

New technology meets
cost challenges for
bottled water industry

Water Distillation

By Bruce Kucera

Of all the water purification technologies used in the bottled water industry, distillation is the only process that replicates the hydrological cycle: water is heated until it forms steam; the steam is cooled to condensation, creating water, minus the impurities left behind in the boiling. It is a simple evaporation-condensation-precipitation system.

Many bottled water operators use a combination of methods to remove impurities from source water prior to introducing it into the bottle-filling process. That is because no one method can remove all impurities. Available methods include distillation, RO, activated carbon filtration and ion exchange.

The most common single method of removing contaminants from source/feed water in the bottled water industry is RO, with about 40% of U.S. bottlers using this process, compared to an estimated 15% that use distillation. The other 45% of bottlers either do not remove contaminants because they produce and market spring or mineral water, or they use one of the other technologies mentioned above.

Cost is one of the main reasons

why few bottlers use distillation. The major cost factor is equipment.

The cost of energy required to heat the water to boiling in the distillation process has made even the cost of producing a gallon of distilled water a lot more expensive than RO. However, new distillation technology has answered that challenge.

In the long run, distillation can be quite economical. While RO typically creates 1 gal of reject water for every gallon of product water produced, distillation produces up to 6 gal of product water for every gallon of reject water.

High quality water can be produced by distillation from virtually any source: municipal supplies, wells, springs, lakes and rivers. Because of the extended boiling process, any microbiological contaminants, including *Cryptosporidium*, are killed.

Two basic types of distillation systems are Vapor Compression and Multiple Effect.

Vapor Compression

The boiling process begins with both heating elements turned on. As the water in the boiling chamber reaches near-boiling temperatures,

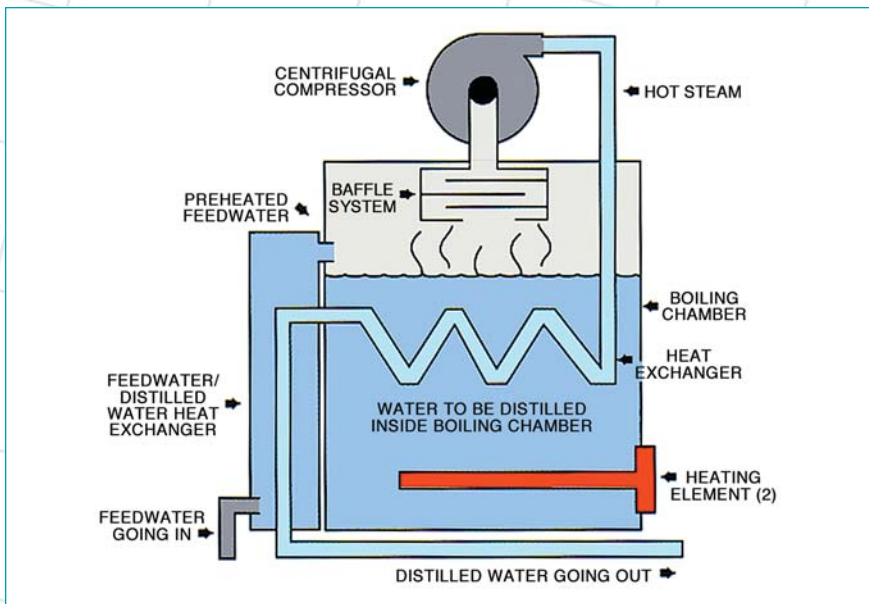


FIGURE 1: Vapor Compression

the compressor turns on, engaging the non-contacted liquid ring seal. When the operating boiling temperature is reached, the No. 2 heating element turns off and the No. 1 heating element cycles on and off, maintaining the boiling at just the right temperature. This step minimizes the amount of energy required to heat the water, achieving maximum efficiency (Figure 1).

The steam from the boiling water then flows through a baffling system and into the compressor. In the compressor, the steam is pressurized, which raises the steam's temperature before it is routed through a special heat exchanger located inside the boiling chamber. The pressurized steam is at a higher temperature than the feed water inside the boiling chamber.

The pressurized steam transfers its heat to the feed water inside the boiling chamber, causing this water to boil, which, in turn, creates more steam. While the pressurized steam is giving off its latent heat, the steam condenses. One of the heating elements will cycle on and off periodically as needed to provide any "make-up" heat that is required to keep the system operating at optimum temperature for

maximum efficiency.

At this stage the condensed steam is considered distilled water, but it is still very hot—only slightly cooler than boiling temperature. This outgoing hot distilled water preheats the incoming new feed water that will soon be distilled.

As the incoming water is preheated, the outgoing distilled water cools to within 20°F of the incoming feed water temperature. This exchange helps to preheat the incoming feed water to within a few degrees of the boiling temperature, saving even more energy. High quality Vapor Compression distillers recycle nearly 98% of energy required.

Vapor Compression distillers use about 0.12 Kw/H of electrical power to produce 1 gal of distilled water. Depending on local electricity rates, power costs could be as little as one cent per gallon.

Multiple Effect

Multiple Effect distillers are simpler in design. With no moving parts, there is almost nothing that could wear out. Distillers with more than one boiler are designed to recycle the heat energy which created the steam in the first boiler to

heat the water in the second boiler. A two-boiler unit produces twice the distilled water as a single-boiler unit for the same cost. A four-boiler unit produces four times the water, and a six-boiler unit will produce 6 gal of water for the approximate cost of distilling 1 gal of water.

Multiple Effect gets its name from the use of more than one boiler to produce distilled water. Multiple Effect systems use from two to six boiling chambers/effects. The more boiling chambers, the more efficiently the water is produced.

With this technology, energy contained in the steam produced in the first boiling chamber is reused to boil more water in subsequent boiling chambers. As with the Vapor Compression systems, it is this recycling of energy that provides the energy-saving feature of Multiple Effect distillation. To start, water in Chamber 1 is boiled, creating steam and a slight pressure within the chamber. This steam is collected and passed through a heat exchanger within Chamber 2. The feed water in Chamber 2 surrounds the heat exchanger. Since the steam from Chamber 1 is hotter than the water in Chamber 2, heat is transferred from the hot to the cooler, eventually causing the water in Chamber 2 to boil. Depending on how many chambers/effects the system has, this process continues (Figure 2).

Multiple Effect systems are very efficient for bottling plants requiring up to 500 gal of purified water a day. Vapor Compression systems are more efficient for larger applications.

Distillation vs. RO

Technical advances, as seen in the latest Vapor Compression systems, allow many of today's better commercial distillation systems to produce water to 1 ppm total dissolved solids (TDS) at a fraction of

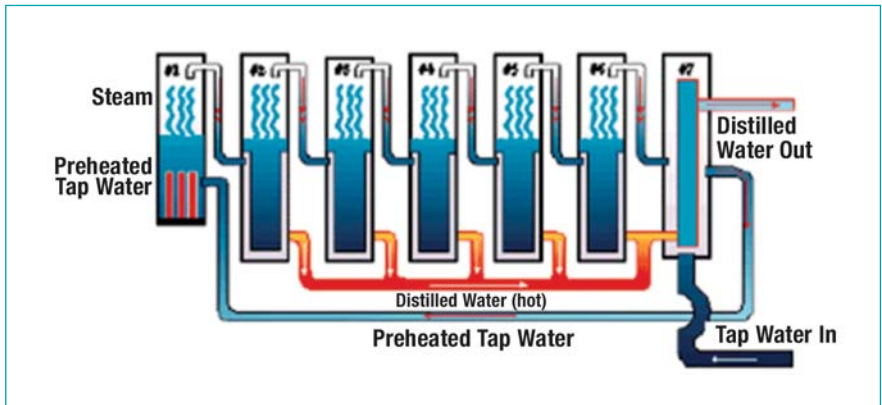


FIGURE 2: Multiple Effect

the cost of earlier distillers. Bottled water companies can offer very competitive prices on their products, often equal to, or even less than, companies using RO systems.

In practice, how does using distilled water add value to a bottled water operation?

“Initial investment is certainly higher for distillation equipment than for RO,” said Troy Krause, manager of Planet Earth, a bottled water company based in Lincoln, Neb. “But the actual costs of producing a gallon of water using the newest Vapor Compression-style distillers is now about equal to a gallon produced by RO.”

The distillers produce water at one cent per gallon. RO produces water at slightly less. Locally, Planet Earth competes on an even field with its RO competitors.

Planet Earth, like most other bottlers using distillation, first softens its feed water with an ion exchange treatment system. “This treatment removes a lot of the minerals that can create scaling and other corrosion within the distillers themselves,” Krause said. “We want to remove as much of chlorides and nitrates as we can up-front, so we don’t have to deal with them in the distillers.”

Planet Earth also uses an activated carbon filtration system to “put a polish on our finished product to make it the highest quality water we can produce,” Krause explained. “If our product water doesn’t test out at 1 ppm TDS, then we don’t bottle it.”

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product in the customer’s eye if they know it’s distilled, according to Krause.

“Distillation gives us product differentiation,” Krause said. His sales staff is trained to emphasize that product differentiation. “We tell them the benefits of distilled water include a better taste, a more consistent product, and that distillation removes more impurities than RO,” he said. While the differences are very small, “distillation consistently removes about 99.9% of the contaminants, while RO may start at about 98%, then rapidly degrades.” *bw*

About the Author

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