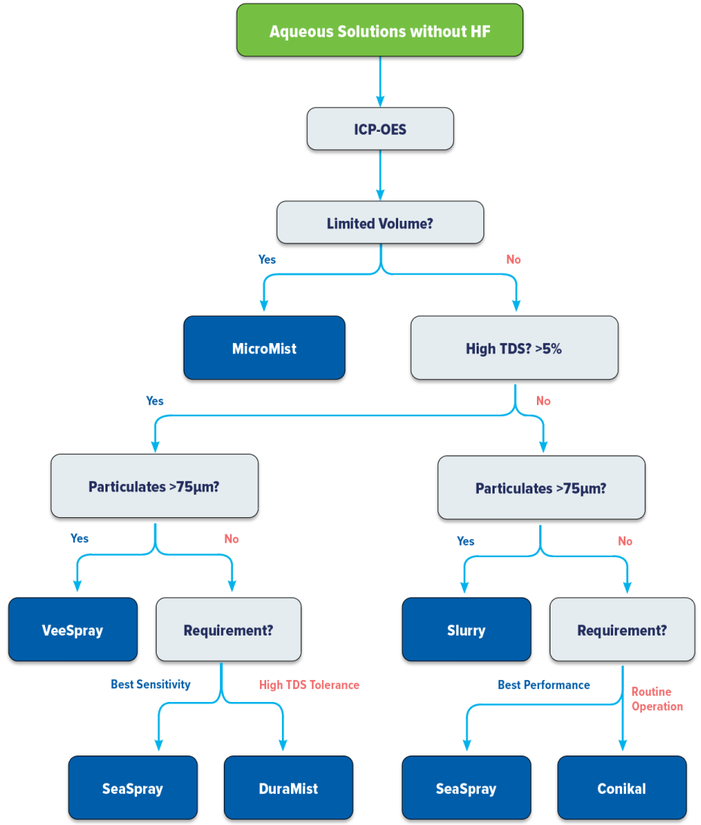
This may seem obvious, but the default or standard configuration that your instrument ships with is often not the best for your application.

- **“Optimize” can mean many things, so it is important to determine the needs of your system, such as:**
  - Maximum sensitivity
  - Improved precision
  - Robustness for “high matrix” samples
  - Minimal carryover
  - Improved washout for high throughput
  - Considerations for low sample volume (e.g., low-flow neb, low-volume spray chamber, etc.)
  - Compatibility with certain acids or solvents
  - The list goes on…

The “optimal” configuration is unique to each lab, and we’re here to help!







Thank You!

www.geicp.com

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Quality By Design