Water containing high levels of dissolved carbon dioxide and/or mineral acids is common in ground waters all over the Earth.

Acidic water has a pH of less than 7.

In some cases this can cause rapid corrosion and development of pin-hole leaks in household and commercial piping.

Blue stains from copper pipe corrosion, or rusty water from iron pipes can cause staining of clothes and fixtures.

pH

Source

The term "pH" is used to indicate acidity or alkalinity of a given solution. It is not a measure of the quantity of acid or alkali, but rather a measure of the relationship of the acid to the alkali. The pH value of a solution describes its hydrogen-ion activity. The pH scale ranges between O and 14.

[0]==========[7]==========[14]
Acidic Alkaline

Typically all natural waters fall within the range of 6.0 to 8.0 pH. A value of 7.0 is considered to be a neutral pH. Values below 7.0 are acidic and values above 7.0 are alkaline. The pH value of water will decrease as the content of CO_2 increases, and will increase as the content of bicarbonate alkalinity increases. The ratio of carbon dioxide and bicarbonate alkalinity (within the range of 3.6 to 8.4) is an indication of the pH value of the water. Water with a pH value of 3.5 or below, generally contains mineral acids such as sulfuric or hydrochloric acid.

Acidic Water

Source

Acidic waters usually attain their acidity from the seepage of acid mine waters, or acidic industrial wastes. Acid mine waters are frequently too low in pH to provide suitable drinking water even after neutralization and treatment.

What Tests Are Run On Water?

Several tests can be performed on the water to ensure the water is fit for consumption. Some of these tests include **Water Temperature**, **pH**, **Dissolved Oxygen (DO)**, **Turbidity**, **Total Dissolved Solids**

(TDS) and Salinity, **Water Hardness**, and **Water-Borne Microorganisms**.

Water Temperature: Water temperature can give us an idea of the overall water quality. Unusually high temperatures indicate that water quality has gone down. Warmer water has a smaller amount of dissolved oxygen (discussed later) and thus a higher chance that microorganisms are growing.

pH: pH is essentially a measure of acidity. pH values range between 0 and 14, with 7 being neutral. Below 7 indicates an acidic solution and above it is increasingly basic.

Chem Window --- pH

So why do we take pH readings of our drinking water? Since we must maintain our body pH at 7.4, highly basic or acidic water is not suitable for drinking.

How does water deviate from its pure pH of 7?

Even pure rain is naturally a little acidic. Water exposed to the atmosphere becomes slightly acidic because of dissolved CO_2 from the air.

$H_2O + CO_2 <===> H_2CO_3 <===> HCO_3^- + H^+$

In addition to the naturally occurring CO_2 from the air, large amounts of organic waste matter in water will also increase the CO_2 content, increasing acidity. The waste serves as food for microorganisms, which allows them to multiply and release CO_2 as a product of respiration.

A great deal of the H^+ ions come from acid rain, which is itself a product of polluted air. Industrial and automotive sources release large amounts of SO_2, NO_X, and CO_2, which react in the atmosphere to produce acid rain.

Dissolved Oxygen (DO): Dissolved oxygen refers to the amount of oxygen gas (O_2) that has dissolved into the water. This is an important test for water quality because oxygen levels reveal a great

deal about the amount of pollutants in the water. In general, higher dissolved oxygen levels indicate higher water quality.

Abnormally low concentrations of oxygen, however, suggest that there is organic waste matter present in the water. Yuck! Tiny microorganisms feed on this waste matter and consume oxygen to stay alive. So more waste translates to more food for these microorganisms. More food means more microorganisms will grow and even more oxygen will be consumed.

Chem Window --- Dissolved Oxygen

Turbidity: Turbidity is basically a measurement of how cloudy water appears. It is measured by seeing how much light passes through the water. When water has lots of suspended particles like dirt or sand in it, very little light will pass through it. We would say that it is **turbid** (cloudy), or turbidity is high. In pure water, only H_2O molecules are present and light that enters a glass of it will pass through unobstructed. When impurities are present, the large pollutant molecules will either block the light, or absorb certain frequencies of it. Thus, impure water appears cloudy.

Total Dissolved Solids (TDS) and Salinity: This test measures the amount of salts and solids dissolved in water. **Salinity** refers to the "saltiness" of the water. Remember, salts are ionic compounds consisting of an anion and a cation and tend to dissolve easily in water.

Chem Window --- Ions

Some of the dissolved substances we are concerned with are calcium, phosphorous, iron, sulfates, carbonates, nitrates, chloride salts, and other ions. Small concentrations of the these solids are normal, but excessive amounts indicate a poor water source. Here are some sample TDS values:

Parts Per Million (ppm)	Type of Water
0	Pure Water
400-500	Tap Water

<1000	Fresh Water
35,000	Sea Water

Water Hardness: Water hardness is very similar to TDS in that both involve substances dissolved in water. Water hardness, however, concentrates more specifically on two ions: Ca^{2+} and Mg^{2+}. We say water is **hard** when it has high concentrations of these ions.

If you've ever washed a car in hard water, you might have noticed that white spots show up if you don't dry the car. Can you guess why these spots form? Yep, they're the Ca^{2+} and Mg^{2+} that remain after the water has evaporated. Another familiar residue caused by hard water can be found in the shower. Ca^{2+} and Mg^{2+} react with the fatty acids of soap to form a gelatinous curd that most of us know as soap scum. Incidentally, it also takes more soap to work up a lather when you're using hard water.

Water-Borne Microorganisms: During this test, the water is analyzed for small microorganisms. Most freshwater contains at least some microscopic life, but certain microorganisms are very dangerous to us. In the previous section we saw the dangers of **cryptosporidium** and **giardia**.

Another microorganism tested for is **coliform bacteria**. All of us have this bacteria in our intestines, and we excrete it in fecal waste. While this bacteria itself isn't necessarily harmful to us, the presence of it indicates that there is human waste in the water. And when there's human waste, many other pathogens and disease causing substances are likely to be present in the water as well.

Now that the water has been treated and tested, its ready to go to your house! This is done by pumping the treated water into large pipes called **water mains**. Water mains run beneath the streets and carry water to all the pipes in the city. Pumping stations and elevated storage tanks provide the pressure to send the water to all of the faucets throughout the neighborhoods. The result is clean, refreshing water for all of our needs!