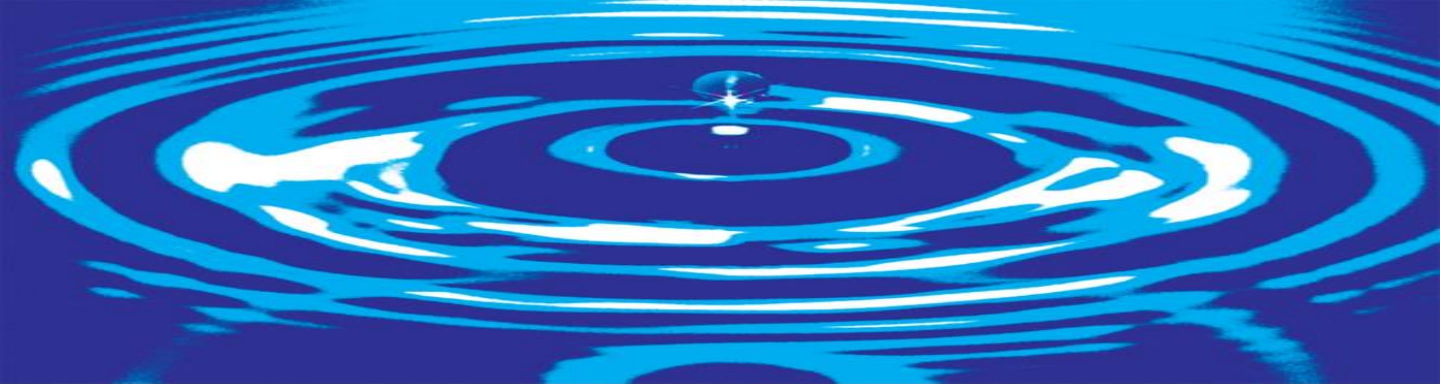

An introduction to:

Brewery Water Pretreatment Fundamentals

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Brewery Water Pretreatment Fundamentals

Introduction:

- **As you are all aware, beer is generally comprised of 90-95% water. One needs to begin with good water in order to create great beer. Do not overlook thorough and proper water pretreatment.**

- **Prior to designing a pretreatment system for your brewery, you must first have a baseline of your tap water chemistry and understand the limitations of your existing or planned plumbing infrastructure.**

Water Test:

- **Ward Laboratories offers a "Brewer's Test Kit" part # W-5A. This kit is mailed to you and consists of a sample bottle, directions and prepaid return postage.**
- **Results are emailed one day after the sample is received by Ward Labs.**
- **Your tap water will be tested for the following parameters: Sodium, Chloride, Magnesium, Potassium, Carbonate, Bicarbonate, Chloride, Iron, Sulfate, Nitrate, Electrical Conductivity, Total Dissolved Solids (TDS), pH, Total Hardness, Total Alkalinity and Total Phosphorus.**
- **www.wardlabs.com or 1-800-887-7645**
- **The cost per test kits is less than $40.**
- **See Appendix A for "Brewer's Ideals"**

System Sizing and Flowrates:

- **Flowrate is simply how much water you will require and how quickly you would like that volume available**
- **Flowrate is measured in GPM (gallons per minute)**
- **Calculating your desired flowrate is easy. For example:**
  30 Bbl HLT X 31 Gal per Bbl = 930 total gallons desired.
  930 gallons / desired fill time 60 minutes = 15.5 GPM flowrate.
- **Once you have determined your target flowrate, you will need to make sure your existing or planned plumbing will be capable of delivering that GPM.**
- **You will need to determine the pressure of your feed water. Your building may have a pressure gauge near the point of entry from the street.**
- **If no pressure gauge is present, you can assemble a suitable one from parts acquired at Home Depot or Lowes. The easiest way to test pressure is at**
  a garden hose spigot. You will need a 0-100psi gauge with ¼" MPT threads, a female garden hose adapter and reducing bushing or two. Total cost: less than $25.
- **It is also advisable to consult a pipe diameter / psi graph to ensure your piping diameter and pressure will produce your desired flowrate. See Appendix B.**
- **If you have or are planning a taproom and restaurant,**
  pushing your plumbing to it's limit in the brewery can lead to water starvation in the rest of the building.
  A booster pump may be needed in low pressure bldgs.

Brewery Water Pretreatment Fundamentals

<u>Sediment Filtration:</u>

- **Sediment filtration is often overlooked and its importance is commonly underestimated.**
- **One of the largest contributing factors to premature filtration failure are water main breaks which allow dirt, silt and fine clay to undermine the downstream filtration.**
- **The first step in any water pretreatment system should be sediment filtration.**
- **Flowrate is not as critical with sediment filtration because we are simply making an effort to trap particulate material. Increased contact time does not lead to better filtration.**
- **In 2013's "The Report Card for America's Infrastructure" prepared by the American Society of Civil Engineers, it is estimated there are 240,000 in the US annually.**
- **New York's climate and aging infrastructure will stake a claim to many of these failures.**
- **Consider sediment filtration an inexpensive insurance policy which protects the more expensive downstream carbon filtration.**

Carbon Filtration:

- Activated carbon is employed to remove chlorine which can create "off" tastes and aromas.
- For small breweries wall mounted filters may be adequate. However, all carbon filters are not equal.
  - High quality 4"x20" carbon filter = 40,000 gal treated
  - Low quality 4"x20" carbon filter = 20,000 gal treated
- Flowrate is a critical factor in maintaining proper contact time between the water and carbon.
- Another consideration is pressure drop through each stage of filtration and how it compounds as water moves downstream. This especially important if you have low pressure to start with. Most commercial buildings have 60-65psi. Anything below 40-45psi is considered a low pressure application.
- For low pressure situations where wall mount filters are desired, you may want to consider a radial flow carbon filter which will maintain a higher flow rate with a lower pressure drop.
- Also consider total water usage not just brewing water. I typically hear an average of 7-9 gallons are used throughout the brewery for each gallon sent to the brew house (ie. water for cleaning, keg washing, etc).
- Aim for low to no maintenance. For example, annual filter replacement. I do not recommend exceeding 12 months of service on a filter regardless of gal used.

Carbon Filtration continued:

- **When high flowrates (7gpm+) are desired. Wall mount filters will not provide adequate contact time.**
- **The traditional high flowrate method of dechlorination has been backwashing carbon tanks with a metered head which can be programmed to backflush the carbon and prepare it for continued use.**
- **The drawback to this method is quite a large tank will be needed to achieve flowrates at or above 15gpm. For example if you are using 1” pipe, a 21”x62”, a 6 cu. ft. tank will be required to accommodate 18gpm.**
- **After several years, the carbon will need to be re-bedded. This can be quite a chore with a tank that has a dry weight of 370lbs.**
- **Rather than re-bed these tanks, I have heard of many breweries that consider them disposable and simply buy a new carbon tank every few years.**

Brewery Water Pretreatment Fundamentals

Carbon Filtration continued:

- **Recently a new carbon filtration technology was introduced to address the limitations of wall mount filters and backwashing tanks.**
- **A single 6” x 30” carbon filter has a working max flow rate of 15gpm and is rated to dechlorinate 250,000 gal.**
- **A 9” x 40” fiberglass tank is used with these filters. The tanks have a convenient quick release ring and removable top cap that facilitates filter replacement in less than 3 minutes. An integrated handle on each filter makes top loading replacement filters an easy task.**
- **Two of these tanks can be plumbed in parallel to achieve 30gpm and a combined total of 500,000 gal of dechlorinated water.**
- **This technology’s high flow rate, low pressure drop and long service life make them ideal for brewery use.**

Brewery Water Pretreatment Fundamentals

Chloramine Removal:

- **Chloramine is a combination of chlorine and ammonia.**
- **The addition of ammonia makes this disinfectant more stable and oxidizes at a slower rate which also makes it more difficult to remove.**
- **Standard activated carbon will not remove chloramine.**
- **Specialized catalytic carbon must be employed.**
- **Chloramine use is limited in New York. A quick phone call to your water department will determine which disinfectant is used locally.**
- **Catalytic carbon can be loaded in a backwashing tank or is also available in the 6" x 30" filter size. Note: recommended flowrate is 7gpm and only 50,000 gal service life.**

Ultraviolet Light Disinfection:

- **Many brewer's like to use UV light as a method of post-dechlorination disinfection.**
- **Most UV lights have an audible alarm to indicate bulb failure.**
- **UV lamps are diabolically engineered to last 9000 hours which coincidentally just over a year.**
- **If you desire to use a UV light, plan on annual replacement of the bulb and keep a spare on hand.**

Flow Control and Monitoring:

- **Monitoring and flow control are critical tools that assist in observing and predicting the pretreatment system's behavior.**
- **Inlet/outlet pressure gauges are inexpensive indicators of filter performance. Typically a inlet/outlet pressure differential of 15-20psi reveals the need to change filters.**
- **Flowmeters are another critical tool that maximize proper contact time with carbon and/or UV light.**
- **Flow control can be employed to guarantee the max gpm is not exceed.**
- **Digital gallon totalizers/flowmeters can isolate brewing water usage from that of the rest of the facility. Again providing confirmation that the system's capabilities and performance have not been compromised.**
- **Monitoring provides empirical data on system performance and easy rectification of any issue.**

Brewery Water Pretreatment Fundamentals

Problem Water:

- **Most of the municipal water in New York is suitable for brewing beer. However, they may be areas that have hard or high TDS (Total Dissolved Solids) tap water that is challenging to brew with.**
- **Also, all well water is not “bad” water. In fact, some wells provide excellent water. However, another population of wells can present a variety of issues (such as sulfur veins, hard water, nitrate contamination from commercial fertilizer, etc.)**
- **In extreme cases, well or municipal water that is deemed undesirable or unsuitable for brewing may require purification via reverse osmosis.**
- **Reverse osmosis systems require pretreatment that consists of the aforementioned sediment and carbon filtration as well as some form of scale control.**
- **ROs come in a variety of sizes.**


An introduction to Reverse Osmosis:

- RO production ratings can be rather deceiving.
- All RO production is rated at 77F feed water temp. So the stated output is not realistic for our climate.
- As the feed water gets cooler, the RO production decreases. There can be as much as a 40% seasonal differential in output. See Appendix C for a temperature correction chart.
- For example, let's take a look a 750 GPD RO system. 750GPD @ 77F = 673GPD @ 70F = 438GPD @ 50F
- Also, RO production is listed in GPD. In order to achieve this number the system would have to run 24-7. To get a more realistic idea of the true output of an RO, convert GPD to GPH or GPM.
- With RO systems the product water is typically stored in a holding tank prior to use. However in the brewing world, it is feasible to use the HLT as your storage tank.
- Today's light commercial and commercial ROs are capable of a 98%+ rejection rate. This 98% pure water can then have its profile built by the brewer to replicate any water source in the world.
- The RO water can also be blended with pretreated tap water to achieve a target or desired level of TDS.

Anti-scale Treatment for Boiler Make Up Water:

- **Boilers should be fed with treated water to prevent impurities from precipitating out of suspension and bonding to the heating surfaces.**
- **¼" of scale can increase energy costs by 25%.**
- **Scale also leads to expensive boiler repairs.**
- **A water softener is the traditional method of scale prevention in boilers. Softeners require frequent regeneration and filling of the brine tank with fresh salt.**
- **The second method of boiler scale control is chemical dosing with anti-scalents. This will require purchasing and maintaining the proper level of anti-scalent.**
- **Anti-scale medias have emerged as the favored method of scale control in the last few years.**
- **Scale is caused by hard calcium ions falling out of suspension and bonding to metal surfaces. These new medias convert the hard calcium ions into soft calcium crystals which remain soluble and will not precipitate.**
- **The media is simply placed in a simple up-flow tank and has a service life of 3 years.**
- **To learn more about anti-scale media visit www.thescalesolution.com.**

Appendix A: Brewing Ideals

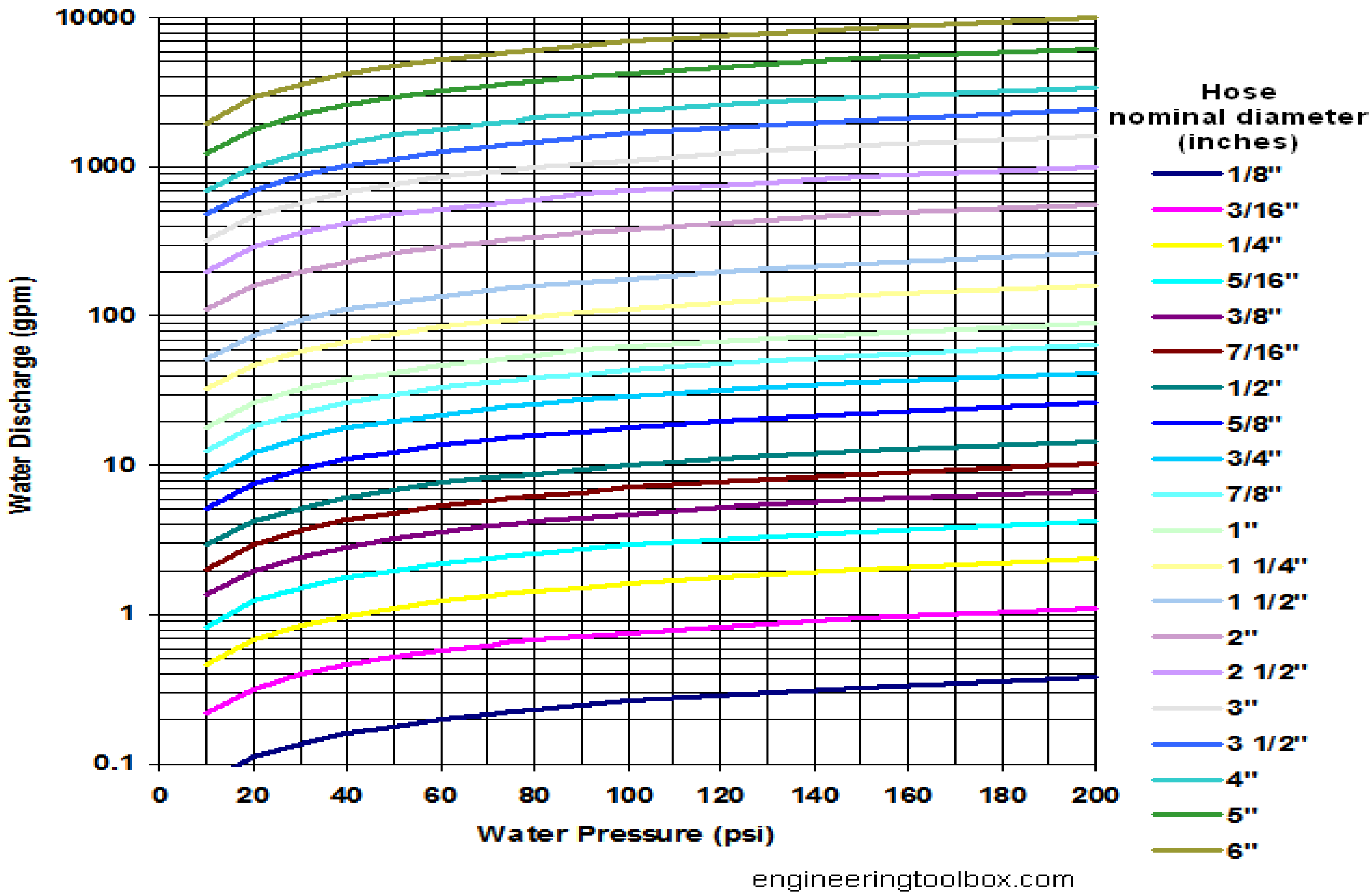
Brewing Ideals for Water

PH	5-9.5
TDS (Total Dissolved Solids)	<500
TSS (Total Suspended Solids)	N/A
TOC (Total Organic Carbon)	N/A
Sodium, Na	0-50
Potassium	<10
Magnesium	0-40
Nitrate	<44
Carbonate	N/A
Sulfate	0-250
Chloride	0-100
Total Alkalinity	0-100
Flouride	0
Total Iron	0
Calcium	50-150
Total Hardness	N/A

*All measurements are in mg/l (milligrams per liter) = PPM (parts per mill)

**To convert Total Hardness into grains divide by 17.1

Appendix B: Pipe Diameter vs Psi Graph



Appendix C: Temperature Correction Factor Chart

AXEON Membrane Temperature Correction Factor

Temperature °F (°C)	Temperature Correction Factor	Temperature °F (°C)	Temperature Correction Factor	Temperature °F (°C)	Temperature Correction Factor	Temperature °F (°C)	Temperature Correction Factor	Temperature °F (°C)	Temperature Correction Factor
50.0 (10.0)	1.711	57.2 (14.0)	1.475	64.4 (18.0)	1.276	71.6 (22.0)	1.109	78.8 (26.0)	0.971
50.2 (10.1)	1.705	57.4 (14.1)	1.469	64.6 (18.1)	1.272	71.8 (22.1)	1.105	79.0 (26.1)	0.968
50.4 (10.2)	1.698	57.6 (14.2)	1.464	64.8 (18.2)	1.267	72.0 (22.2)	1.101	79.2 (26.2)	0.965
50.5 (10.3)	1.692	57.7 (14.3)	1.459	64.9 (18.3)	1.262	72.1 (22.3)	1.097	79.3 (26.3)	0.962
50.7 (10.4)	1.686	57.9 (14.4)	1.453	65.1 (18.4)	1.258	72.3 (22.4)	1.093	79.5 (26.4)	0.959
50.9 (10.5)	1.679	58.1 (14.5)	1.448	65.3 (18.5)	1.254	72.5 (22.5)	1.090	79.7 (26.5)	0.957
51.1 (10.6)	1.673	58.3 (14.6)	1.443	65.5 (18.6)	1.249	72.7 (22.6)	1.086	79.9 (26.6)	0.954
51.3 (10.7)	1.667	58.5 (14.7)	1.437	65.7 (18.7)	1.245	72.9 (22.7)	1.082	80.1 (26.7)	0.951
51.4 (10.8)	1.660	58.6 (14.8)	1.432	65.8 (18.8)	1.240	73.0 (22.8)	1.078	80.2 (26.8)	0.948
51.6 (10.9)	1.654	58.8 (14.9)	1.427	66.0 (18.9)	1.236	73.2 (22.9)	1.075	80.4 (26.9)	0.945
51.8 (11.0)	1.648	59.0 (15.0)	1.422	66.2 (19.0)	1.232	73.4 (23.0)	1.071	80.6 (27.0)	0.943
52.0 (11.1)	1.642	59.2 (15.1)	1.417	66.4 (19.1)	1.227	73.6 (23.1)	1.067	80.8 (27.1)	0.940
52.2 (11.2)	1.636	59.4 (15.2)	1.411	66.6 (19.2)	1.223	73.8 (23.2)	1.064	81.0 (27.2)	0.937
52.3 (11.3)	1.630	59.5 (15.3)	1.406	66.7 (19.3)	1.219	73.9 (23.3)	1.060	81.1 (27.3)	0.934
52.5 (11.4)	1.624	59.7 (15.4)	1.401	66.9 (19.4)	1.214	74.1 (23.4)	1.056	81.3 (27.4)	0.932
52.7 (11.5)	1.618	59.9 (15.5)	1.396	67.1 (19.5)	1.210	74.3 (23.5)	1.053	81.5 (27.5)	0.929
52.9 (11.6)	1.611	60.1 (15.6)	1.391	67.3 (19.6)	1.206	74.5 (23.6)	1.049	81.7 (27.6)	0.926
53.1 (11.7)	1.605	60.3 (15.7)	1.386	67.5 (19.7)	1.201	74.7 (23.7)	1.045	81.9 (27.7)	0.924
53.2 (11.8)	1.600	60.4 (15.8)	1.381	67.6 (19.8)	1.197	74.8 (23.8)	1.042	82.0 (27.8)	0.921
53.4 (11.9)	1.594	60.6 (15.9)	1.376	67.8 (19.9)	1.193	75.0 (23.9)	1.038	82.2 (27.9)	0.918
53.6 (12.0)	1.588	60.8 (16.0)	1.371	68.0 (20.0)	1.189	75.2 (24.0)	1.035	82.4 (28.0)	0.915
53.8 (12.1)	1.582	61.0 (16.1)	1.366	68.2 (20.1)	1.185	75.4 (24.1)	1.031	82.6 (28.1)	0.913
54.0 (12.2)	1.576	61.2 (16.2)	1.361	68.4 (20.2)	1.180	75.6 (24.2)	1.028	82.8 (28.2)	0.910
54.1 (12.3)	1.570	61.3 (16.3)	1.356	68.5 (20.3)	1.176	75.7 (24.3)	1.024	82.9 (28.3)	0.908
54.3 (12.4)	1.564	61.5 (16.4)	1.351	68.7 (20.4)	1.172	75.9 (24.4)	1.021	83.1 (28.4)	0.905
54.5 (12.5)	1.558	61.7 (16.5)	1.347	68.9 (20.5)	1.168	76.1 (24.5)	1.017	83.3 (28.5)	0.902
54.7 (12.6)	1.553	61.9 (16.6)	1.342	69.1 (20.6)	1.164	76.3 (24.6)	1.014	83.5 (28.6)	0.900
54.9 (12.7)	1.547	62.1 (16.7)	1.337	69.3 (20.7)	1.160	76.5 (24.7)	1.010	83.7 (28.7)	0.897
55.0 (12.8)	1.541	62.2 (16.8)	1.332	69.4 (20.8)	1.156	76.6 (24.8)	1.007	83.8 (28.8)	0.894
55.2 (12.9)	1.536	62.4 (16.9)	1.327	69.6 (20.9)	1.152	76.8 (24.9)	1.003	84.0 (28.9)	0.892
55.4 (13.0)	1.530	62.6 (17.0)	1.323	69.8 (21.0)	1.148	77.0 (25.0)	1.000	84.2 (29.0)	0.889
55.6 (13.1)	1.524	62.8 (17.1)	1.318	70.0 (21.1)	1.144	77.2 (25.1)	0.997	84.4 (29.1)	0.887
55.8 (13.2)	1.519	63.0 (17.2)	1.313	70.2 (21.2)	1.140	77.4 (25.2)	0.994	84.6 (29.2)	0.884
55.9 (13.3)	1.513	63.1 (17.3)	1.308	70.3 (21.3)	1.136	77.5 (25.3)	0.991	84.7 (29.3)	0.882
56.1 (13.4)	1.508	63.3 (17.4)	1.304	70.5 (21.4)	1.132	77.7 (25.4)	0.988	84.9 (29.4)	0.879
56.3 (13.5)	1.502	63.5 (17.5)	1.299	70.7 (21.5)	1.128	77.9 (25.5)	0.985	85.1 (29.5)	0.877
56.5 (13.6)	1.496	63.7 (17.6)	1.294	70.9 (21.6)	1.124	78.1 (25.6)	0.982	85.3 (29.6)	0.874
56.7 (13.7)	1.491	63.9 (17.7)	1.290	71.1 (21.7)	1.120	78.3 (25.7)	0.979	85.5 (29.7)	0.871
56.8 (13.8)	1.486	64.0 (17.8)	1.285	71.2 (21.8)	1.116	78.4 (25.8)	0.977	85.6 (29.8)	0.869
57.0 (13.9)	1.480	64.2 (17.9)	1.281	71.4 (21.9)	1.112	78.6 (25.9)	0.974	85.8 (29.9)	0.866

°F = (°C x 9/5) + 32

Corrected Flow Rate = (Measured Flow Rate)*(TCF @ Feed Water Temp.)

AXEON WATER TECHNOLOGIES

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Notes: