Water Purification

Barnstead

Distillation

Filtration

Deionization

UV Oxidation

Reverse Osmosis

Water Purification

PURE WATER THE BASICS

Barnstead

LABORATORY ULTRAPURE WATER

Ultrapure water is essential to every laboratory and Barnstead is the only manufacturer of a complete line of laboratory water purification systems including carbon adsorption, distillation, reverse osmosis, deionization, microfiltration, ultrafiltration, ultraviolet oxidation and the combination of ultrafiltration/ultraviolet oxidation.

LABORATORY APPLICATIONS FOR ULTRAPURE WATER

In addition to general preparation of reagents and washing of plastic and glassware, ultrapure water is essential in specific biotechnology applications for the preparation of media and electrophoresis gels. In vitro fertilization, tissue and cell culture, and DNA research also require ultrapure water that is both biologically pure and free of trace metals and dissolved organics. Ultra-sensitive analytical instruments including HPLC, GFAA, ICP/MS, IC, AAS and GC/MS are capable of detecting elements and compounds in nanograms per liter (ng/L) or parts per trillion (ppt). These instruments require water that is absolutely pure.

STANDARD CAP*/NCCLS*

	Type I	Type II	Type III
Specific Conductance (Microhmos, Max.)	<0.1	<0.2	<0.5
Specific Resistance (Megohm, Min.)	>10.0	>2.0	>1.0
Total Matter (mg/liter, Max.)	—	—	—
Silicate (mg/liter, Max.)	<0.5	<0.1	<1.0
Potassium Permanganate Reduction (Minutes, Min.)	—	—	—
Culture/Colony Count (Colony Forming Units/ml)	<10.0	10	NA
pH	NA	NA	NA

* *CAP - The College of American Pathologist*

* *NCCLS - The National Committee for Clinical Laboratory Standards*

ASTM[1]

	Type I	Type II	Type III	Type IV
Electrical Conductivity, Max. µS/CM AT 298 K (25°C)	0.056	1.0	0.25	5.0
Electrical Resistivity, Min. MΩ • CM AT 298 K (25°C)	18.0	1.0	4.0	0.2
pH AT 298 K (25°C)	*	*	*	5.8-8.0
Total Organic Carbon (TOC), MAX., µG/L	100	50	200	no limit
Sodium, Max., µG/L	1	5	10	50
Chlorides, Max., µG/L	1	5	10	50
Total Silica, Max., µG/L	3	3	500	no limit

	Type I[2]	Type II[2]	Type III[2]
Maximum Heterotropic Bacterial Count	10/1000 ml	10/100ml	10
Endotoxin, EU[3]	<0.03	0.25	NA

* *The measurement of pH in Type I, II and III reagent water has been eliminated from this specification because these grades of water do not contain constituents in sufficient quantity to significantly alter the pH.*

[1] *ASTM The American Society for Testing and Material, Volume 11.01, Section DH93-91 Dated 1992.*

[2] *Microbiological contamination: when bacterial levels need to be controlled, reagent grade types should be further classified.*

[3] *Endotoxin Units.*

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COMMON WATER IMPURITIES

Suspended Particles

Sand, silt, clay and other suspended particles cause water to be turbid. They are measured with a turbidity meter which passes a beam of light through water and measures the amount of light scattered by the suspended particles. Suspended particles can plug valves and foul reverse osmosis membranes. They are typically removed by filters with pore sizes of 1 to 20 microns.

Colloids

Colloidal particles range in size from 0.01 - 1.0 micron and can be either organic or inorganic. They are quantified by measuring the rate that water blocks a submicron filter. Colloids foul reverse osmosis membranes and lower resistivity in deionized water systems. They are removed or reduced by macroreticular anion exchange resin, ultrafiltration, reverse osmosis, and distillation.

Dissolved Inorganic Solids

Silicates, chlorides, fluorides, bicarbonates, sulfates, phosphates, nitrates and ferrous compounds are present as cations (positively charge ions) and anions (negatively charged ions). They are measured with a conductivity/resistivity meter which transmits an electrical current between two electrodes. Water with higher concentrations of ions conducts electricity more easily than water with lower concentrations of ions. Ions affect the results of inorganic analyses such as IC, AAS, ICP/MS, and may retard cell and tissue growth in biological research. They are removed by cation and anion exchange resins or distillation, and reduced by up to 98% by reverse osmosis.

Dissolved Organics

Organic solids are present from plant and animal decay and from human activity. They may include proteins, alcohols, chloramines, and residues of pesticides, herbicides and detergents. Their presence is indicated by the potassium permanganate color retention test and measured by a Total Organic Carbon Analyzer. They foul ion exchange resins, interfere with organic analyses including HPLC, gas chromatography and fluoroscopy, and hinder electrophoresis, tissue and cell culture. Dissolved organics may be removed by activated carbon, macroreticular resin, reverse osmosis and ultrafiltration, and oxidized by ultraviolet light.

Dissolved Gases

CO_2 dissolves in water to form weakly acidic carbonic acid (H_2CO_3). This gas can be measured with a conductivity/resistivity meter. CO_2 is only removed by strong base anion exchange resins. Oxygen is the most common non-ionized gas and is monitored with oxygen sensing electrodes. Oxygen may cause corrosion of metal surfaces and is removed by anion exchange resins in the sulfite form.

Microorganisms

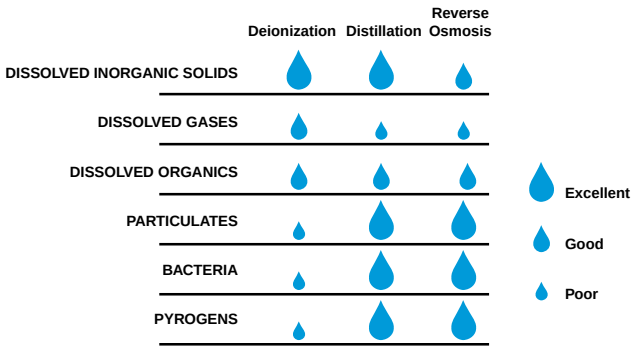
Bacteria, fungi and algae are found in most surface waters. Bacteria are measured by culturing a sample and counting the colony forming units per milliliter (CFU/ml). City water treatment facilities commonly add chlorine to kill microorganisms. This chlorine is removed in the first step of most water purification systems which allows bacteria to multiply in the system. Distillation effectively kills microorganisms, reverse osmosis removes them and UV light can control their growth. All ultrapure water systems must have a 0.2 micron or smaller absolute filter on the outlet to prevent bacteria from contaminating the ultrapure product water. In addition, all water pathways in the system should be regularly sanitized.

Pyrogens and Viruses

Pyrogens or bacterial endotoxins are lippopolysaccaride molecules attached to cell membranes of gram negative bacteria. Viruses are considered to be non-living nucleic acids. Pyrogens are detected by injecting a sample into test rabbits and monitoring their body temperature rise, or measured with the more sensitive LAL (Limulus Amoebocyte Lysate) test. Pyrogens cause fever when injected into mammals and hinder cell and tissue growth on culture. Pyrogens and viruses can be removed or reduced by distillation, ultrafiltration, reverse osmosis, and carbon adsorption.

Nucleases & DNA

RNase and DNase are naturally occurring enzymes that are instrumental in regulating bodily functions. DNA is the building block of life itself. As important as these are to the life process, they can be devastating to life science applications. If these contaminants are present in the pure water used, the ability to amplify DNA molecules will be severely limited. They can be removed by a combination of adsorbtion, ultrafiltration and ultraviolet oxidation.



Water Purification

PURE WATER THE BASICS

Barnstead

HOW DO I CHOOSE THE CORRECT WATER PURIFICATION SYSTEM?

Water purification technologies

Water purification is a step-by-step process often requiring a combination of technologies. Barnstead is the only manufacturer of a complete range of equipment utilizing all technologies necessary to purify water in your laboratory.

Distillation

Distillation is the most common water purification technology in laboratories worldwide. Water undergoes phase changes during the process, changing from liquid to vapor and back to liquid. It is the change from liquid to vapor that separates water from the dissolved impurities. Distillation has the broadest capabilities of any single form of water purification.

Reverse osmosis

Reverse osmosis occurs when water is pushed through a semipermeable membrane using external pressure. The membrane has molecular weight cut off in the 300 Dalton range. Most water impurities do not pass through the membrane. They collect on the membrane surface and are flushed to the drain. Reverse osmosis is a popular method of pretreatment to distillation or deionization systems and for purifying water for general applications such as glassware and plasticware washing.

Deionization

Deionization is also referred to as demineralization or ion exchange. It is the removal of ions from feed water by synthetic resins. These resins have an affinity for dissolved inorganics and are divided into two classifications: cation removal resins and anion removal resins. Deionization is the only technology which produces the resistivity requirement for Type I reagent grade water.

Filtration

Barnstead offers both depth and membrane filters. Depth filters are commonly made by winding fiber around a hollow and slotted tube. As water passes through the fiber toward the tube, particles are removed and held in the fiber. Depth filtration is used as a first step in most water purification systems to remove particulate matter. Membrane filters usually have a submicron pore size. Particles and bacteria cannot pass through the membrane and are held on the membrane surface. Membrane filtration includes reverse osmosis and ultrafiltration. It is also used as a final step in deionization systems to prevent submicron particles and bacteria from entering the product water.

Ultrafiltration (UF)

Ultrafiltration is used in reagent grade water systems primarily to remove pyrogens (bacterial endotoxins) from water. The ultrafiltration membrane has a molecular weight cut off of less than 10,000 Daltons. Pure water permeates the membrane but particles, pyrogens, colloidal silica, bacteria, and high molecular weight organics are rejected.

Adsorption

Adsorption uses high surface area activated carbon to remove organics and chlorine from feed water. It is used as a first or second step in most water purification systems and may be used as a final step to achieve low TOC. Organics and chlorine adhere to the surface of the activated carbon and remain in the cartridge.

Ultraviolet (UV) oxidation

Photochemical oxidation with ultraviolet light at dual, 185 and 254, nanometer wavelengths can eliminate trace organics, and kills microbes in pure water. When used in a Barnstead reagent grade water system, ultraviolet light can reduce trace organics to less than 1 ppb TOC. Ultraviolet light at a 254 nanometer wavelength can be used in storage reservoirs or distribution lines to prevent bacterial growth.

Combination Ultraviolet oxidation and Ultrafiltration (UV/UF)

The use of ultraviolet oxidation and ultrafiltration technologies in conjunction with adsorption and deionization in the same system produces water free of virtually all impurities. These technologies have demonstrated the ability to remove nucleases such as RNase, DNase and DNA when challenged with known concentrations of the material. The UV/UF units produce reagent grade water with resistivities up to 18.3 megohm-cm, organics < 2 ppb, pyrogens <0.001 EU/ml and no detectable RNase, DNase or DNA.

WATER ANALYSIS ULTIMATELY DETERMINES EQUIPMENT OPTIONS

In this applications section, it is our intent to present you with a basic overview of the types of Barnstead systems that have been successfully used in laboratories over the years. It is intended only as a guideline, however, in that we often find drastic tap water fluctuations not only throughout a country but sometimes within a small community. As a result, the system that is individually suited for your needs can best be determined by our W.A.T.E.R.™ program.

Applications themselves vary; for example, to pick tissue culture as an application encompasses an endless number of variations. Cell lines are different and may be sensitive to different types of water. We have found that researchers working with the same cell line have used different types of high purity water systems and have achieved favorable results. *Please note: Systems capable of producing Type I water are also suitable for less demanding Type II or Type III applications such as washing glassware.*

Application	Biologically Pure water for applications such as: - Tissue Culture - Life Sciences - Microbiology	Organically Pure water for applications such as: - HPLC - ICP/MS - GCMS - TOC	Ionically Pure Reagent Grade Water Type I	Type II	Type III
FEED WATER: Average Raw Water (10 grains per gal. or greater)	Still Pretreatment followed by: Glass Distillation or Reverse Osmosis followed by Deionization and Ultrafiltration	Reverse Osmosis followed by: Deionization w/UV Oxidation or For BOD, COD only Glass Distillation	Reverse Osmosis followed by: Deionization or Still Pretreatment and Distillation followed by Deionization	Still pretreatment followed by: Distillation	Still pretreatment followed by: llation
High Quality Raw Water (3-10 grains per gal.)	Glass Distillation or Deionization and Ultrafiltration	Reverse Osmosis followed by: Deionization w/UV oxidation or For BOD, COD only Glass Distillation	Deionization Distillation/ Deionization	Distillation	Distillation or Single Cartridge Deionization
Central Deionization, Central Distillation, or Central Reverse Osmosis	Glass Distillation or Deionization and Ultrafiltration	Deionization w/UV oxidation or For BOD, COD only, Glass Distillation	Deionization Still Pretreatment / Distillation / Deionization	Distillation	Distillation or Single Cartridge

Water Purification

W.A.T.E.R.™ ANALYSIS PROGRAM

Barnstead

TEST THE WATER BEFORE YOU TAKE THE PLUNGE!

- *— Free water analysis program*
- *— Eliminate the variables and make the best choice for a water system*

WHY USE THE W.A.T.E.R. PROGRAM?

- The W.A.T.E.R. program is the most comprehensive water testing program available.
- Your water system purchase should be based on facts, not guesses or estimations.
- Not all feed water or applications are equal. Your water system should suit your application, capacity requirements, budget and feed water source..
- Save valuable laboratory time and money by eliminating the variables before its too late.
- Not all water systems are created equal. Some system cartridges have less capacity than others, meaning an increased operating cost for you. We'll tell you what your annual operating costs will be before you purchase your system.

  Here's How it works:
- Contact your local laboratory equipment sales rep, Barnstead sales rep or Barnstead customer service for a free W.A.T.E.R. test kit.

  or
- Return the postage paid card located in the back of this book for your free W.A.T.E.R. kit.
- Fill the sample bottle with water from your anticipated feed water.
- Fill out the short questionnaire pertaining to your water requirements, applications and budget.
- Place the completed application and water sample bottle in the return box. Add postage and mail to the Water Lab at Barnstead/Thermolyne.
- Our team of water experts will perform different tests on your sample, including TOC, conductivity, resistivity, and total ionized particles.
- Upon evaluation, your water test results will be matched with your laboratory requirements listed on the questionnaire.
- A water system will be recommended based on our water evaluation and the responses on your questionnaire.
- We will determine annual operating costs for the system based on your usage and feed water test results.
- The test results, equipment recommendation, operating cost and quotation will be mailed directly to you.
- At no obligation to you, we will have a representative call you to discuss your customized report and help you finalize any details with regard to your system.

  Barnstead offers a complete line of water purification products from deionization, to reverse osmosis, to distillation. We make our analysis thoroughly and objectively in order to recommend a system that is right for your laboratory.

48 Hour or Sooner Express Shipping Guaranteed!*

RUSH

****see inside front cover for details***

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