

Validation of Thermo Scientific Barnstead Nanopure® UV Water – Trace Metals, Anions and Cations

Modern analytical instrumentation allows for the determination of metals and ions in water at the low parts per trillion level. At these low levels, extreme care must be taken to ensure that a sample is not contaminated during sampling, storage or handling. Water from a Nanopure UV was analyzed using validated trace element techniques in a clean room environment. Inductively coupled plasma – mass spectrometry (ICP-MS) and ion chromatography (IC) were used to analyze the water for trace metal or ion contamination. The results indicated that the water is below the limit of detection for all calibrated compounds, which include 13 major anions and cations and 68 trace metals.

Methods

Our Nanopure uses the highest quality ion exchange resins (semiconductor grade) to remove ionic contamination and produce pure water with a resistivity of 18.2 MW-cm. The final wetted parts in the system consist of the high-purity materials including virgin polypropylene cartridge tubes and high-purity fluoropolymer delivery components. Additionally, our Nanopure UV uses a 185/254 nm UV lamp upstream of a final polishing resin to oxidize and subsequently sequester any organically bound metals that may otherwise interfere with an application. Although water that measures 18.2 MW-cm is theoretically pure, in reality it may still contain parts per trillion levels of various ionic species and therefore needs to be validated with the highest-sensitivity instrumentation. Our Nanopure UV (Model #D11911) was set up with a Nanopure

cartridge pack (Model #D50280 for reverse osmosis or distillation feed and #D50281 for deionized feed) in a clean room at Balazs Analytical Laboratory in Sunnyvale, CA. The water feeding the Nanopure was from the laboratory's central water system and exceeded the minimum Nanopure feed requirements. The pack was purged of air with the "air purge" menu selection and allowed to recirculate for several days to condition the cartridge pack and system components. A new 0.2 micron hollow-fiber, cellulose-acetate final filter was also installed. This filter is an important component of the system since it removes submicron particles and bacteria from the product water. The filter was initially purged with 10 L of water to condition it and then subsequently purged with 0.5 L of water prior to sampling the water for analysis. All sampling was performed using clean techniques with acid-washed bottles. Anions and cations were analyzed using a Dionex Model 500DX ion chromatograph with dual columns and dual conductivity detectors. Trace metals were analyzed using ICP-MS with a quadrupole detector for the lowest limits of detection. Because of interferences using ICP-MS, silica was analyzed by a wet chemical spectrophotometric method in which dissolved silica reacts with molybdate to form a colored complex.

Results

All of the calibrated compounds were below the limit of detection in the Nanopure UV product water. The results are reported as < (Limit of Detection) in Tables 1-3.

TABLE 1

Anions by Ion Chromatography

ANION	RESULT (PPB)
Fluorine (F-)	<0.01
Chloride (Cl-)	<0.02
Nitrite (NO2-)	<0.02
Bromide (Br-)	<0.02
Nitrate (NO3)	<0.02
Phosphate (HPO42-)	<0.02
Sulfate (SO42-)	<0.05

Results reported as < Limit of Detection

TABLE 2

Cations by Ion Chromatography

CATION	RESULT (PPB)
Lithium (Li+)	<0.01
Sodium (Na+)	<0.01
Ammonium (NH4+)	<0.05
Potassium (K+)	<0.02
Magnesium (Mg2+)	<0.02
Calcium (Ca2+)	<0.02

Results reported as < Limit of Detection

See Table 3 on next page.

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TABLE 3

Trace Metals by ICP-MS

ELEMENT	RESULT (PPB)	ELEMENT	RESULT (PPB)
Aluminum (Al)	<0.003	Gadolinium (Gd)	<0.001
Neodymium (Nd)	<0.001	Sodium (Na)	<0.007
Antimony (Sb)	<0.002	Gallium (Ga)	<0.002
Nickel (Ni)	<0.004	Strontium (Sr)	<0.001
Arsenic (As)	<0.005	Germanium (Ge)	<0.003
Niobium (Nb)	<0.001	Tantalum (Ta)	<0.004
Barium (Ba)	<0.001	Gold (Au)	<0.006
Osmium (Os)	<0.002	Tellurium (Te)	<0.005
Beryllium (Be)	<0.003	Hafnium (Hf)	<0.001
Palladium (Pd)	<0.002	Terbium (Tb)	<0.001
Bismuth (Bi)	<0.001	Holmium (Ho)	<0.001
Platinum (Pt)	<0.009	Thallium (Tl)	<0.006
Boron (B)	<0.05	Indium (In)	<0.001
Potassium (K)	<0.1	Thorium (Th)	<0.003
Cadmium (Cd)	<0.003	Iridium (Ir)	<0.002
Praseodymium (Pr)	<0.001	Thulium (Tm)	<0.001
Calcium (Ca)	<0.2	Iron (Fe)	<0.02
Rhenium (Re)	<0.003	Tin (Sn)	<0.005
Cerium (Ce)	<0.001	Lanthanum (La)	<0.001
Rhodium (Rh)	<0.001	Titanium (Ti)	<0.002
Cesium (Cs)	<0.001	Lead (Pb)	<0.003
Rubidium (Rb)	<0.001	Tungsten (W)	<0.005
Chromium (Cr)	<0.004	Lithium (Li)	<0.002
Ruthenium (Ru)	<0.002	Uranium (U)	<0.002
Cobalt (Co)	<0.001	Lutetium (Lu)	<0.001
Samarium (Sm)	<0.002	Vanadium (V)	<0.003
Copper (Cu)	<0.003	Magnesium (Mg)	<0.002
Scandium (Sc)	<0.01	Ytterbium (Yb)	<0.001
Dysprosium (Dy)	<0.001	Manganese (Mn)	<0.002
Selenium (Se)	<0.02	Yttrium (Y)	<0.001
Erbium (Er)	<0.001	Mercury (Hg)	<0.02
Silicon (Si)*	<0.5	Zinc (Zn)	<0.005
Europium (Eu)	<0.001	Molybdenum (Mo)	<0.004
Silver (Ag)	<0.001	Zirconium (Zr)	<0.005

*Silicon analyzed using colorimetry

Results reported as < Limit of Detection

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