Water Chemistry

Or how to overcomplicate brewing – Greg Berner



Overview

- Water Composition
- Reading a water report
- Brewing Salts
- Mash pH and benefits
- Balancing Minerals
- Online resources



Water Composition

- Calcium (Ca^{2+}) → 50 – 150ppm (up to 250ppm)
- Magnesium(Mg^{2+}) → 0 – 30ppm (up to 50ppm)
- Sodium (Na^{+}) → 0 – 150ppm (up to 200ppm)
- Chloride (Cl^{-}) → 0 – 250ppm (up to 300ppm)
- Sulfate (SO_4^{2-}) → 50-150ppm or 150-350 (up to 750ppm)
- pH and Alklanity (HCO_3^{-}) → 0-50ppm pale, 50-150ppm amber beers, 150-400ppm for dark beers



Reading a water report

Parameter	Testing Result Annual Average (mg/L)	Saskatchewan Environment Water Quality Objective (mg/L)
Sodium (Na)	54.8	<200 (AO)
Sulphate (SO4)	175	<500 (AO)
Total Dissolved Solids (TDS)	432	1500
Manganese (Mn)	<DL	0.05 (AO)
Nitrate (NO3)	0.35	45
Potassium (K)	6.4	No Standard
Hardness (CaCO3)	220	800
Iron (Fe)	<DL	0.3 (IMAC)
Magnesium (Mg)	25.6	200
Calcium (Ca)	44.8	No Standard
Chloride (Cl)	20.6	<250 (AO)
Fluoride (F)	0.11	1.5
Alkalinity (total)	140	500

- Regina Water Report from Feb 2019 (link here)
- Values highlighted are the relevant ones
- mg/L = ppm
- pH is not found on the report
  - I measured it in my lab at 7.08



Brewing Salts

- Calcium Carbonate ($CaCO_3$) aka “Chalk”
  - This has limited solubility in water, it must be added to the mash instead.
  - Raises the pH of the mash
  - Used for adding alkalinity to soft water for dark beer.

- Calcium Sulfate ($CaSO_4 \bullet 2H_2O$) aka “Gypsum”
  - Source of calcium and sulfate ions. Sulfates add to the “bite/crispness” for hop bitterness
  - Lowers the pH of the mash
  - Good way to add calcium if the water is low in sulfates



Brewing Salts

- Calcium Chloride ($CaCl_2 \cdot 2H_2O$)
  - Useful for adding calcium when the water is low in chlorides
  - Lowers the pH
- Magnesium Sulfate ($MgSO_4 \cdot 7H_2O$) aka “Epsom salt”
  - Source of magnesium and sulfate ions. Sulfates add to the “bite/crispness” for hop bitterness
  - Slightly lowers the pH of the mash
  - Use sparingly as the limit for Mg^{2+} is quite low at 50ppm.



Brewing Salts

- Sodium Bicarbonate ($NaHCO_3$)
  - Raises the pH and alkalinity
- Potassium Metabisulfite ($K_2S_2O_5$) aka “Campden Tablets”
  - Eliminated chloroamines from water
  - Chloroamines can be a source of phenolic off flavours



Mash pH and benefits

- pH is a measure of how acidic or basic something is
  - $\mathrm{pH} = -\log[H_3O^+]$
- Ideal range is 5.2-5.6 for your mash
  - Improved enzyme activity in your mash thus more starch to sugar conversion
  - Improved yeast health in wort
  - Inhibition of bacterial growth
  - Better hops extraction during boils
  - Improved clarity
  - Higher storage stability for aging beer
- This can be adjusted with either acids (lactic or phosphoric) or acidulated malt



Balancing Minerals

- 2:1 SO_4^{2+} to Cl^- is good for bitter beer
- 1:2 SO_4^{2+} to Cl^- for mild ales
- 1:3 SO_4^{2+} to Cl^- for stouts and porters
- Chloride and Sodium add the maltiness of a beer.
- Sulfate highlights bitterness and reduces malt flavour.
- 0-50ppm HCO_3^- for pale beers
- 50-150ppm HCO_3^- for amber beers
- 150-400ppm HCO_3^- for dark beers



Online Resources

- Bru'n Water (https://sites.google.com/site/brunwater/)

- Brewer's Friend (https://www.brewersfriend.com/mash-chemistry-and-brewing-water-calculator/)