pH – What is it and where can I get some?

By Mike Retzlaff

The term pH expresses the degree of acidity or alkalinity of a solution, in which "p" is the negative logarithm of "H," hydrogen concentration (pH = -log[H+]). It being expressed as a logarithm is similar in concept to the Richter scale to measure earthquakes. Each number is ten times the value of the previous number. A pH of 6 is ten times more acidic than a pH of 7. Now you can relax; that's about as technical as I'll get in this article.

pH runs on a scale of 1 to 14 with 7 being neutral. Most municipal water supplies have a pH of slightly over 7 which keeps pipes from corroding. The pH level affects enzyme function, hop extraction, and yeast vitality. It also affects the drinkability of your finished beer! We've all read or been told that we want a pH of 5.2 to 5.5 in our mash. Different enzymes which break down the components of malted and unmalted grains require different pH levels that work best with the individual enzyme. A compromise is made in brewing to give the enzymes a fighting chance to do their job. pH 5.3 is probably the best level to shoot for in this quest. This pH goal is measured at mash temperatures.

There are natural components in malt which cause the pH level to drop when the malt is mixed with water. Roasted grains are more acidic and cause the pH to drop more than paler malts. I used to check pH of the mash with litmus papers. Within the last few years, the papers I had been using became unavailable. All I can get now are the little plastic sticks with a test patch on the end. These work but reading them without proper lighting gives me fits. I bought a pH meter and my life got much easier. It is accurate and the guessing game is over. Because of my ability to check pH with certainty, I was encouraged to do something about the chemistry of my water. Fortunately there is only minor adjustment required to tune-in the water for most of what I brew. I started using John Palmer's RA worksheet. One thing he stresses is the Residual Alkalinity of brewing water.

The concept of residual alkalinity was published in 1953 by Paulas Kohlbach, who determined that calcium and magnesium in brewing water react with malt phytin to neutralize alkalinity.

Alkalinity that is not neutralized by calcium and magnesium is termed "residual" alkalinity, and this residual alkalinity will drive the pH of the mash, and subsequently the beer, upwards. As mentioned before, this changes the beer's flavor, dulling it or even causing it to be harshly bitter.

Residual alkalinity is not the balance of hardness to the alkalinity; it is the balance of alkalinity to the calcium and magnesium levels and the malts. For this reason, you need to know the individual calcium and magnesium levels in the water, not just the total hardness as $CaCO_3$. It is the residual alkalinity and the natural acidity of the malts in the grain bill that determines the mash pH. Get a water chemistry report from your water supplier.

Another thing that Palmer stresses is the Chloride/Sulfate ratio. The chloride to sulfate ratio is known to be a strong factor for the taste of the beer. A beer with a ratio of chloride to sulfate of 0.5-1 will have a maltier balance, while a beer with a chloride to sulfate ratio of 1-2 will have a drier, more bitter balance. Jefferson Parish municipal water is already in the slightly bitter range of this ratio at about 1.58. (sulfate ÷ chloride = ratio)

Adding salts is one way to build the RA and flavor profile that you want for the beer. You may want to trade-off between different calcium salts to balance the anion content. For example, if the sulfate level gets too high from adding gypsum, use some calcium chloride instead. If the alkalinity is not high enough for a dark beer, try adding a combination of sodium bicarbonate and calcium carbonate.

Here is where the sulfate to chloride ratio is useful to help choose which salts to use in adjusting the RA. It works hand in hand with pH adjustment. If you are intending to brew a hoppy beer, use sulfate salts to move the balance toward the bitter end. If you are intending to brew a malt dominated beer, then use chloride salts to move the balance toward the malty end. Alternatively, you can use a combination of chloride and sulfate salts to keep the character balanced.

For best results, in all beer styles, the mash pH should be 5.1–5.5 when measured at mash temperature, and 5.4–5.8 when measured at room temperature. (At mash temperature the pH will measure about 0.3 lower due to greater dissociation of the hydrogen ions.) Darker malts have more natural acidity, and therefore require more residual alkalinity to balance them to arrive at the optimum pH. This relationship is a general one – different malts of the same Lovibond color value can have different amounts of acidity. You can use the calculated color of a beer recipe as a guide, but don't rely on it as gospel to determine the appropriate amount of residual alkalinity; it is a general relationship, like cloud color and rain.

The pH of the wort drops with the addition of hops during the boil. The pH of the beer continues to drop during fermentation. Most finished beer should be about pH 4.6 or slightly less. Higher pH will cause the beer to taste dull or flabby. Think of it as squeezing a lemon on fish or a salad; it brightens the flavors. Many beer styles such as Wit and Stout should have a lower pH. There are a number of sour beers which normally range down to pH 3.2 because of a ferment inoculated with bacteria.

I don't recommend fiddling with water chemistry without using something like Noonan's Water Witch, Palmer's RA worksheet, or a brewing software package. The mathematics can get quite involved and guessing could easily be worse than doing nothing at all. Besides, the water of the New Orleans metro area doesn't need much help but you'll never know how good your beer can be if you don't give it a shot.

What pH is and how it works is not hard to understand. It is simply one of the indicators and tools we can use to brew better beer.

Recommend reading: (see if I'm full of poop!)

Fix, G., ***Principles of Brewing Science***

Noonan, G., ***New Brewing Lager Beer***

Palmer, J., Kaminski, C. ***Water – A Comprehensive Guide for Brewers***