Technical Note:
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Choosing Distillation for your Water Purification Applications

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Overview

Laboratory water has multiple uses in life sciences, from rinsing glassware, to making biological media and buffers, or being used to provide pure water for lab equipment such as autoclaves and dishwashers. Of the broad array of water purification technologies available, it is important that users select the most appropriate method for their applications.

Although distillation is one of the oldest methods of purifying water, it remains a valid option today. Water purification distillers (stills), can be used to effectively distill water and remove inorganic solids and organics with boiling points higher than water, bacteria, and pyrogens. The majority of current users employ distillation based on tradition, because it was referenced in a protocol, or suggested by a respected colleague. However, some users may question the value of purchasing a still over alternative systems. The reality is that distillation effectively fulfills Type II water requirements. Understanding the strengths and weaknesses of distillation clarifies which technology best fits a given application requirement.

Stills are an ideal choice for supporting a variety of lab water requirements including:

- Pyrogen- and bacterial-free source of water for buffers or reagent preparations not requiring ultrapure Type I water.
- Large volumes of Type II water. The distillation process itself is slow so the purified water is stored in a reservoir, which allows for fast, on-demand dispensing.
- Feeding dishwashers, autoclaves, incubators, or other lab equipment in which deionized (DI) water is too pure and reverse osmosis (RO) water may not be pure enough.
- Tissue culture protocols require water from glass stills.
- Hormone research may stipulate water having contact with only glass components and not plastic.

Stills vs. Deionization and RO Systems

There are many different options available today to treat tap water and make it suitable for general laboratory work. In comparing distillation to other purification methods such as electrodeionization (EDI), DI using resins, or RO, the following concerns lend credibility to distillation:

- A requirement for consistent high quality, bacteria-free water.
- Cost associated with cartridge, membrane, or filter changes.
- The ability to turn off systems for extended time periods such as in seasonal facilities.
- Achieving lower maintenance costs - service is only required for mechanical parts, eliminating service call charges to change consumables.

Thermo Scientific Barnstead Classic Stills are constructed of copper and bronze with a coating of pure tin.

Stills - a Quick Look Comparison

There are clear advantages and disadvantages to using a still versus a DI or RO system that should be considered when making a buying decision.

Advantages to Stills
Offers the broadest removal capabilities of any single form of water purification with removal of 99.5% of impurities found in water, including bacteria, nitrates, sodium, hardness, dissolved solids, most organic compounds, heavy metals, and radio nucleotides
Requires no filters or cartridges eliminating concerns about consumable longevity, shelf-life, or a need to maintain stock
Cleaning of stills involves simple maintenance practices with pre-treatment further minimizing the frequency of cleaning
Feed water quality does not impact distillation effectiveness whereas cartridges and membranes are less efficient over time given poor quality feed water
Offers an extremely long service life
Highly scalable solution with large systems capable of providing water to several labs
Excellent option for seasonal facility start up/shut down
Disadvantages to Stills
Requires storage tank for purified water; (this is also true for other Type II and RO systems)
Stills use a considerable amount of energy and water and require periodic heater changes
Heat generated during the purification process must be dissipated into surrounding environment
Low boiling point organics and chloramines can carryover in distilled water, requiring additional treatment where a given application specifies very low total organic carbon (TOC)
May require an extra accessory to automate stills
Depending on the quality of feed water, stills require periodic cleaning with strong acids and may necessitate the use of pretreatment

Glass- and Tin-Lined Stills

There are two common types of stills that produce laboratory grade water. There are glass-lined stills such as the Thermo Scientific Barnstead Mega-Pure Glass Still series or tin-lined stills such as the Thermo Scientific Barnstead Classic Stills portfolio. The differences can be classified as follows:

- Tin-lined stills are typical in industrial applications, where there is a concern about glass breakage.
- Glass-lined stills are often found in life science laboratories, where protocols may require that water has not come into contact with any other materials except glass during water purification to avoid leaching of metals or plastic chemicals. As an added advantage, the glass stills are transparent, so it is easy to see if the unit needs to be cleaned.

Considerations When Purchasing a Still

If you are considering the purchase of a still there are some basic questions that you should consider before making a decision. This will help to ensure that you get exactly what you need from your water purification system:

1) What volume of water do you need on a daily basis and are there peak times of demand?
2) What is the water hardness like in your lab?
   If you would like to find out your water hardness levels, have a water test performed. The Thermo Scientific H_2O Select analysis program is a free service, which will match your water and application demands to the best water purification system.
3) Will you be feeding ancillary laboratory equipment or a distribution loop?
4) What are your application requirements (i.e. do you need pyrogen-free water)?

Running a Still: Cost Analysis

Running cost, whether it is for a system with cartridges or a still, is always something to take into consideration. Below (Table 1 and 2) is a comparison of the capital and annual operating costs for Mega-Pure® Glass Stills, Classic Stills, RO Systems (the Barnstead RO) and Type II Systems (the Barnstead TII) of similar output capacities. Generally speaking, stills require a higher up-front investment, but then have lower annual operating costs.

Conclusion

Stills continue to have a prominent place in the production of laboratory grade Type II water for researchers who need large quantities of water without the worry of changing filters or cartridges.

TABLE 1: CAPITAL COST

Unit	Thermo Scientific Barnstead Mega-Pure Glass Still (13 LPH*)	Thermo Scientific Barnstead Classic Still (10GPH*)	Thermo Scientific Barnstead RO System (12LPH)	Thermo Scientific Barnstead TII System (12 LPH)
List Price	$11,130	$11,970	$4,200	$5,580
Tank	$1,620	$3,660	$871	$816
Total	$12,750	$15,630	$5,071	$6,396

TABLE 2: ANNUAL OPERATING COST

Unit	Thermo Scientific Barnstead Mega-Pure Glass Still (13 LPH*)	Thermo Scientific Barnstead Classic Still (10GPH*)	Thermo Scientific Barnstead RO System (12LPH)	Thermo Scientific Barnstead TII System (12 LPH)
Total Cost	$300	$300	$743	$1553
	Typical usage assuming purchase of 1L HCl per year and new heating element every two years	Typical usage assuming purchase of 1L HCl per year and new heating element every two years	Typical usage assuming all consumables are changed on an annual basis	Typical usage assuming all consumables are changed on an annual basis

*Does not include other ancillary parts such as optional distribution pumps

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