

Helping a University Research Laboratory Produce High-Purity Water

by Trude Witham

When the University of Alabama at Birmingham needed high-purity water for its new research laboratory, it chose a system that could reliably meet the stringent water quality requirements for human immunodeficiency virus (HIV) research (*Figure 1*).

“HIV infects the host cell by inserting the reverse transcribed viral DNA into the human host chromosome,” according to Aaron L. Lucius, Ph.D., assistant professor of chemistry at the university. “This activity of inserting the viral DNA is performed by the enzyme, Integrase (IN), which is an essential enzyme in the virus life cycle. The IN protein is a unique drug target not only because inhibiting this enzyme would inhibit infection, but thus far no human homologues of HIV IN have been identified. We are examining the thermodynamics and kinetic mechanisms of HIV Integrase binding to nucleic acid substrates in vitro, including both RNA and DNA substrates. Therefore, it is imperative that we have a source of water that is free of RNases and DNases.”

Dr. Lucius added, “We use fluorescence techniques including fluorescence resonance energy transfer (FRET), polarization, anisotropy, and static and dynamic light scattering. Because water sources often contain organic compounds, and organic compounds fluoresce, maintaining the total organic carbon (TOC) at a very low level is critical for maximizing our signal-to-noise ratio.”



Figure 1 University of Alabama at Birmingham.



Figure 2 PURELAB Ultra Genetic system.

Dr. Lucius was familiar with laboratory water treatment systems and their features, and after evaluating different options, he chose a PURELAB® Option R system and a PURELAB Ultra Genetic system (*Figure 2*) (Siemens Water Technologies, Lowell, MA). The Option R incorporates reverse osmosis (RO), deionization (DI), ultraviolet (UV) sterilization technologies, and recirculation in one compact unit. It is designed for standard laboratory techniques and for pretreating ultrapure water polishing systems such as the PURELAB Ultra Genetic.

The Ultra Genetic incorporates DI, UV and ultrafiltration (UF) technologies, and is designed to provide American Society for Testing and Materials (ASTM) Type I ultrapure water for critical biological and analytical applications. It monitors TOC in real time, reporting the level every 2 sec.

The system flow path is as follows: tap water enters the Option R system, where a charcoal filter removes free chlorine and particles larger than 5 μm . The water then enters the RO cartridge pack, which consists of two RO cartridges that remove 95% of the monovalent ions, 98% of the divalent ions, and organics with a molecular weight greater than 200. Next, the water enters a DI cartridge that removes the remaining ions. From there, the water passes through a 254-nm UV sterilizing filter for bacterial removal, and then into a reservoir. The quality of the

water exiting this system is 15-megohm-cm. This water is fed to the Ultra Genetic system for further polishing. The water enters the DI cartridge pack, which consists of two DI cartridges. A dual-wavelength (185-nm and 254-nm) ultraviolet sterilizer in between the two DI cartridges oxidizes the organics that made it through the first DI cartridge, and also kills bacteria and reduces the TOC. This water then enters a 5000-nominal molecular weight UF cartridge that removes pyrogens. The quality of the water exiting this system is 18.2-megohm-cm.

“The lab water systems I have used in the past never reported on anything more than resistance of the water, i.e., 18.2-megohm-cm,” says Dr. Lucius. “I liked the fact that this system gives me a measure of TOC, which, although I do not have a systematic determination of the benefit, I can

rest assured that there will be a minimal amount of organics. In this vein, I like the fact that we have two UV sources that destroy microorganisms and reduce TOC.”

In operation since late 2006, the system is exceeding the university’s expectations for water quality. **Siemens** will provide service on the system for one year under a service contract.

Dr. Lucius concluded, “Overall, I have been happy with the system. It provides water that is RNase and DNase free with TOC levels less than 3 parts per billion.”

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