AQUA CHEM

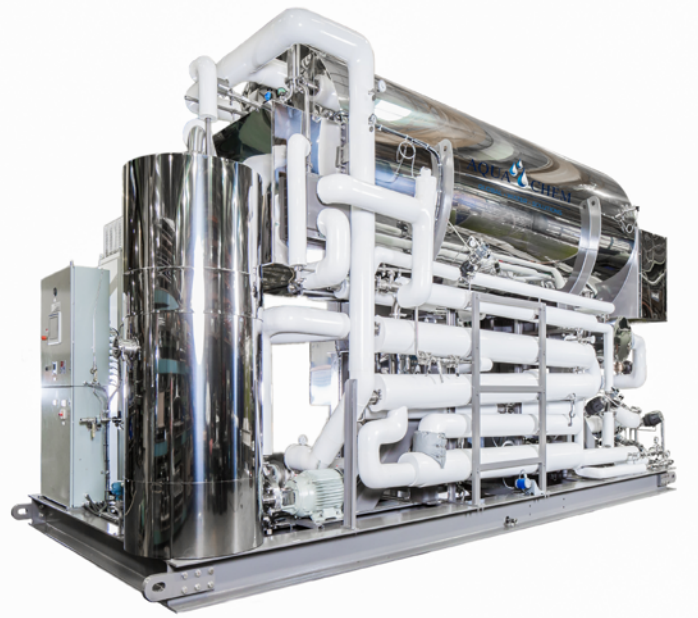
GLOBAL • WATER • SOLUTIONS

WATER PURIFICATION EXPERTISE FROM THE EXPERTS

PHARMACEUTICAL
BEVERAGE
OIL & GAS
MILITARY

VAPOR COMPRESSION DISTILLATION

IMPROVE THE EFFICIENCY OF YOUR WATER DISTILLATION EQUIPMENT



Raw water quality varies from location to location and even within a given site. It may change seasonally, during wet or dry spells, and hourly depending on the amount of treatment done at the municipal water source. With this degree of variation, how can you ensure consistent and adequate feedwater to your distiller?

As a starting point, it is necessary to obtain an accurate and complete feedwater analysis. Municipal public quality reports typically only include EPA reportable contaminants and often excluding common minerals and metals that are critical for optimizing distiller performance.

A 3rd party water analysis could cost between $100 and $300 and should include at least the following:

- **Conductivity**
- **Total Hardness as CaCO3**
- **Alkalinity as CaCO3**
- **pH**
- **Calcium as Ca**
- **Magnesium as Mg**
- **Sulfate as SO4**
- **Silica as SiO2**
- **Chloride as Cl**
- **Iron as Fe**
- **Sodium as Na**
- **Ammonia NH3**

Also desirable is information on nitrate, phosphate, sulfide, and total dissolved solids (TDS).

WATER SOFTENING

Next, review the feedwater requirements of the distiller manufacturer. Aqua-Chem's Horizontal Spray Film® Vapor Compression stills typically require only softened water while many other manufacturers require deionized water for proper equipment operation. To prevent scale formation the feedwater must be very low in silica and "hardness" minerals like calcium, and magnesium. Total Hardness should be less than 0.5 mg/L as CaCO3 and should not exceed 5.0 mg/L as CaCO3.

There are several methods and technologies for removing hardness from water, including chemical precipitation and ion exchange resins. Commonly used water softener resins directly replace calcium

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and magnesium ions with sodium, thus no calcium carbonate (CaCO3), Calcium sulfate (CaSO4) or magnesium hydroxide (Mg(OH)2) scale will form to foul the heat transfer surface areas, maintaining heat transfer efficiency and reducing downtime for cleanings. Resin softeners do not remove silica, however if the calcium and magnesium has been removed, silica scales will not form.

An Aqua-Chem water expert can size and recommend a water softener solution to meet your needs. Resin softener capacity is generally rated in grains of hardness (gr or kgr) that it will exchange between regeneration cycles.

You may use the following as a rule of thumb to help you size your softener:

First, obtain the Total Hardness as CaCO3 in mg/L or ppm (parts per million). If not explicitly stated in the water analysis, you can calculate the Total Hardness by taking 2.5 times the calcium (as Ca) plus 4.12 times the magnesium (as Mg).

Thus:
Ca(mg/L) x 2.5] + [Mg(mg/L) x 4.12] = Total Hardness as CaCO3 (mg/L)

Next, calculate the required water softener capacity in grains per day by dividing the Total Hardness (as CaCO3) by 17.1 and multiplying this by your anticipated water usage in gallons per day (GPD).

Thus:
Total Hardness as CaCO3 (mg/L) ÷ 17.1) x Water Usage (in GPD) = Required capacity in grains per day.

After a given period, a timer automatically switches from the first mineral tank to the second. The still can then continue to operate while the first tank is being regenerated. This system is activated on a set interval without regard for water usage. It is a good method if you confident of the usage for the time cycle of the softener but if water consumption or water quality changes can easily under or over run the water softener capacity.

There are three common system configurations for a water softener:

1. **Simplex (Single)** mineral tank with manual or automatic regeneration. Without redundancy, the distiller must be shut down every time the water softener needs regeneration. The softener should not be by-passed to avoid depositing scale on the heat transfer surface areas.

2. **Duplex (Double) Alternating** mineral tank with timer initiated regeneration. After a given period, a timer automatically switches from the first mineral tank to the second. The still can then continue to operate while the first tank is being regenerated. This system is activated on a set interval without regard for water usage. It is a good method if you confident of the usage for the time cycle of the softener but if water consumption or water quality changes can easily under or over run the water softener capacity.

3. **Duplex Alternating** mineral tank with water meter initiated regeneration. This system is like the above except that regeneration is initiated after a given number of gallons have been softened, regardless of the amount of time elapsed since the previous regeneration. This is the most water efficient configuration.

CHECKING FOR HARDNESS

The effluent from the softener should be checked regularly for hardness and the best time to check is just prior to commencing regeneration to confirm that there has been no hardness break-through. Two simple tests to check for hardness are listed below:

1. Soap Bubble Test
Simple, quick, and inexpensive, but this test is not sensitive enough to detect hardness less than 5.0 mg/L as CaCO3 or 0.29 GPG.

2. Color Comparator Titrate Test
Also, inexpensive, simple, and fairly accurate, it can give actual numerical values even at low hardness levels. Down to 1.0 ppm or 0.058 GPG or less with low-range test kits.

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DEMINERALIZATION

An ion exchange resin demineralizer (or deionizer as it is commonly called) is not normally required pretreatment for an Aqua-Chem VC distiller. When a deionizer is used, a water softener is not required. A deionizer may consist of any of the following:

1. Cation Resin Bed
Removes nearly all raw water cations (such as Ca, Mg, Na). Instead of Sodium salt, regeneration requires H+ hydrogen ions and is performed with an acid such as sulfuric (H_2SO_4) or hydrochloric (HCl).

2. Anion Resin Bed
Removes raw water anions (such as SO_4, Cl, HCO_3). Regeneration is performed with an alkali such as caustic soda (NaOH).

3. Mixed Resin Bed
This is both a cation and an anion exchanger and is often referred to as a polishing deionizer.

A deionizer can remove dissolved Silica and is typically required when feedwater levels exceed 4.0 mg/L. In this case a cation-anion-mixed bed deionizer system is recommended with a silica anticipatory probe to automatically regenerate before the silica begins to break through the deionizer.

NOTE: Silica scale is very difficult, if not impossible, to remove. *This scale may not respond at all to strong acid or strong base chemical cleanings and may require temperature shocking or physical scraping to dislodge.*