Application Note: SSL2451

Validation of Thermo Scientific Barnstead Nanopure® UV Water-Trace Organic Compounds

Several high-sensitivity analytical methods were used to identify any volatile or semivolatile organic contamination in Nanopure UV product water. The results indicate that the water is below the limit of detection for a broad range of organic compounds.

Introduction

Our Nanopure UV ultrapure water system (Model #D11911) irradiates system water with a combination of 185 nm and 254 nm ultraviolet light to oxidize and destroy organic carbon delivered by the feed water. Our Nanopure cartridge packs, model #D50280 for reverse osmosis or distallation feed and model #D50281 for deionized feed further reduces organic carbon and oxidation products with its unique formulation of ion exchange resin and activated carbon. Together the system provides a reliable source of water to use with the most sensitive analytical methods for organic compounds. The water from the system was validated using methodologies designed to quantify and characterize volatile and semivolatile organic compounds. Each method used gas chromatography with mass spectrometry detection (GC-MS). The water feeding the Nanopure was provided by each laboratory's central water system and exceeded the minimum requirements of the Nanopure. The system was equipped with a new Nanopure cartridge pack and a 0.2 micron hollow fiber final filter (D3750). The pack was purged of air with the "air purge" menu selection and allowed to recirculate for 2 hours to condition the cartridge pack and system components. Figure 1 shows a typical "rinse-up" of the pack to a steady state value of <2 ppb total organic carbon (TOC) and 18.2 Mø-cm resistivity. After the rinse period, approximately 10 L of water was dispensed to drain to condition and rinse the final filter. Water samples were collected with suitably prepared glass sampling vials.

Purgeable Organic Compounds in Water by GC-MS EPA Method 524.2

Performed by: The State Laboratory of Hygiene
University of Wisconsin Center for Health Sciences

Volatile organic compounds may be present in raw water or produced during the chlorination of potable water. Volatile organic compounds were collected by purging inert gas through a Nanopure UV sample and extracting the purged compounds with an adsorbent. The adsorbent was heated and backflushed with helium and the sample was analyzed with a Hewlett Packard (HP) GC equipped with a 5973 Mass Selective Detector. Table 1 lists the calibrated compounds and the results of the analysis. None of the compounds were detected in the Nanopure UV water.

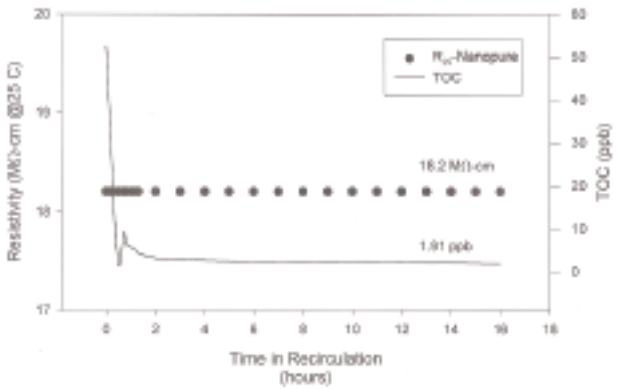

Figure 1: Nanopure Cartridge Pack Rinse-Up

TABLE 1 Volatile Organic Compounds

COMPOUND	RESULT (PPB)
benzene	<0.15
1,3-dichloropropane	<0.15
bromobenzene	<0.15
2,2-dichloropropane	<0.15
bromochloromethane	<0.15
1,1-dichloropropene	<0.15
bromodichloromethane	<0.15
cis-1,3-dichloropropene	<0.15
bromoform	<0.15
trans-1,3-dichloropropene	<0.15
bromomethane	<0.15
ethylbenzene	<0.15
n-butylbenzene	<0.15
hexachlorobutadiene	<0.15
sec-butylbenzene	<0.15
isopropylbenzene	<0.15
tert-butylbenzene	<0.15
p-isopropyltoluene	<0.15
carbon tetrachloride	<0.15
methyl-tert-butyl ether	<0.15
chlorobenzene	<0.15
methylene chloride	<0.15
chloroethane	<0.15
naphthalene	<0.15
chloroform	<0.15
n-propylbenzene	<0.15
chloromethane	<0.15
styrene	<0.15
2-chlorotoluene	<0.15
1,1,1,2-tetrachloroethane	<0.15
4-chlorotoluene	<0.15
1,1,2,2-tetrachloroethane	<0.15
dibromochloromethane	<0.15
tetrachloroethylene	<0.15
1,2-dibromo-3-chloropropane	<0.15
toluene	<0.15
1,2-dibromoethane	<0.15
1,2,3-trichlorobenzene	<0.15
dibromomethane	<0.15
1,2,4-trichlorobenzene	<0.15
1,2-dichlorobenzene	<0.15
1,1,1-trichloroethane	<0.15
1,3-dichlorobenzene	<0.15
1,1,2-trichloroethane	<0.15
1,4-dichlorobenzene	<0.15
trichloroethylene	<0.15
dichlorodiflouromethane	<0.15
trichlorofluoromethane	<0.15
1,1-dichloroethane	<0.15
1,2,3-trichloropropane	<0.15
1,2-dichloroethane	<0.15
1,2,4-trimethylbenzene	<0.15
1,1-dichloroethylene	<0.15
1,3,5-trimethylbenzene	<0.15
cis-1,2-dichloroethylene	<0.15
vinyl chloride	<0.15
trans-1,2-dichloroethylene	<0.15
m/p-xylene	<0.15
1,2-dichloropropane	<0.15
o-xylene	<0.15

Results reported as < Limit of Detection

Semivolatile Organic Compounds in Water by GC-MS: Base/Neutral and Acid Extractables EPA Method 8270/625

Performed by: The State Laboratory of Hygiene
University of Wisconsin Center for Health Sciences

Semivolatile organic compounds can be the major component of TOC in an ultrapure water system. Of particular importance are the phthalate esters which are common plasticizers. A 1 L sample of Nanopure UV water was serially extracted in a separatory funnel with methylene chloride at a pH greater than 11 and again at a pH less than 2. The methylene chloride extract was dried, concentrated to a volume of 1 mL, and analyzed by GC/MS (Finnigan 50 mass spectrometer). Table 2 lists the calibrated compounds and the results of the analysis. None of the compounds were detected in the Nanopure UV water including the important phthalate esters bis(2-ethyl hexyl) phthalate and butyl benzyl phthalate.

Semivolatile Organic Compounds in Water by Thermal Desorption - GC-MS

Performed by: Balazs Analytical Laboratory
Sunnyvale, CA

Further validation of semivolatiles, including the siloxanes, was performed with a thermal desorption method developed by Balazs. A 1 L sample of Nanopure UV water was drawn through a stainless steel sampling tube containing a proprietary adsorbent to trap organic compounds. The compounds were desorbed with a Perkin-Elmer ATD-400 and analyzed with a HP 6890 GC with a HP 5973 quadrapole Mass Selective Detector. An internal standard, toluene-d8, was added to the sampling tube to check the performance of the instrument. The method allows for the identification of any compound detected by searching a Wiley library of 275,000 mass spectra. With the Nanopure UV water, no compound was identified above the reporting limit of 25 ppt.

TABLE 2

Base/Neutral and Acid Extractable Organic Compunds

COMPOUND	RESULT (PPB)	COMPOUND	RESULT (PPB)
acenaphthene	<10	4-chloro-3-methylphenol	<11
4,6-dinitro-2-methyl phenol	<15	naphthalene	<12
acenaphthylene	<10	2-chloronaphthalene	<10
2,4-dinitrophenol	<15	2-nitroaniline	<10
anthracene	<5	2-chlorophenol	<28
2,4-dinitrotoluene	<5	4-nitroaniline	<50
benzo (a) anthracene	<10	4-chlorophenyl phenyl ether	<10
2,6-dinitrotoluene	<10	nitrobenzene	<12
benzo (a) pyrene	<10	chrysene	<10
1,2-diphenylhydrazine	<5	2-nitrophenol	<25
benzo (b) fluoranthene	<10	dibenzo (a,h) anthracene	<10
fluoroanthene	<5	4-nitrophenol	<15
benzo (g,h,i) perylene	<10	dibenzofuran	<5
fluorene	<5	n-nitrosodimethylamine	<10
benzo (k) flouranthene	<5	1,2-dichlorobenzene	<11
hexachlorobenzene	<10	n-nitroso-di-n-propylamine	<10
benzoic acid	<20	1,3-dichlorobenzene	<11
hexachlorobutadiene	<10	n-nitrosodiphenylamine	<10
benzyl alcohol	<10	1,4-dichlorobenzene	<11
hexachlorocyclopentadiene	<10	pentachlorophenol	<15
bis (2-chloroethoxy) methane	<11	2,4-dichlorophenol	<20
hexachloroethane	<10	phenanthrene	<5
bis (2-chloroethyl) ether	<13	2,4-dimethylphenol	<25
indeno(1,2,3,c,d)pyrene	<10	phenol	<17
bis (2-chloroisopropyl) ether	<12	diethyl phthalate	<5
isophorone	<10	pyrene	<10
bis (2-ethyl hexyl) phthalate	<5	dimethyl phthalate	<10
2-methylnaphthalene	<10	1,2,4-trichlorobenzene	<10
4-bromophenyl phenyl ether	<10	di-n-butyl phthalate	<5
2-methylphenol	<11	2,4,5-trichlorophenol	<10
butyl benzyl phthalate	<5	di-n-octyl phthalate	<5
4-methylphenol	<12	2,4,6-trichlorophenol	<20

Results reported as < Limit of Detection

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