We don't think you can brew with water straight out of a lake.

BEER BASICS

WATER

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Up next in our Back to Basics series is water. You already know all about hops and barley if you have been playing along, and you might also think you know everything there is to know about water, but there is more to water than what is on the surface, especially when talking about beer.

70% OF THE SURFACE OF THE EARTH IS WATER; 61% OF YOUR BODY IS WATER, AND **100% OF YOUR BEER IS WATER**

H_2O

However you pour it, most of the volume of beer is water. Beer is made from the sugar from malted barley, embellished with aromas and flavors from hops, and fermented by yeast, but without good water to begin with it would be little more than dirty alcoholic dishwater.

Water's source plays a significant role when it comes to mineral content and impact on a beer's flavor. Certain mineral compositions benefit certain beer styles, like the soft water of Pilsen Czech Republic, home to the original Pilsner beer, or the hard water of Burton upon Trent and its fine English ales. Fortunately, we know a lot about water mineral content, and brewers can take steps to modify their water to match a desired water profile.

What's in a Well?

Traditionally, breweries were located near clean reliable water sources, and proximity to water was often the determining factor as to where a brewery was built. Pure spring water was once a brewery's most valuable asset, especially when less was known about water quality, analysis, and treatment. Today, however, due to water quality concerns as well as consistency of supply, many breweries are switching to city water. Though less romantic, city water is consistent and in good supply, and its composition is no secret. This allows the brewer to treat it as he wants.

Municipal water supplies are usually gathered from several deep wells, reservoirs, and sometimes rivers. Brewers might abandon their traditional water sources for city water for many reasons, but one of the more common is that their private water sources might not be able to provide all the water they need, especially if their brewing capacity has increased over time. This is the case with Yuengling (in Pottsville, Pennsylvania), one of the oldest family owned breweries in America.

There are a few breweries that still use more traditional water sources, though. Abbey of Notre-Dame de Saint-Rémy, for example, makers of Rochefort, draw their water from a well inside the monastery's walls. That type of brewery, however, is much scarcer than it once was.

The variety of ways water can be subtly altered is so great that some breweries install their own treatment equipment. Because water profiles can change with the seasons, water analysis and treatment are ongoing tasks. On average, homebrewers do not have to worry much about this. A rule of thumb for homebrewers is if it tastes good coming out of the tap you can brew with it. Still, some homebrewers obtain water reports about their local water and modify it as they see fit.

One reason water varies so much from place to place has to do with what happens to the "pure" water that falls from the sky once it strikes earth. If the make up of the earth where it lands is hard rock, the water will not penetrate deeply and will not absorb many minerals, thus leaving it "soft." If, however, the rocks are more permeable, such as limestone or sandstone, water will seep into them and dissolve minerals on the way to the reservoir, becoming "hard" water. The make up of the ground will determine how the water is "filtered" and what it picks up on its way to your tap.

Beer is safer than drinking the water in most countries.

Hey if you treat water does it really mater what the local water is like?

Water Treatments

When mineral or chemical content is unsatisfactory and affects the beer in an undesirable way, something must be done. This can be very complicated when talking about shifting around protons and electrons, mash pH, and the variety of treatment options. We will take a look at some of the common water treatments and try to keep it simple.

A brewer will often need to reduce the amount of bicarbonate in his "hard" water. As Wikipedia puts it, "many bicarbonates are soluble in water at standard temperature and pressure, particularly sodium bicarbonate and magnesium bicarbonate [calcium is another that is often present]; both of these substances contribute to total dissolved solids, a common parameter for assessing water quality." The most basic method to reduce bicarbonate is to boil and aerate the water. Aeration drives off the carbonic acid that is decomposed to CO2 during the boil. After the water is boiled and the sediment settles to the bottom, the water can be decanted off. There are other methods as well, such as deionization or acid treatment.

Chlorinated compounds (chlorine) are other pesky presences in municipal water supplies. Chlorine hampers yeast growth and contributes that summer-pool aroma and taste. The water can be boiled before using to drive the chlorine off, or carbon filtration such as a charcoal filter can be used for a more involved approach. Perhaps the simplest approach to reducing chlorine, though, is to add potassium metabisulfite, or in a homebrewer's term, camden tablets.

Sometimes a brewer wants to add things to his water. Certain minerals like calcium, magnesium, and zinc are helpful for healthy yeast growth and fermentation when present in proper quantities. Some water profiles are lacking in these (ex: ion-exchanged soft water), but fortunately the grains will usually be able to supply what is needed, except for zinc. Therefore, brewers might add yeast nutrients containing zinc and other yeast vitamins.

Other additions to the brew kettle may involve sodium, chloride, and sulfate. Sodium and chloride can round out the flavor of a beer and help emphasize sweetness, while sulfates may foster a crisper bitterness from the hops. If a brewer knows his water profile and the ppm (parts per million) of these minerals, he can add what he wants.

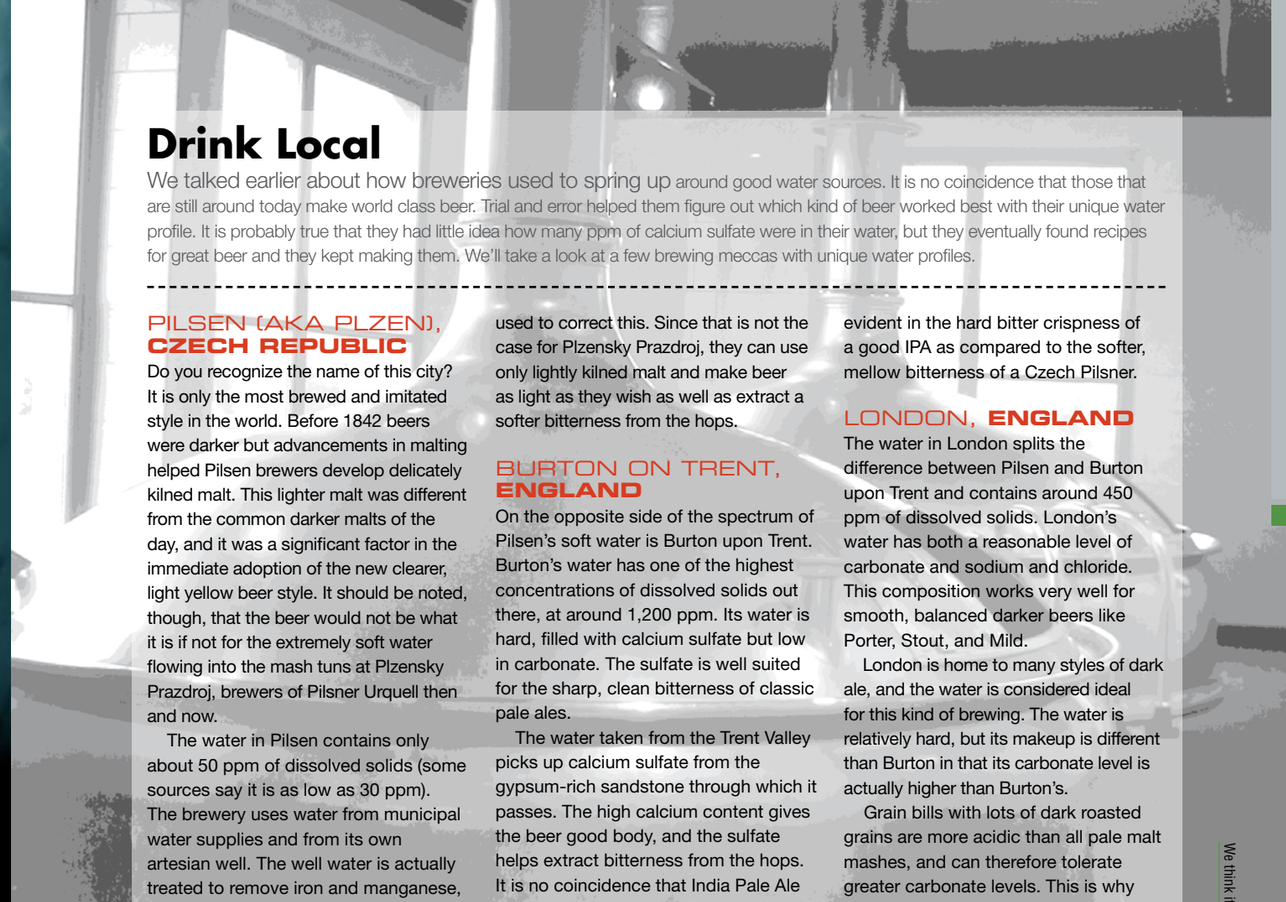
WATER, WATER, EVERYWHERE

Of course there is water in beer, but that is only half the story when it comes to the water used in the brewing process. First, brewing equipment has to be clean and sanitized. Homebrewers and commercial brewers may differ in their methods of accomplishing this, but water is always used.

Next comes the fun part, the mash. The crushed barley is mixed with heated water in the mash tun, and complex reactions between the stewing malt and water result in ion exchanges. We have talked about the effort brewers go through to get their water just right; it all comes together in the mash tun.

More water is used to sparge (rinse) the grain after the mash is complete. Sparging is how brewers extract remaining sugars in the grain. Cleaning up is the most enjoyable part of the entire brewing process, and brewers of all sorts revel in using lots of water during this joyful task. I'm kidding about the enjoyment, not the water.

Think brewers have used enough water to make beer? can you say bottles and kegs? These need to be cleaned and sanitized too. Water profiles, minerals, and ions do not come into play in cleaning and sanitizing, but water is still being employed.



Drink Local

We talked earlier about how breweries used to spring up around good water sources. It is no coincidence that those that are still around today make world class beer. Trial and error helped them figure out which kind of beer worked best with their unique water profile. It is probably true that they had little idea how many ppm of calcium sulfate were in their water, but they eventually found recipes for great beer and they kept making them. We'll take a look at a few brewing meccas with unique water profiles.

PILSEN (AKA PLZEN), CZECH REPUBLIC

Do you recognize the name of this city? It is only the most brewed and imitated style in the world. Before 1842 beers were darker but advancements in malting helped Pilsen brewers develop delicately kilned malt. This lighter malt was different from the common darker malts of the day, and it was a significant factor in the immediate adoption of the new clearer, light yellow beer style. It should be noted, though, that the beer would not be what it is if not for the extremely soft water flowing into the mash tuns at Plzensky Prazdroj, brewers of Pilsner Urquell then and now.

The water in Pilsen contains only about 50 ppm of dissolved solids (some sources say it is as low as 30 ppm). The brewery uses water from municipal water supplies and from its own artesian well. The well water is actually treated to remove iron and manganese, making it a little softer than it already is.

A soft-water profile not only yields beers with smooth hop bitterness, but also allows for lighter colored beers. Brewers often need to use darker malts to balance the pH of the mash. Waters high in carbonate (unlike Pilsner Urquell) make a mash too alkaline when only pale malts are used, and darker malts are used to correct this. Since that is not the case for Plzensky Prazdroj, they can use only lightly kilned malt and make beer as light as they wish as well as extract a softer bitterness from the hops.

BURTON ON TRENT, ENGLAND

On the opposite side of the spectrum of Pilsen's soft water is Burton upon Trent. Burton's water has one of the highest concentrations of dissolved solids out there, at around 1,200 ppm. Its water is hard, filled with calcium sulfate but low in carbonate. The sulfate is well suited for the sharp, clean bitterness of classic pale ales.

The water taken from the Trent Valley picks up calcium sulfate from the gypsum-rich sandstone through which it passes. The high calcium content gives the beer good body, and the sulfate helps extract bitterness from the hops. It is no coincidence that India Pale Ale is often associated with Burton, even if the style did not originate there (it originated in London).

A brewer can emulate this water profile by "Burtonizing" his water. This involves removing carbonate and adding sulfate by including both gypsum and Epsom salts. The difference this water profile makes is evident in the hard bitter crispness of a good IPA as compared to the softer, mellow bitterness of a Czech Pilsner.

LONDON, ENGLAND

The water in London splits the difference between Pilsen and Burton upon Trent and contains around 450 ppm of dissolved solids. London's water has both a reasonable level of carbonate and sodium and chloride. This composition works very well for smooth, balanced darker beers like Porter, Stout, and Mild.

London is home to many styles of dark ale, and the water is considered ideal for this kind of brewing. The water is relatively hard, but its makeup is different than Burton in that its carbonate level is actually higher than Burton's.

Grain bills with lots of dark roasted grains are more acidic than all pale malt mashes, and can therefore tolerate greater carbonate levels. This is why successfully brewing darker beers is often easier than brewing lighter beers; darker brews are not as finicky about water chemistry. A brew master of Fuller's once remarked that they "Burtonize" their water in London when brewing their bitters, more evidence of the difference between the two cities' water supplies.

We think it mattered more back when they used the water right out of the ground.

BREWING GREEN

There are many ways breweries can be conservative about energy use and waste production. Smart use of water is certainly a large part of that; here are some examples of what breweries are doing:

Fourex (XXXX) brewery in Australia installed a water recycling plant that helps them cut water use by 40% without affecting the taste of the beer. The recycled water does not go into the beer, but is used to clean packaging lines, lubricate the conveyor chain, and flush toilets.

New Belgium Brewing in Fort Collins, CO made a change when faced with surcharges from the city to dispose of their large volume of waste water. Instead of paying the fee, they took the money and purchased their own water treatment equipment. They began to recover biogas from processed water and use it to produce electricity. They anticipated a payback for the cost of the treatment equipment in five years, but it came in less than three.

In a more general sense breweries can simply update outdated and inefficient equipment to newer water-saving devices, such as in the bottling and kegging room where a lot of containers need to be washed and sanitized. Something as simple as newly designed spray nozzles can use less water, be more reliable than old equipment, and minimize a brewery's downtime. Smart breweries may also recover heat from final rinse water and apply it towards the next batch of water that needs heating.

Whether the equipment is modern and efficient, or clunky and old, a brewery is going to need a lot of water to make beer. The first-time homebrewer might not have a care in the world about what type of water he is using; however, most commercial brewers need to know something about water chemistry and decide if they need to treat their water. In the end it is all about how water is combined with the barley and hops, fermented by yeast, and transformed from a clear liquid into the colorful elixir we know and love.

SOURCES:

New Brewing Lager Beer—Gregory Noonan

Designing Great Beers—Ray Daniels

Beer Companion—Michael Jackson

Brewing Classic Styles—Jamil Zainasheff and John J. Palmer

How to Brew—John Palmer