Methods of Producing Lab Water

By Jon Bergman and Joe Palma

Water is a critical component in the laboratory for various applications, from the production of aqueous solutions to the cleaning of glassware. Laboratory water is frequently used by analytical equipment, such as high-performance liquid chromatography (HPLC) analyzers. The demand for high purity water, whether it is for hands-on wet chemistry or for feeding analytical equipment, has increased over the years.

It is not uncommon for laboratories to share a single water treatment system. A technician might fill up a single 30-liter carboy for use at a remote location away from the water system. For others, research and development in the laboratory pushes their water system to provide on-demand, ultra-high purity water for small process applications.

With this increasing demand for lab water, understanding the various configurations with their advantages and limitations will allow water purification companies to better sell and service these markets.

Direct feed

For this configuration, city or tap feed supply is purified by using in-line, activated carbon and two deionization tanks to a faucet or outlet connection. Tanks are typically rented and installed under a sink or in a utility room.

Water effluent quality indicator lights with a fixed resistivity set point are used in between the worker and polishing tank to notify the user of an exhausted tank. For bacteria removal, a minimum of an absolute 0.2-micron filter capsules or cartridges are installed close to the outlet.

Direct feed becomes a useful arrangement where space is limited, capital funds are reduced and manual operation is acceptable. Typical installations are not engineered to circulate the water in a closed loop. Hence, the water will stagnate requiring an operator to procedurally flush the unit before each use.

Flushing can be overlooked and the potential of compromised water may be increased. Water quality lights provide a useful indication of tank exchange but offer very little guarantee of water purity. During periods of inactivity, water degradation can occur within the piping causing water quality levels to fall below a desired, predetermined set point.

Direct-feed systems can serve many general needs in the laboratory but they may also serve as a pretreatment for polishing systems for more critical applications. When filling carboys or small vessels, the POU capsule filter will determine flow rate. Micron rating and total membrane surface area are the primary factors that affect flow. Flow rate ranges from one to 10 liters per minute (Lpm.)

Centralized systems (RO and/or DI)

If there is a requirement for multiple points of use for treated water, a centralized water filtration system can typically meet this demand. Water can be purified in a staged process such as reverse osmosis (RO) or deionization (DI), which is then stored in an atmospheric storage tank. A distribution pump circulates the water through secondary equipment such as deionization polishers, UV sterilization and sub-micron filtration.

The product water is then distributed through a network of demand points. At these point of use (POU) locations, water could undergo a final treatment, adhering to the water quality requirements at that particular location.

Centralized water filtration systems are ideal for large-scale facilities with multiple uses for treated water at high flow rates. There is typically a high initial capital cost and overhead associated with operation and maintenance. Generally there is no feedback at the point of use, which would require the user to install a meter and/or a final polishing system.

The system could contain spots where the water is isolated from the loop, creating deadheads and requiring additional bacteria filtration. Maintenance, such as loop sanitization, will break the supply to all points of use. Adding supply points can be costly if at all possible.

Flow rate will be limited if additional filtration or polishing is required at the point of use. The high cost of operation, along with man-hours required to maintain the loop, makes this particular setup a bit of a burden for small-scale operations.

POU laboratory systems

Laboratory POU systems filter water within the general area of use. That is, the system can be found somewhere in the lab. These are offered as stand-alone systems for low-flow applications or used to polish DI, RO or distilled water from an outside source (direct feed or centralized systems). These systems will incorporate the technology and flow characteristics of a central system but on a much smaller scale.

Point of use laboratory systems are very flexible units providing their own benefits, shortcomings and translating aspects of a centralized loop. The design is typically modular allowing the system to be conveniently stored on a counter, shelf, cabinet or mounted on a wall.

Manufacturers generally tailor systems to produce a certain grade of water, taking the guesswork out of selecting systems. They are designed with internal recirculation loops and can have a high level of automation.

Users can monitor water quality and, in some more sophisticated systems, monitor consumable service life. Flow rates are low, generally less than two liters per minute. The capital costs are related to the degree of functionality offered.

High-flow point of use systems

POU systems for the laboratory have evolved to combine new technology to allow higher flow rates for container and light process filling. High-flow, point of use (HF POU) systems include the same characteristics with localized recirculation, deionization and resistivity display. But they achieve better flow rates, use submicron filtration and ultraviolet (UV) sterilization technology.

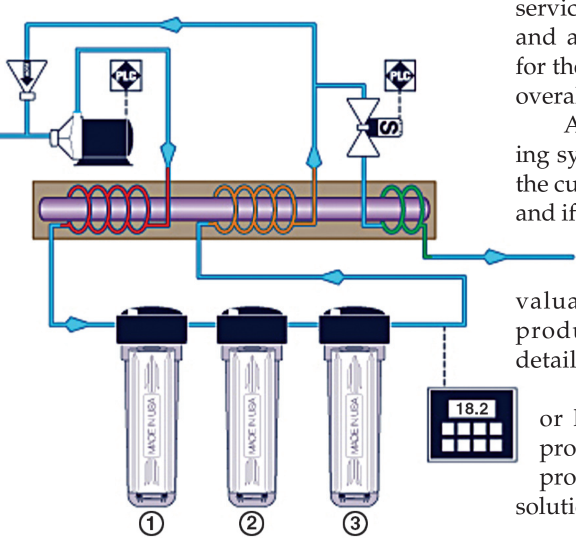
HF POU systems incorporate the filters in the flow path instead of at the outlet connection. This approach is similar to what is done on larger scale systems for critical ultrapure loops such as pharmaceutical and semi-conductor applications.

The HF POU yields an improved dispensing rate of 4.0 Lpm versus the standard 1.0 to 2.0 Lpm. To ensure bacteria sterility, UV technology can be used to continually irradiate the dispensing port (Figure 1).

In the laboratory, filling can be a totally manual process by opening up a valve or using dispensing guns that are either locked, rubber banded or sometimes even taped in the open position while the carboys or vessels are being filled. Filling is often left unattended and spills and flooding of the laboratory can occur.

These HF POU hybrid systems are a mini-production system utilizing PLC control and batch programmability. They provide an easy solution of quickly filling containers or small vessels with ultrapure water while eliminating spills or flooding with automated control.

Figure 1: High flow rate POU



Batch programming is a convenient method to give multiple users their own volumetric dispensing at the push of a button. Although not all systems on the market include multiple batching, it is a value-added feature for those who fill routinely. The combination of high flow and multiple batching gives the user the necessary means to fill automatically while attending to other operations within the lab.

Determining needs

Knowing your customers' needs in terms of flow rates, water grade quality requirements and system reliability is only a portion of what is needed to provide good service. Being aware of new technology and approaches provides new options for the user to improve productivity and overall water quality.

Asking the right questions or providing system audits will help to identify if the customer's water profile has changed and if system modifications are required.

The use of trusted suppliers of lab water equipment can provide valuable insight into understanding product differences and application details.

Whether a lab is using direct-feed or high-flow POU systems, always provide customers with the necessary product knowledge and offer the best solution for their lab water needs.

About the authors

♦ *Jon Bergman is Sales Manager for Aries Filterworks, a Division of ResinTech Inc. Bergman is responsible for sales of high purity water systems and related cartridge products. He was previously a sales engineer with Mar Cor Services, designing and selling industrial water systems. Bergman has a Bachelor's Degree in industrial engineering from Penn State University. Joe Palma is Technical Manager for Aries Filterworks. He has over ten years experience providing technical support in the petrochemical, environmental and water treatment industries. He has a Bachelor's Degree in physics from Rowan University and a Master's Degree in physics from Temple University.*