REAGENT WATER

SIMPLE Questions & SURPRISING Answers

Q: Is my 18 MΩ-cm water pure?

A: Probably not! Truly pure water has a resistivity slightly above 18 MΩ-cm, due to the small dissociation of water molecules into H^+ and OH^- ions. However, deionized, 18 MΩ-cm water, often referred to as *ultrapure water,* is likely to be so impure that it smells. In an aqueous solution, electric current is carried by ions and to carry current efficiently the ions must be small enough when hydrated to move freely. Large ions; contaminants that do not form ions, or ionize only weakly; and particles (e.g., silt, microorganisms, colloids etc.) carry little, or no, current. In other words, it is possible to have an 18 MΩ-cm soup! Contaminants that are not detected by resistivity testing are abundant in source water, but they are also formed within certain types of water purification systems — **beds of exchange resins and carbon shed, breed, and bleed.**

Is 18 MΩ-cm water pure .... *Look at this!*

Particulates, TOC, and endotoxins ...... *A soup!*

And resistivity ...... *Over 18 MΩ-cm!*

Q: Is TYPE-I water best?

A: It is impossible to say ... the Standard is ambiguous and testing is not required. The most frequently cited reagent-grade water standards are those offered by ASTM (American Society for Testing Materials), NCCLS (National Committee for Clinical Laboratory Standards), ISO (International Organization for Standardization), and USP (United States Pharmacopoeia). Except that each was crafted under circumstances that can best be characterized as politically charged, with importance attached to nearly every word and turn of phrase, the four standards are very different. Yet, they are frequently summarized in abbreviated tables, giving the incorrect impression that obtaining universally accepted, well-defined grades of reagent water is routine. Excerpting the table defining limits for Type-I water out of the context of the complete ASTM Standard Specification for Reagent Water has misled many to believe that all Type-I water systems will produce water of that purity, routinely, whereas, a reading of the entire document gives a very different impression.

There will be differences between waters that meet the same standard. It is impractical, if not impossible, for a standard to specify all the parameters associated with acceptable solutions to the design of a water purification process, or to fully define the product water. However, standards that combine practical, scientifically rational specifications for *process* and *product* with a requirement for relevant monitoring will definitely be useful. The goal should be to achieve the greatest benefit for the lowest cost of compliance. Obtain a copy of the standard you use, read it carefully, and judge for yourself if it meets these criteria.

Q: *How should I monitor purity?*

A: *Resistivity is not enough,* when the final stages of your water purification system involve cartridge technologies. Purification components in cartridge systems are, by their nature, expected to fail or exhaust at irregular intervals. However, resistivity can only monitor one of the many functions such systems are expected to perform, specifically how well the ion exchange bed removes ions from the water stream. The rest of the system could become useless or, even worse, begin contributing substantial contamination, without the slightest indication of trouble. This scenario is especially likely to occur when a cartridge system is used to *polish* already deionized water and the purification components, including the ion exchange bed, will appear to last forever.

Bear in mind that beds of carbon and ion exchange resins are chromatography columns. Contaminants, bound by these beds from the time they were first placed in service, will elute as concentrated, sequential peaks when the beds begin to exhaust or, in the case of carbon, when the concentration of divalent ions or surface active materials shifts in the water steam. And the contaminants that elute first will be the most difficult to detect with resistivity testing.

At a minimum, total organic carbon (TOC) should be monitored in conjunction with resistivity. Monitoring endotoxins will contribute important additional control. Employed in combination, these three global tests are sensitive indicators of water purity and they can detect the majority of failures in cartridge systems.

Changing the purification components of your cartridge system on a frequent schedule will not substitute for adequate monitoring, because the product water may contain higher levels of contamination than you would knowingly accept in your application. Ion exchange resins, carbon, and filters can shed and bleed contaminants, which are not be detected by resistivity. Microorganisms flourish in cartridge systems and though their cells are easily blocked by filtration or killed by UV, products of their metabolism and breakdown are not so easily removed.

By contrast, when the final stage of your water purification system utilizes effective distillation, resistivity is a sensitive performance indicator. Stills that produce water with a resistivity of >10 Meg Ω-cm will be extraordinarily effective at removing every type of water contaminant, because virtually every class of water contaminant is represented by common, well-ionized substances and distillation is not an ion-selective process. Also, unlike cartridge systems, stills can be designed so they are not prone to unpredictable performance or insidious failure. Nevertheless, TOC and endotoxin testing should be performed often enough to maintain a high level of confidence.

Q: *What type water should I use?*

A: *The best water you can get!* After all, the quality of your work depends on the quality of your water. **The good news is that changing to higher quality water will save you money** by reducing production costs, minimizing the scatter of data, and reducing the number of experiments that have to be repeated. Your High-Q dealer can help you make an informed choice from the best systems available.

For More Answers

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