Optimal Water Quality of an Elix® 3 water
for Trace Elemental Analysis

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Introduction

Inductively coupled plasma mass spectrometry (ICP-MS) instrumentation performances and capabilities are continuously improving, which brings new challenges to the services, reagents, and tools used to optimize the overall analytical method. The wide use of ultrapure water to prepare samples and standards, clean and rinse plasticware and ICP-MS components, or run blanks, makes it a critical component of the analytical method. The Q-POD® Element unit was designed to fulfill the stringent requirements of trace elemental analysis.

Milli-Q® water purification system

Q-POD® Element dispenser

Figure 1. Setup and use of the Q-POD® Element unit

Setup and Use

The Q-POD® Element unit is a point-of-delivery purifier designed to deliver ultrapure water specifically dedicated to ICP-MS and other trace metal and ion analysis techniques, including graphite furnace atomic absorption (GF-AA) and trace ion chromatography. The purpose of the Q-POD® Element unit is to ensure removal of ions and metals to the lowest trace level, right before water is dispensed, and to enable distribution in a laminar flow hood. It is intended to be connected to, and fed by, a water purification system delivering ultrapure water (with resistivity of 18.2 MΩ.cm at 25 °C and low levels of organics: TOC < 5 ppb), such as a Milli-Q® Integral or Milli-Q® Advantage system (Figure 2). It is designed to remove the traces of ions that may be present in ultrapure water and minimize any risk of elemental contamination.

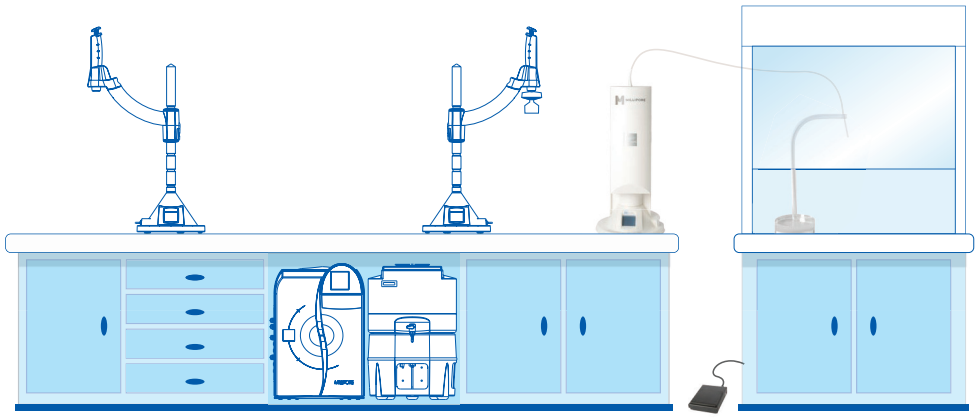

Figure 2: Typical Milli-Q® Integral water purification system installation with a Q-POD® Element unit

Key Components of the Q-POD® Element Unit

- Ion exchange resin cartridge

The Quantum® ICP cartridge contains high capacity ion exchange resins to ensure that no ions are left in the water at the moment it is delivered. Specifically manufactured Jetpore® cationic and anionic ion exchange resins are combined in a mixed bed to provide maximum ion removal efficiency. The cartridge has a polyethylene housing, and a particularly low ion-releasing O-ring was selected to ensure the waterproof connection between the cartridge and the Q-POD® Element unit.

- Optimizer LW™ 0.1 µm final filter

This 0.1 µm ultra high density polypropylene filter, manufactured according to the cleanliness norms used in the semi-conductor industry, ensures that no particles are released in the ultrapure water.

- Solenoid valve

The solenoid valve selected is specifically adapted to ultra trace analysis. Water is never in contact with metal parts; materials in contact with water are high quality, low extractible PVDF and PFA elements.

- Water delivery tubing

The material of the tubing used to deliver water under a laminar flow hood was selected for its purity.

- Footswitch operation

The footswitch allows easy water dispensing, leaving the user's hands free to work with plasticware, samples or reagent bottles. It also helps prevent contamination of the system from hands, gloves, or breathing.

Key Benefits of Combining a Milli-Q® System and Q-POD® Element Unit

- Highest water quality

As described above, all components and purification media used in the Q-POD® Element unit have been selected to ensure that ions are removed down to the ppq or ppt level.

In addition, the 0.1 µm final filter prevents the presence of particles in the water flowing into the nebulizer. Particle-free water helps protect the nebulizer, providing longer periods of use between maintenance procedures.

Finally, the Q-POD® Element unit benefits from the important fact that the Milli-Q® system placed upstream delivers water with little organic content. Organics can be detrimental in ICP-MS procedures because they burn in the plasma and pollute the instrument. Also, organometallic species exist in the tap water delivered to the laboratory. If the organic moiety is not broken up to free the element, organometallic molecules will be present in the water used for the ICP-MS analysis. This may result in erroneous calibration curves and background signals. The water delivered by the Milli-Q® system has low organic content: total oxidizable carbon (TOC) is below 5 µg/L (ppb); in addition, organometallic molecules are broken up by the system's dual wavelength UV lamp.

- Constant water quality

Connecting a Q-POD® Element unit to a Milli-Q® water purification system ensures consistent water quality at the time of delivery. The Milli-Q® purification system itself delivers ultrapure water reliably and consistently. The Q-POD® Element located downstream ensures the removal of ions down to the sub ppt level that is required for water used in ultra-trace analysis.

- Water delivery at the point of use

Importantly, high purity water can be directly delivered at the point of utilization in cleanrooms and laminar flow hoods, making it unnecessary to transport water in a container, and thus reducing potential contamination. The absence of apparent metallic parts in the Q-POD® Element unit and the use of high quality plastics also help ensure water purity. Finally, the footswitch further reduces the risk of contamination, as it frees the scientist from needing to handle the purification unit.

- Flexibility to use water from the Milli-Q® system for other applications

Within the same laboratory, diverse analytical techniques are increasingly used today. ICP-MS is paired, for instance, with chromatography techniques (e.g., HPLC) in analytical, environmental, or geochemical laboratories. It can also be paired with protein analysis in proteomics and diagnostic laboratories. While the water delivered at the Q-POD® Element level is the most suitable for ion analysis, water delivered by the Milli-Q® purification system is appropriate for other analytical techniques.

Experimental Data

ICP-MS data were obtained to document the performance of the Milli-Q® and Q-POD® Element configuration.

Experimental Conditions

A Milli-Q® Integral 3 water purification system was used, fitted with a Quantum® TEX cartridge and connected to a Q-POD® Element unit. The water delivered by the system had a resistivity of 18.2 MΩ.cm at 25 °C and low TOC (below 5 ppb). An Agilent® 7700s ICP-MS system and a MFN 100 MicroFlow nebulizer from Agilent Technologies were used. Conditions: RF power 600 W/950 W, sampling position 18 min, carrier gas flow rate 0.70 L/min, make-up gas flow rate 0.85 L / min, extraction electrode 1: 0.10 V , extraction electrode 2: 0.22 V. Method: standard addition.

Results and Discussion

The experiment was performed by Agilent® Technologies in Japan, and results are reported in Table 1. The results obtained for levels of metals in water are below detection limits for the majority of the elements. Most of the elements in the ultrapure water delivered by the Q-POD® Element are present at concentrations below 1 ppt, matching the levels required for analysis in the microelectronic industry and other specialized laboratories.

Table 1. ICP-MS analysis of water purified by a Milli-Q® Integral water purification system coupled with a Q-POD® Element unit.

Symbol	Isotope	Concentration (ppt)	DL (ppt)	Plasma power
Li	7	< DL (N.D.)	0.01	1
Be	9	< DL (N.D.)	0.00	2
B**	10	< DL (6.44)	9.53	2
Na	23	0.17	0.07	1
Mg	24	< DL (0.02)	0.08	1
Al	27	< DL (0.00)	0.20	1
K	39	0.37	0.16	1
Ca	40	2.7 *	0.86	1
Cr	52	< DL (0.03)	0.94	1
Mn	55	0.18	0.17	1
Fe	56	< DL (0.07)	0.81	1
Co	59	< DL (0.01)	0.04	1
Ni	60	< DL (0.10)	0.99	1
Cu	65	< DL (0.03)	5.32	1
Zn	66	0.77	0.36	2
Ga	69	< DL (N.D.)	0.00	1
As	75	< DL (0.66)	1.52	2
Sr	88	< DL (N.D.)	0.00	1
Ag	107	< DL (0.01)	0.64	1
Cd	111	< DL (N.D.)	0.13	2
Sn	118	< DL (0.05)	0.41	2
Sb	121	< DL (N.D.)	0.00	2
Ba	138	< DL (N.D.)	0.01	2
Pb	208	< DL (N.D.)	0.22	2
Bi	209	< DL (N.D.)	0.02	2

* Interference with Ar

** Lower values for Boron may be achieved when using a boron-specific cartridge

Plasma 1: 600 W; Plasma 2: 950 W

N.D.: Not Detected

DL: Detection Limit

Data courtesy of Agilent® Technologies, Japan.

Conclusion

The combination of a Milli-Q® water purification system with a Q-POD® Element unit results in ultrapure water that is suitable for the most demanding applications and analytical techniques used for ion and metal analysis. This solution is designed for ICP-MS users and scientists who require ultrapure water with trace levels of metals and ions. It provides scientists with high water quality and consistency, as well as the convenience and flexibility of having Milli-Q® water available at the point of use.

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