An Introduction to Laboratory Water Purification

A high-purity DI polisher that incorporates multi-pass UV for microbial-free water, two-stage deionization and a full-size,0.2-µm filter. It produces water that meets or exceeds the moststringent water quality standards.

A high-purity DI loop for general laboratory water purification offers full recirculation with three cartridges. It's shown here with recirculation dispensing gun and 0.05-µm capsule filter.

By Jon Bergman and Larry Gottlieb

Summary: *Scientists use deionized water in a variety of areas. To provide the proper deionization system, it's important to understand the specific needs and requirements of laboratory grade water. Laboratory water systems come in standard configurations with a variety of available options.*

Every laboratory has a need for purified water. Scientists use deionized water in a variety of areas from glassware washing to DNA synthesis. While some laboratories are stand-alone businesses, many operate within a larger business. These captive labs are the quality control or research and development (R&D) centers for high-tech industries.

The laboratory water purification market includes hospitals, universities and research companies. Other markets include pharmaceutical, electronics, forensics and environmental firms. Many of these companies purchase purified laboratory grade water at significant expense, freight and storage space. Lab water purification systems are an excellent way to provide reagent grade water on demand. While there's a vast spectrum of end-users, a similar design and approach can be applied for laboratories requiring water purification.

Assessing impurities

In order to provide the proper purification system, it's important to understand the specific needs and requirements of laboratory grade water. Understanding water impurities that affect laboratory testing is critical to servicing this market. Aside from the conventional impurities such as suspended solids, dissolved solids and gases, laboratory water systems may have to meet specific standards for resistivity, organics, bacteria, pyrogens, and nucleases.

Resistivity

Resistivity is measured by passing an electrical current through the water. Resistivity is a measurement of the mineral content of the water. Lab systems should produce water with a resistivity of 18+ megohm-cm.

Organics

Organic contaminants are residuals from natural plant and animal decomposition. Organics can also be synthetic compounds from pollution. Naturally occurring compounds include tannic, humic and fulvic acids. Total organic carbon (TOC) is a measure of both natural and synthetic substances. Organics removal can be of primary concern to the scientist depending upon the nature of their work.

Bacteria

Bacteria is a class of microscopic o ganisms that reproduce by fission spores. There are many different typ of bacteria. Some bacteria are self-su taining while others survive on non-li ing material. The amount of bacteria generally measured by culturing t sample and counting the active colonie

Pyrogens

Pyrogens are endotoxins create from an organisms's fragmented ce walls and are measured in endotoxi units (EU). Their presence is determine by using the limulus amebocyte lysa (LAL) test. The LAL test uses the bloc of the horseshoe crab that clots in t presence of endotoxin.

Nucleases

Nucleases—Rnase (ribonuclease and Dnase (deoxyribonucleases)—a enzymes that degrade DNA and RN The need for Rnase/Dnase free water critical in microbiology where the te sample cannot be compromised wi foreign DNA matter.

There are a few organizations with the analytical industry that provide w ter purification standards for laborato use (see *FYI*). The College of America

Pathologists (CAP) and the National Committee of Clinical Laboratory Standards (NCCLS) use a Type I, II, and III platform (see *Table 1*). The American Society of Testing and Materials (ASTM) uses a similar platform but with a slightly tighter specification. ASTM also provides a Biomedical Grade Water specification giving particular attention to the sterility of the dispensing port.

Making reagent grade water

Many scientists and researchers require their laboratory water to meet one of these specifications. In order to consistently achieve these levels of purity, it has become commonplace to install a point-of-use (POU) water purification system. These POU systems utilize disposable filters and cartridges to maintain water purity.

Table 1. Laboratory grade water (CAP / NCCLS)

	Type I	Type II	Type III
Conductivity (microSiemens)	<0.1	<0.5	<10.0
Resistivity (megohm-cm)	>10.0	>2.0	>1.0
Bacteria (CFU/ml)	<10.0	10	N/A
Silicate (mg/L)	<0.05	<0.1	<1.0
Total solids (mg/L)	0.1	1	5
TOC (mg/L)	<0.05	<0.2	1
pH	-	-	5.0 - 8.0

There are several areas to address when providing a laboratory water system. The first step is to determine what type of water quality is needed. Second is to determine how much of it is needed and lastly, where it's needed. Many times, there are multiple labs in a single location. Each lab may require its own system or several labs may share the water from a single system.

Feed water is critical to system performance. Many larger facilities have a central purification system or some other form of pretreatment feeding the laboratory polishers. Smaller laboratories may need to install pretreatment or directly treat the tap water. A system run on a tap water feed may not be able to meet the most stringent water quality standards. Additionally the unit will need to be serviced more frequently. Cartridges and filters will need to be replaced more often due to the higher load on them.

A point-of-use system run with proper pretreatment will act solely as a water polisher. Polishing units are capable of producing water suitable for almost any application. Sanitization of these systems and periodic routine maintenance is critical to keep the system running properly.

Systems come in standard configurations with a variety of available options. Standard laboratory POU systems incorporate disposable filtration cartridges, a recirculation pump and a resistivity meter. The cartridges can provide a variety of filtration functions including deionization, organics removal and filtration. The pump continuously recirculates the water in the system to keep the resistivity high and to keep bacteria from growing in the system. The resistivity is displayed letting the scientist know the purity of the water. A drop-off in resistivity indicates the need to service the system.

Ultraviolet (UV) light packages are a useful option in point-of-use systems. UV keeps the system relatively free from microbial contaminants and reduces the TOC in the product water. UV is used where organics, bacteria and TOC are of primary concern.

Final filtration is also an integral part of every lab water system. Submicron capsule filters are generally the final step in the purification process. A 0.2 micron (µm) filter is most frequently used to remove bacteria before dispensing the final product water. Finer capsule filters (.05 µm absolute) are sometimes used to remove pyrogens and nucleases. Capsule filters will restrict the flow rate at which water is produced.

Conclusion

Scientists need well-maintained, high purity water systems in order to do their jobs properly. Servicing scientific accounts means understanding their water purification needs and being able to supply the proper products and services.

FYI: Lab Water Online

Additional resources for this article can be found at:

- College of American Pathologists: www.cap.org
- National Committee of Clinical Laboratory Standards: www.nccls.org
- ASTM:

  1) Committee D19 on Water: www.astm.org/COMMIT/COMMITTEE/D19.htm

  2) D5196-91(1999) Standard Guide for Biomedical Grade Water—www.astm.org/cgi-bin/SoftCart.exe/DATABASE.CART/REDLINE_PAGES/D5196.htm?E+mystore

  3) "ASTM Solicits Feedback on Important Factors of Water Used in Laboratories": www.astm.org/SNEWS/APRIL_2002/labwater_apr02.html
- Laboratory Talk, "Water Purification": www.laboratorytalk.com/indexes/categorybrowsely.html

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