Water I or And Now a Few Words From Yosemite Sam

By Greg Hackenberg
[originally appearing in *Hopline* vol. 26, Issue 7 (July 2015)**]**

> *Water*
> *Water, water, every where,*
> *Nor any drop to drink.*
> *- The Rime of the Ancient Mariner*

I'm back from Hopline Hiatus…which kind of sounds like a cartoon character, maybe one of Yosemite Sam's incarnations? Tarnation! Anyway, after teaching the unit on water in Carol Rice's Beer School I figured I could pull all my notes into something coherent, or at least fake it. So here starts a series on everyone's favorite and most pressing topic: Brewing Liquor aka water. If you like, you can imagine all this in Yosemite Sam's voice as you read.

As you probable have figured out, I was being facetious there. Not the Yosemite Sam part, the "everyone's favorite" part. Because, let's face it, while water is the most plentiful ingredient in Beer, typically 95% or so, to most it is an afterthought, if even that. To others it can be a point of obsession. You can visit any online forum for examples. But generally, if you mention it you get a lot of the following:

- It is essential to duplicate the classic water profile to get the water "correct" for the style.
- I don't do anything and my beer is just fine It's far too complicated and involves way too much calculation and chemistry.
- For soft water an addition of gypsum will improve your beer.
- Who are you and how did you get in here?

And, okay, you got me; just about any potable, decent tasting water can be used to make beer. But water is the medium and provides a portion of the chemicals necessary for most of the key reactions in the brewing process, from the mash, to the boil, during fermentation and in the finished beer. Ignore it, and you are ignoring a lot that goes into making a good beer. And you do want to make good beer, right? Well, at least drink it…

So let's take that first concept of matching a 'classic' water profile. The first thing you need to know is that they hardly are, 'classic'. There are often several profiles published for the same region all with differing amounts, most lacking any source for where this data came from. Many are probably averages from contemporary domestic drinking water sources, probably not those used by breweries either today or in the past.

And this all assumes the brewer would use the water straight from the tap. But Brewers are a clever lot, and we know they have been treating their water in multiple ways for centuries (and I'll be getting into exactly what they did in later installments). So the whole matching a water profile concept is rather dubious. And it is in this misguided effort that an awful lot of unnecessary complexity around water has been pushed over the years.

As for the second and third claims, it is true that there are far more important techniques and procedures to master. But once you have, there are a few basic steps you can take that can greatly improve your beer. If you'd like to, there are a few slightly more complicated steps that can improve it a good bit more. If you really enjoy this sort of thing or you are looking for that little extra something for competition you can go all in, but even that is not as difficult as it might sound.

The forth is a bit of past brewing advice I included as an example of some of the gross oversimplifications out there, one you will hopefully understand by the time I've wrapped this up. The long and the short of it is that a particular style of beer made with a particular water source may benefit from such an addition; however in some cases it can be disastrous.

So to start out, we are going to be looking at three roles water plays in brewing that you should pay attention to. Once you understand how these work and why, things should start to make sense. Don't worry! There'll be no math involved, chemical equations, or overly complicated concepts. There will be a few numbers, those chemical symbols with the little subscript numbers, and nothing beyond the basic concepts.

The first, and probably most important, is in determining the pH of the mash.
The second is in providing mineral for the mash and by the yeast for growth and fermentation.
The third is in the contributions to flavor and character in the finished beer.

Now there are a lot of other things affected by the chemistry of the water: extraction of tannins, protein coagulation, hop utilization, Maillard reactions, nutrient uptake by yeast, inhibition of beer spoilage organisms, clarification in kettle and fermenter, and so on. Some of these will be addressed along the way, but I'm generally going to stick to the big three.

Water II or Take Me To The River

By Greg Hackenberg
[originally appearing in *Hopline* vol. 26, Issue 8 (August 2015)**]**

"Thou ought to knowe that clere rennynge Waters that ben nyghe to cytees in pure grounde as small brokes be the best and lyghtest. Water that cometh out of stony erthe where as is moche fumosytees is hevy, contagyous, & noysom. Water of puddles or fenne full of frogges, addres, and other venymous worms be unholsom." - Secretum secretorum

In putting together the lesson on water for Beer School inevitably things need to be cut. This month's installment is going to cover some of things that could not be included or glossed over. So, for those who took the class, this could be considered a follow up, "for further reading" sort of thing. And for those that didn't, just keep on reading.

I mentioned last time that there were a few basic steps any brewer could take that could greatly improve their beer. Well, the most basic of all is simply to understand the water you are using and how it is going to interact with the beer you would like to make. It's going to take more than this one installment to do that, but this is going to get you on your way.

As I said last time, just about any potable, decent tasting water can be used to make beer. And our quote at the start generally concerns the best water to drink, but it has relevance. Potable water…you see what I did there? Working around the archaic language, it talks of three possible sources. The first is the clean flowing brooks, the best.

The second would be your “mineral water” often from some legendary source, typically renowned for some healing quality or what-not. I’ve been to a couple of these “healing” springs, and basically you’re talking about water that tastes so awful it must be good for you. Whether it is or not, water from these sources posses high concentrations of off putting minerals, not to mention being terribly hard (more on that to come).

The third is good old swamp water. Fens are swamps, like Fenway Park in Boston which is nothing but a fetid morass built on the swampy bits off Boston Bay…okay, I digress, but I grew up a Yankee’s fan…Bucky Dent and all that. While you could, given the boiling, make beer from it, surface water of this sort is typically very soft (again, more on that). Stick with the “best and lightest”.

So what sort of water do we have ‘round these parts? Is it the best and the lightest? Well, if you’re talking Orleans and Jefferson…it aint bad, despite rumors to the contrary. Yes, the “we live along the nation’s sewer…” and all that. And despite the bottles water craze, which more often than not is just filtered domestic tap water, even here we have pretty much the safest water in recorded human history. But what about beer?

I’ll spare you the “how to read a water report” crap, because without seventeen phone calls and a few transfers to get to a hydrologist, what you would get from your water company is a laundry list of chemical names showing a whole lot of stuff federal regulation deem important for water to be deemed potable, that as brewers we could care less about. Potable water…remember? What I mean by not bad, is that for brewing purpose, good old Mississippi river water falls in at the mid range of the spectrum for beer, meaning, it’s going to work reasonably well for nearly all beers, and there are no fundamental flaws with it that might have any detrimental effects on most beers. Hooray!

By “all beers” the range I’m talking about is generally the SRM. And this is the first definition I am going to throw out. That’s **Standard Reference Method-SRM**, which is a measure of beer color. Anyone perusing BJCP style definitions have run across this, and most recipes and beer software will include it. Charts abound, but here are some highlights via BJCP: 2-3 is straw, 3-4 gold, 5-6 gold, 6-9 Amber, 10-1 amber/copper, 14-17 copper, 17-18 copper/light brown, 19-22 brown, 22-30 dark brown, 30- 35 black, 35+ “It's like, how much more black could this be? And the answer is none. None more black.” – Nigel Tufnel . I actually met Harry Shirer aka Nigel Tufnel, Mr. Burns, Smithers, et al…total, pompous, ass. Yeah, I know, now I’m starting to sound like Harold, but I digress…

So where are we? So Roughly 9-15 SRM is the ideal range for our water. Roughly because the water profile will vary as much as the river stages do, so we do see some significant oscillation throughout the year. The long and the short is, we’re pretty fortunate with a middle of the road water that allows us to make most beer without too much trouble. Not everywhere can say the same…Houston…But we can go a lot better with a few tweeks.

I mentioned a few simple steps you can take, right? The one I’m going to start with, and this month’s lesson is to **run your water through a carbon filter**. Club equipment includes one, with good reason. While chlorine will boil out, and our levels are not as high as some places, a simple carbon filter will get it out of the way from the get go. And it will remove any particulates and even some undesirable odors (read: summer river water, when the river stage is low). There a numerous options. I’ve got the basic cartridge type that will hook up to a standard hose which ran around $30. The basic level carbon filters are cheap and since you are not running a household water supply through them, will last a long, long time.

Next, hoses. There are varicose web sites warning of the supreme dangers of drinking from a garden hose. It is true trace chemicals will leach into the water, but to do so you generally need to leave a hose full of water out in the sun a few day. I'm guessing you might have tasted such water in your lifetime and said "blech!" or something along those lines. So long and short is to do what you did then and just flush out the water that's been sitting around in the hose. Once you do the water should be just fine. If you have any concerns, you can pick up a Boat/RV/camper water hose with an FDA approval for drinking water.

Next up…what is next up? Mash pH. I know you're waiting with baited breath.

Water III – Chemicals In Our Beer And Other Conspiracies

By Greg Hackenberg

[originally appearing in *Hopline* vol. 26, Issue 11 (November 2015)**]**

"Not all chemicals are bad. Without chemicals such as hydrogen and oxygen, for example, there would be no way to make water, a vital ingredient in beer." - Dave Barry

I know it's been a while, but I'm back and I know if you've been playing along at home, you should be ready for the next installment where we were going to delve into the eternal mysteries of mash pH. "Ready", of course, could mean ready to skip this part altogether, but I hope you'll bare with me and see that it's not so complicated. Really, this part is simply about understanding what's going on in the mash you've got going. We'll work into what you can do about it later…remember, local water is going to work reasonably well for nearly all beers, but "reasonably" is a bit subjective. Anyway…

In our first installment, I described the three major roles water plays in brewing. The first and most important was in determining the pH of the mash. Before we begin I have to point out that our good friend and hopline contributor Mike Retzlaff, covered this topic in his article "pH - What is it and where can I get some?" and is available on the CCH website. It covers a lot of the same ground, but in a different way. I'll be going at it in a bit more round-a-bout way.

Now, to begin, we have to get a few terms straight. Tops on the list is **pH**, which is a numeric scale used to specify the acidity or **alkalinity** of a solution. It measures activity of Hydrogen ions, which you really don't need to know. What you do need to know is that it goes from 1-14, the low end being **acidic**, 7 being **neutral** and the high end alkaline or **basic**. It is a logarithmic scale so each numeric increase represents a 10 fold increase. But that's that math stuff, don't worry about that.

A tad bit confusing in this is that **alkalinity** in water actually expresses the ability of a substance to resist a change in pH. To keep things simple and to make Chemists and other science types cringe, from here out this ability to resist a change will be called the **Buffering Capacity**, a **Buffer** is something in the water that provides that ability, and alkalinity will refer solely to refer to things pushing us to the higher end of the pH scale. This will help it all make sense, at least I hope it will.

On to mash pH. When we mash we are employing a number of enzyme functions to convert starches to sugars. As you know, temperature plays a huge roll in the outcome. But pH, while not quite as important, plays a pretty big role, too. But unlike temperature you are pretty much aiming for one target. That is a pH between 5.2 and 5.6 at mash temperature. As long as the pH remains in the ballpark, the mash functions will proceed without issue. However, if the pH falls too far outside this range, there can be a significant impact on the quality of the beer.

A pH of 6 or higher (more basic) can increase the extraction of tannins, produce harsh hop bitterness and produces beers with malt character often described as "dull". Further, low PH carried into the kettle can reduce hop utilization.

A pH of 5 or lower (less alkaline) can impair beta amylase functions, impairing conversion, and produces beers with malt character often described as "grainy" and one-dimensional. <snark on> Yum! <snark off>

So what about water determines the mash pH? Well, there are three of those buffers I mentioned at play that shake out to give us the mash pH.

As counterintuitive as it might appear, the pH of the water is of little importance. It is the buffering **capacity** of the water that is the critical factor that serves as the first of those three. The **buffering** capacity is determined by the carbonate content of the water. This is expressed in water reports as **Bicarbonate** (HCO3) or as **calcium carbonate** (CaCO3). They measure the same thing, just in different ways. The greater the amount, the greater the buffering capacity, and is it is an **alkaline** buffer. So the more you have the higher your final mash pH is going to be.

Our second buffer is the available calcium and magnesium, the "hardness" of the water. You probably have heard of water described as "hard" or "soft". This is a crude term for the Calcium and Magnesium content of water, which actually refers to how easy or how "**hard**" it is to produce soap lather; "**soft**" water having low mineral content and "hard" having high content. On its own it has no effect on the pH.

But it’s not on its own, at least not in your mash, we have the grain. The grain provides phosphates which reacts with the hardness and through several resulting reactions serve to **acidify** the mash, thus lowering the pH of the mash. Water with low hardness will produce a weaker buffer and higher hardness a stronger buffer. It is the interaction of the two buffers that determines what we call the **Residual Alkalinity**. Now our third buffer comes into play, and we can begin to see how certain water leads to certain beer styles.

There’s more to gain than just reacting to the hardness. Our third buffer is found when we add darker malts to the mash, your toasted and roasted ones, especially. These malts, due to Maillard reactions in the kilning and roasting processes, provide an additional acidic buffer which serve to lower the residual alkalinity and lower the mash pH, hopefully into our 5.2 to 5.6 range.

Now this is the money part here: beer made where Residual Alkalinity is high, the addition of darker malts or an acid would be necessary to keep the mash pH in the desired range. Lower Residual Alkalinity would favor lighter beers without the darker malts. This is largely what we see when we examine historic beer cities, the water and the styles of beer that arose there. Here are a few examples:

Pilsen: Extremely low hardness and low alkalinity allows optimal mash pH to be reached with only lightly kilned base malt. Pilsners

Munich: With only moderate hardness, but higher bicarbonate levels, additions of darker Munich and other malts are required. Oktoberfest and Dunkel

Dublin: Moderate hardness with extremely high bicarbonate levels, the resulting alkalinity requires the addition of significant amounts of highly roasted grains. Stout

Burton-on-Trent: Extremely high hardness and extremely high bicarbonate levels serve to largely cancel each other out allowing pale beers. Pale Ale

Orleans/Jefferson: With fairly low hardness, and moderate bicarbonate levels, addition of some darker malts is required. Amber or Brown ale

Houston: Extremely low hardness and extremely high bicarbonate levels, even the darkest stouts will be difficult to brew without significant water treatment. Failure

That's it folks. It really comes down to the interplay of those three elements…that's it, really. If you stick to the 9-15 SRM range, you've got nothing to concern yourself with…well, maybe a few things, but that's the more advanced stuff. So next up, "Thank God I don't live in Houston, but I don't want to make a Brown Ale, what can I do?"

WATER Part 4
According to Greg Hackenberg Water IV
[originally appearing in *Hopline* vol. 27, Issue 10 (October 2016)**]**

"Whiskey and Beer are a man's worst enemies... but the man that runs away from his enemies is a coward!" - Zeca Pagodinho, Brazilian Songwriter

So it's been awhile…yeah like nearly a year a while…since I managed to get the next part of my epic water series up. To quote a dear and dearly departed friend "I been busy! Alright!" So, when last I left you the question on your mind was along the lines of… "thank God I don't live in Houston, but I want to make something other than brown ales, what can I do?" If you are having trouble recalling, what the deal with brown beer and Houston is, you may want to go back to the Hopline articles and review part 3. It covers the basic reactions that determine the mash pH and why our local tap water works best for beer in the color range of 9-15 SRM, aka brown beers, and why Houston water doesn't work for much of anything.

So what can you do? Well, as I've said from the beginning "just about any potable, decent tasting water can be used to make beer". With our water if you go lighter or darker, you should be too far amount out of optimal pH range, and probably not enough to have a really significant effect.* So for most of you just relax, don't worry, etc. But…yes a 'but'…you can make your beer a good bit better with a few simple tweaks. What kind of tweaks? Nothing too difficult…really. And, yes, I like ellipses…so sue me.

Let's get this out of the way right now; brewers have been modifying their water for centuries. This is not some fancy new technique, nor are these techniques rocket science. In other words, a few simple water modification and your beer will be better. And we have a couple of options when it comes to those modifications. In this installment I'll run through the simplest.

Changing
The first and most basic is changing your water source to one that works for the beer you want to make. There are a number of potential sources. Kentwood, Abita and Ozarka are all available locally and have extremely low hardness and bicarbonate content, great for light colored beer. Reverse Osmosis RO is another option. The low-to-no mineral content can be a problem, you'll need to add somethings back and I'll have more on that next time. But they are also a good for our second option…

Dilution
The next is simply adding a portion of distilled, RO, Kentwood, Abita and Ozarka or water of very low mineral content to lower the alkalinity and hardness. Minerals can be added back in if necessary.

Acid additions
Acids in the form of Lactic or Citric can be added to the mash to correct the pH. This is what Club has been doing at Brewoffs for lighter beers. Care must be taken in adding acid, as you can have very sudden and significant shift in the pH once the buffers are overcome. Add it in small amounts. There are online calculators the will figure the amount out based on the water, grain, etc. But local tap will vary over the year with river stages and whatnot. But then, the club has a pH meter, and, again, I'll have more on those later.

Boiling
A bit of work, but here's how it works. Munich, water is wonderfully suited to brew Oktoberfest and Dunkels. But the city is also known for one of the lightest beer style out there, Munich Helles (and if you can get your hands on a good fresh sample…wow!). This is where the aforementioned temporary hardness and permanent hardness come into play. There is enough calcium in the Munich water to bind with the bicarbonate during the boil to remove the alkalinity to the point where wonderful light lagers can be brewed. Process is simple: boil 15 minutes, sit for a half hour, and then decanting the water off the precipitate.

How does all this play out locality for lighter beers:
Changing: Kentwood has a range of 5-10 SRM, Ozaraka is 6-11 SRM.
Dilution: A 50-50 dilution of Tap and Ozarka/RO give us 8-13 SRM.
Boiling: Orleans/Jefferson Parish water 9-15 SRM, boiled drops to 7-11 SRM.

Well, that give us a bit more latitude for lighter beers…But (always with the buts?) what if I want to go darker?

Staged Additions
For those Stouts and Porters, I'd recommend something know as Staged Grain Additions. Now this IS a newfangled idea, one I first heard about in a podcast with Randy Mosher, homebrew god and author of Radical Brewing, etc. and all around expert. As you may recall from extract brewing days, roasted grain and crystal malt do not need to be mashed. A good steep is all they require to impart the roasty goodness. So, get them ground separately and hold back enough from the mash to hit the 9-15 SRM and just add the rest to the sparge.

Brewing software can help a lot on this, but there is always the old back-of-the-envelope calculation method:
Malt Color Unit = (Weight of grain in lbs.) * (Color of grain in degrees lovibond) / (volume in gallons).

Do this for each of your grains and add them together or subtract as needed and bingo! Next up adding things to your water…

If you go way back to part one, I gave the three roles that water and water chemistry plays in your beer. The first is in determining the pH of the mash. We've got the gist of that. The second is in providing mineral for the mash and by the yeast for growth and fermentation. And the third is in the contributions to flavor and character in the finished beer. I'll cover the pH related part of mineral additions along with the other two next time.

*Brew in a bag BIAB brewers take note, the large amount of water and its requisite mineral content can wreak havoc on your pH in lighter beers. You should actually do okay on darker beers. But you will want to either dilute or make acid additions to keep the pH down.