IMPORTANCE OF A WATER ANALYSIS FOR ENGINEERING OF A REVERSE OSMOSIS SYSTEM

Selecting a manufacturer that is well versed in the design, engineering, and manufacturing of reverse osmosis systems is a key step in the qualification process of a new supplier. However, ensuring that they possess the knowledge, skills, and understanding of water chemistry is also critical. Water chemistry is the starting point to designing or selecting a reverse osmosis system for any application. This can be the variable that leads a project to become a total success or total failure.

Having a thorough understanding of the application and feed water source is a key requirement and can help determine the appropriate membrane type for the application. There are different types of membranes used to treat tap water, brackish water, seawater, and wastewater. Regardless of the membrane type, the performance of a membrane is specified based on its rate of water production (permeability) and the percent of total salts it retains (rejection). In theory, the selection of the "ideal" membrane for a given application is the highest water production rate with the highest salt rejection at the lowest feed pump pressure (i.e., low operating cost). However, none of this can be possible without knowing the feed water chemistry.

It is common in the industry when a supplier begins the manufacturing process of a reverse osmosis system, they request a water analysis or water system questionnaire to be completed. This provides the engineers with a set of parameters that they must consider during the design and specification steps of the design process. If this step is missed or not executed properly, the result could be disastrous for the performance and operation of the system, and it can end up being very costly.

By providing a complete and accurate water analysis, application engineers can provide proper guidance on how to operate the system, as well as giving recommendations for pretreatment in order to achieve the optimal permeate water quality while extending the life of the membranes. Many customers are familiar with the term TDS (total dissolved solids). TDS is a very important parameter in the design of reverse osmosis systems. It is common to see TDS reported in ppm (parts per million), or like this: 2,000 ppm for well water.

TDS is commonly associated with sodium chloride (table salt); however, a variety of inorganic salts, minerals, and some organics also contribute to the TDS level. Hardness

and alkalinity are other terms familiar to individuals who are familiar with traditional water softening. The reporting of both the hardness and alkalinity of water provides information relative to the levels of calcium and magnesium carbonate and bicarbonate, respectively, in the water. Although this information is more descriptive than knowing just the TDS alone, it still does not paint the complete picture of the makeup water.

A complete water analysis would include the major cations and anions. The cations are the positively charged ions such as sodium, calcium, magnesium, and potassium. The anions, on the other hand, are the negatively charged ions such as chloride, sulfate, nitrate, and bicarbonate. A water analysis is considered complete when the equivalent charge of the cations balances with the equivalent charge of the anions.

On the first page of the example water analysis, the anions are listed along with the concentration found in the water measured in units of mg/L (milligrams per liter, which is equivalent to ppm). The cations are shown here as well under the category of metals. In the chart on the right, we find hardness and alkalinity. Note that the unit of measurement is expressed as mg per liter as $CaCO_3$. This unit of measurement is different from grains per gallon. We will not go into discussing the conversion between these measurements; however, it is important to include the exact units of measurement when forwarding the water analysis to an applications engineer.

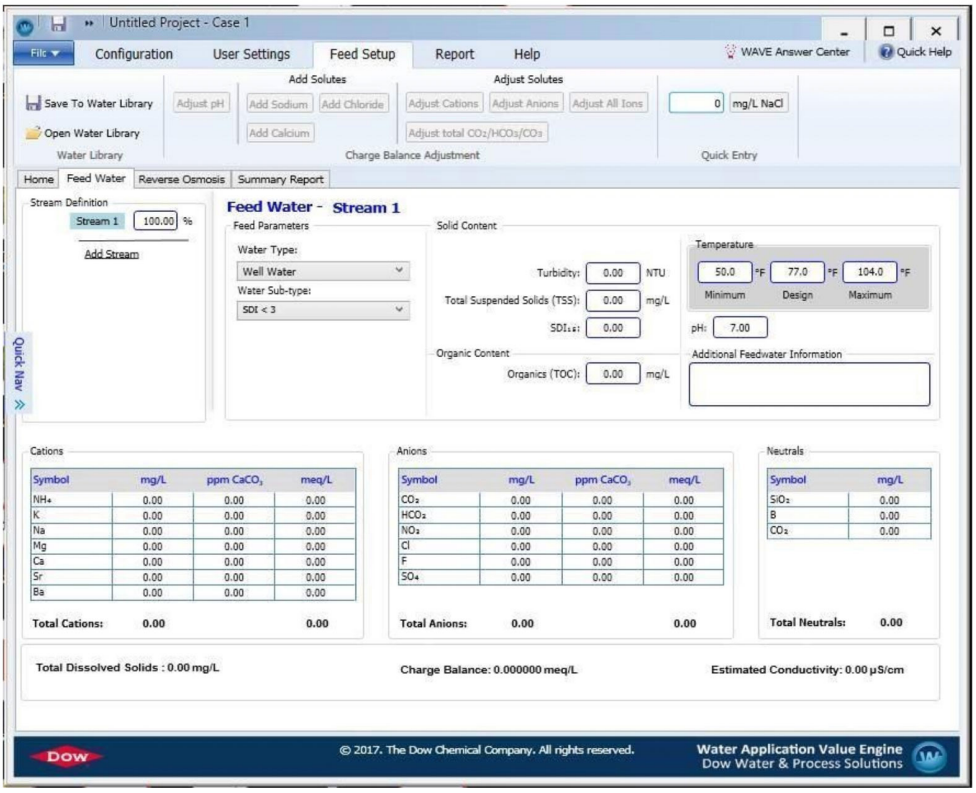
At the top of the water analysis, bicarbonate is given. The presence of either carbonate or bicarbonate in the water is a function of the pH of the water. It is best to measure both temperature and pH with a handheld instrument when collecting the water sample at the project location because they will both change by the time the laboratory analyzes the sample. If a local lab isn't available, then visit a lab that does water analysis with a kit such as NTL Labs (https://watercheck.com/). Upon receipt of the report, an applications engineer will take the water quality data and enter it into the feed water input window of a reverse osmosis system projection software.

SAMPLE ANALYSIS	
PARAMETERS	(MG / L)
pH	7.20
Bicarbonate	88
Carbonate	0
Hydroxide	0
Temperature (°F)	75°
Hydrogen Sulfide	ND
CATIONS	(MG / L)
Arsenic	<.003
Calcium	1040
Chromium	.008
Iron	.15
Magnesium	182
Potassium	67
Sodium	602
ANIONS	(MG / L)
Chloride	2131
Sulfate	1661
OTHER	(MG / L)
Total Hardness as $CaCO_3$	3350
Total Dissolved Solids	5770
Nitrate	.06
TEXAS DEPARTMENT OF HEALTH LIMITS FOR DRINKING WATER	(MG / L)
Chloride	300
Sulfate	300
Iron	.30
Total Dissolved Solids	1000
Nitrate	10
EPA LIMITS FOR DRINKING WATER	(MG / L)
Chloride	250
Sulfate	250
Iron	.30
Total Dissolved Solids	500
Nitrate	10
Nitrite	1.00
Lead	.015
Arsenic	.01
Chromium	.10

Remarks: *Based only on the determination performed above, this water shows higher levels of Chloride, Sulfate and Total Dissolved Solids than what is recommended by the Texas Department of Health for drinking water.*

ANALYSIS SOFTWARE

To the right, is an example where you input all ions that is supplied by the client. As mentioned, mg/L is the equivalent of ppm.



It is important to know which ions and minerals are in the feed water because these impurities become more concentrated. When these highly concentrated impurities precipitate out of solution, scaling occurs. With knowledge of the impurities in the water, applications engineers are better able to select a system design and membrane with an appropriate flux rate and recovery to suit the feed water conditions. Based on the water chemistry, pretreatment methods such as adjustment of pH or the addition of anti–scalant may also be recommended.

For all the individuals who have customers that argue that they don't need a water analysis and or have one from a decade ago, you can provide them with this analogy. If you are ill and go to the doctor and inform the doctor that you are "sick and to fix me." They wouldn't have an idea where to start to try to make you feel better because they have to diagnose you first. A water analysis is very much like this; it provides a diagnostic starting point and identifies the problem areas. This allows an experienced applications engineer to overcome each of the problems and design a high–performing solution for your application that will be able to overcome the contaminants in the feed water source.

AXEON® Water Technologies has been designing, engineering, and manufacturing reverse osmosis systems for over 30 years. Now looked upon as one of the leading system producers in North America, AXEON manufactures thousands of commercial and industrial–sized reverse osmosis systems that are pre–engineered, utilize energy–efficient membranes and pumps, and offer a wide range of options. Our highly skilled staff of technicians and engineers can provide you with guidance and solutions for all your projects and product line needs.