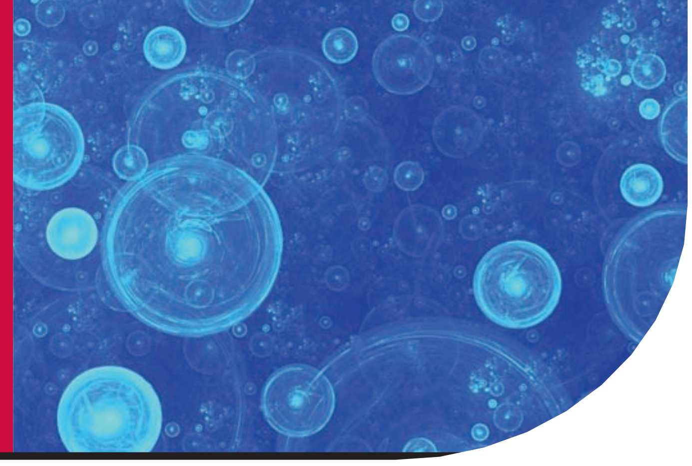
Laboratory Products Focus



Maintaining an Environmentally-Friendly Pure Water Supply

Applications ranging from everyday life-science procedures, through to complex automated drug discovery, require highly purified water. This is essential to ensure that analytical detection limits are optimised and reproducible results are obtained every time. The production of laboratory water is therefore a very important process that will, desirably, combine the effective elimination of specified contaminants, with efficiency and cost-effectiveness as well as being environmentally friendly.

Pure water systems have been designed with energy saving modes, which can effectively conserve power, while still providing water of the highest purity.

The plastic cartridge casings and endcaps can be made from virgin polypropylene, which is fully recyclable.

In an effort to reduce waste, high-quality resin cartridges are available, which will not only continually produce exceptionally pure water, but will also extend the life-span of the cartridge.

Author Details:

Julie Akana, PhD.,
Thermo Fisher Scientific,
Asheville, NC

EFFECTIVE PURIFICATION

Impurities in laboratory water can adversely affect experimental results in many ways. As such, the water needs to be free of contaminants, which can include pyrogens, organic or ionic compounds, bacteria and nucleases. There are six major technologies that can be used to purify water of such inclusions: filtration; adsorption; ultraviolet radiation; distillation; reverse osmosis; and deionisation (see *Table 1* for more information). Pure water systems use a combination of these technologies as different experimental processes require various levels of purity. As a result a wide range of systems are available to match these broad requirements.

Table 1. Impurities removed by each technology.

Technique	Impurities most effectively removed
Distillation	inorganic ions, particles, bacteria, pyrogens
Reverse osmosis	particles, bacteria, pyrogens
Deionization	inorganic ions and dissolved gases
Filtration	particles and bacteria
Ultrafiltration (UF)	particles, bacteria, pyrogens
Adsorption	Organics and chlorine
Ultraviolet (UV) oxidation	organics and bacteria
Combination UV/UF	organic, particles, bacteria, pyrogens and nucleases

Water required for general laboratory purposes, such as autoclaving, humidification and glassware rinsing requires water that is free from particulates, colloids and ions. More sensitive analytical applications should have a water supply that is also free from dissolved gases and organics. These applications include high performance liquid chromatography (HPLC) and mass spectroscopy (MS). Furthermore, life science applications such as cell and tissue culture, PCR, crystallography and antibody production require water of the highest purity level. It therefore needs to be free from all previously mentioned contaminants, as well as nucleases and pyrogens. This ensures that all impurities that have the potential to impact upon experimental results are effectively removed (For full details see *Table 2*).

Table 2. Common impurities that impact on various applications.

	Contaminants to avoid						
Application	Particulates	Colloids	Ions	Dissolved gases	Organics	Nucleases	Pyrogens
General lab purposes							
Autoclave	X	X	X				
Humidification	X	X	X				
Glassware washing/rinsing	X	X	X				
Media preparation	X	X	X				
Analytical							
Ion chromatography	X	X	X	X			
Atomic absorption	X	X	X	X			
High performance liquid chromatography	X	X	X	X	X		
Inductively coupled plasma spectroscopy	X	X	X	X	X		
Mass spectroscopy	X	X	X	X	X		
Gas chromatography	X	X	X	X	X		
Total organic carbon	X	X	X	X	X		
Life sciences							
Genomics (PCR, mutagenesis)	X	X	X	X	X	X	X
Proteomics (crystallography, electrophoresis)	X	X	X	X	X	X	X
Immunology (monoclonal antibody production, blots)	X	X	X	X	X	X	X
Pharmacology	X	X	X	X	X	X	X
Cell and tissue culture	X	X	X	X	X	X	X
Drug discovery	X	X	X	X	X	X	X

DEFINING PURITY

Reagent grade water has been defined by a number of different agencies, including the American Society of Testing and Materials (ASTM) and the Clinical and Laboratory Standards Institute-Clinical Laboratory Reagent Water (CLSI®-CLRW). These organisations have similar but not identical definitions for highly purified water, which are determined based on parameters such as the water's conductance, resistance, the presence of colloids, bacterial count, organic content and pH. Using ASTM nomenclature, type IV is the lowest grade of purity, suitable for most routine lab work, while type I is the highest grade. The most commonly used standard, ASTM D1193-6 is summarised in *Table 3*. This standard can then be further sub-divided into A, B and C, where A is the most pure, as a measure of heterotrophic bacteria count (CFU/ml) and endotoxins (units per ml).

Table 3. ASTM standards for reagent grade water.

Measurement (unit)	Type I	Type II	Type III	Type IV
Resistivity (M -cm) at 25°C	>18	>1	>4	>0.2
Total organic carbon (ppb)	<50	<50	<200	No limit
Sodium (ppb)	<1	<5	<10	<50
Chloride (ppb)	<1	<5	<10	<50
Total silica (ppb)	<3	<3	<500	No limit

When executing a protocol that requires the highest purity levels, associated costs will increase as a result of the additional removal technologies that need to be employed within the water system. Subsequently, efficiency can be maximised by only producing water to the required level of purity. It is therefore important that the different levels of purity are understood and that the system and applications are accurately matched in accordance with the correct water type for an environmentally friendly and cost-effective performance.

THE THREE R'S OF ENVIRONMENTALLY FRIENDLY WATER

Reduce - As a regularly replaced component within a pure water system, cartridges can be an effective target to minimise waste along with any associated cost. In an effort to reduce waste, high-quality resin cartridges are available, which will not only continually produce exceptionally pure water, but will also extend the life-span of the cartridge. As a result, they can be used for longer than alternative types, minimising the need to ship, handle and dispose of used parts. This reduction has many positive environmental implications, not only saving in shipping costs but also reducing packaging materials and associated vehicle emissions.

Reuse - The vast majority of cartridge resins are completely reusable. They can be recovered and reused by other companies in the production of a wide range of materials. However, cartridges used with heavy metals or hazardous radioactive substances cannot be reused for safety reasons.

Recycle - In the global effort to reduce waste, the effective reuse of materials is extremely important and many laboratories are looking to adopt such approaches. Thus, the ability to reuse components that would normally be discarded is becoming highly desirable. In the case of pure water systems, the plastic cartridge casings and endcaps can be made from virgin polypropylene, which is fully recyclable. Cartridges manufactured within a clean environment, using environmentally friendly techniques without the need for any hazardous solvents and adhesives, enables the plastic and resin to be effectively recovered, reground and reused.

WEEE DIRECTIVE

In addition to the ability to reduce waste and improve the environmental performance of pure water systems, many products are now marked with the WEEE (waste electrical and electronic equipment) symbol, meaning they have been designed and built in a way that makes them easier to be disposed of in and environmentally-friendly way. The WEEE Directive also aims to reduce the amount of electronic equipment being produced, encouraging users to reuse and recycle as much as possible.

CONSERVING ENERGY

As a pressing issue in today's environmentally friendly culture, the reduction of energy consumption is being introduced to almost every aspect of life. This is also possible in the laboratory without affecting sample integrity or research quality, which not only helps the environment, but also cuts down on the associated running costs. Pure water systems are often in continuous use in order to maintain consistent purity levels and suppress bacterial growth. If switched off, the water provided would no longer be of the purity level required by the application. Therefore, newer pure water systems have been designed with energy saving modes, which can effectively conserve power, while still providing water of the highest purity.

CONCLUSION

The use of pure water systems, such as those in the Thermo Scientific Barnstead product range, enables users to obtain a cost-effective water supply that meets all of their experimental requirements for purity. Due to the advantageous nature of maintaining a 'green' laboratory, both in terms of the environment and associated costs, it is extremely beneficial to use a pure water system that is highly economical, as well as being environmentally friendly.