# Basic Brewing Water

There is a lot of information published regarding brewing water for beer. Much of it is very complicated because, as simple as it seems, water chemistry is very complicated. But brewing water can be distilled down to a few basic ideas that will help most brewers get the most out of their water.

The two most common things a brewer should be aware of is hardness and alkalinity. Sometimes people will use these terms inter-changeably without realizing they are very different from each other.

**Hardness** is the amount of dissolved calcium and magnesium in the water. These elements can be removed with a water softener to produce "soft" water. Calcium and magnesium can be added to water with common brewing salts.

Calcium and to a lesser degree, magnesium, will interact with the phosphorus found in the malt to produce hydrogen ions. The increased amount of hydrogen ions will lower the overall pH of the mash. This interaction does have its limits and increasing the hardness of the water will not necessarily decrease the pH of the mash. This interaction can be hinder by alkalinity or buffering capacity of the mash.

**Alkalinity** is the ability to resist pH changes that lead to acidity. It's also known as buffering capacity and can be measured with titration. By adding acid slowly and measuring the pH, the water or substance will hold a relatively stable pH until enough acid is added that overcomes the buffering capacity. At that point the pH drops rapidly. The amount of acid added is used to measure the alkalinity.

We don't use the titration method to measure alkalinity, but its important to understand that once the buffering capacity exceeded, smaller amounts of acid are needed to drop the pH than had initially been needed to move the pH lower.

The main source of alkalinity in water is due to mostly bicarbonates, along with hydroxides and carbonates. Ground water usually has some (or a lot) of these minerals dissolved into solution over many years in the earth and it's not always easy to add back alkalinity after it's been removed by distilling or reverse osmosis (RO). For this reason, brewers will often blend an alkaline water with RO water to adjust the overall alkalinity. Water softeners do not remove alkalinity. The most common way to remove alkalinity is with distillation or reverse osmosis.

It should also be noted that if alkalinity is difficult to add to water, then raising the pH of the mash is also becomes difficult. Its better to have a higher pH in the mash and then lower it with an acid such as phosphoric or lactic acid. Should you need to raise the pH of the mash. The best options for raising pH in the mash or wort are sodium bicarbonate (baking soda) or calcium hydroxide (pickling lime). The

downside to baking soda is the sodium it adds to beer, the downside to pickling lime is its not easily dissolved into solution, especially at higher temperatures.

Brewers will often turn to calcium carbonate (chalk) to add alkalinity, but it will not effectively dissolve into solution without the presence of co2 and should be considered useless for this task.

## Types of Water Salts

**Chalk** (CaCo3- calcium carbonate) This salt should be considered mostly useless. It's nearly impossible for homebrewers to get it to dissolve without specialized equipment. It needs to be in the presence of cO2 to dissolve into solution.

**Pickling Lime** (Ca (OH)2- calcium hydroxide) This salt will add alkalinity in the form of hydroxide, it will also be a source of calcium. It has a limited solubility in water and the solubility will decrease with temperature (retrograde solubility). This can be purchased from any grocery store that carries canning supplies. This salt has limited solubility, solubility decreases with temperature increase.

**Baking Soda** (NaHCO3 – sodium bicarbonate) Baking soda can be used in limited quantities to raise the pH of the mash/wort/beer. It adds bicarbonate and increases the buffering capacity of water. The downside is that it adds sodium. Darker beers can benefit from sodium, it can help support malt flavors and can also "round out" the malt character or accentuate the malt. Sodium is not very beneficial to lighter beers or hoppy beers and may causes a muted crispiness to the finish. Luckily, it's mostly dark beers that need a pH boast. Sodium levels should not exceed 75-100ppm overall. Above 100ppm, it can add a saline flavor. Readily dissolves into solution regardless of temperature.

**Table Salt** (NaCl – sodium chloride) Flavor enhancer, used mostly for darker beers. Adds sodium as well as chlorides. Sodium levels should not exceed 100ppm as mentioned above. The chloride should be considered for the sulfate to chloride ratio. Salt can dull a hoppy beer's finish, and this also applies to lighter lagers and ales.

**Calcium Chloride** (CaCl2) Adds hardness in the form of calcium. It also adds chloride. Calcium levels are generally between 60-120ppm for yeast health in most beers. Calcium will have the effect of lowering mash pH by reacting to the phosphates in the malt. Chloride is thought to increase the malt character of beer. This salt dissolves readily into solution regardless of temperature.

**Gypsum** (CaSO4 – calcium sulfate) Add hardness in the form of calcium. Calcium will have the effect of lowering mash pH by reacting to the phosphates in the malt. Also adds sulfates which is thought to enhance bitterness and crispness to the finish. This salt has limited solubility, solubility decreases with temperature increase.

**Epsom Salt** (MgSO4 – magnesium sulfate) Adds magnesium which is beneficial to yeast health and growth. Magnesium has a limited effect on lowering mash pH. Adds sulfate without adding to the hardness of the water.

# Water Solubility of Brewing Salts

| Name | Symbol | Chemical Name | grams per liter |
|---|---|---|---|
| chalk | CaCo3 | calcium carbonate | .013 @ 25C |
| pickling lime | Ca (OH)2 | calcium hydroxide | 1.73 @ 20C* |
| calcium chloride | CaCl2 | calcium chloride | 740 @ 20C |
| table salt | NaCl | sodium chloride | 360 @ 25C |
| baking soda | NaHCO3 | sodium bicarbonate | 165 @20C |
| gypsum | CaSO4 | calcium sulfate | 2.6 @25C* |
| epsom salt | MgSO4 | magnesium sulfate | 351 @ 20C |
| lye, caustic soda | NaOH | sodium hydroxide | 1000 @ 25C |

*Retrograde solubility (solubility decreases as temperature increases)