WATER, pH & MINERALS

Dukes of Ale
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☐Water is the principal ingredient of beer > 90%.

☐Water is a dilute solution of various salts, gases and organic compounds.

☐Water has a huge influence on the quality of the finished product.

☐Water warrants appropriate treatment to produce consistent, quality beer.

☐Water directly used in brewing is properly called "liquor".

☐**Water sources**:

Ground water
lakes, rivers
subject to major variations in quality and composition- climatic, contamination from effluent, agriculture, urban runoff

Surface water
Obtained from boreholes and is usually of more consistent quality.
Historically collected at natural springs for brewing.

All fresh water is derived from rain or snow which percolates through the upper layers of soil and accumulates various salts and small quantities of gases and organic compounds.

Water permeated through rock like limestone & chalk and will have a high content of dissolved solids, high alkalinity and high total hardness. -> NM !!!

Water permeated through rock like granite will be low in dissolved solids, low in alkalinity, and low in total hardness. -> not NM

dissolved cations (+ charged ions) : calcium, magnesium, sodium, potassium, traces of iron and manganese.

dissolved anions (- charged ions) : bicarbonate, sulfate, chloride, nitrate

☐**Water types**

Hard water -> NM !!!
contains calcium and magnesium salts in solution
limestone or chalk –> bicarbonates (high alkalinity), most common water ->NM
sandstone -> sulfates, less common
Hard water has a fuller flavor and considered to be more palatable and beneficial to consume
Soft water -> not NM, except through water softeners
Low mineral content, usually sodium and potassium salts in the form of bicarbonates, sulfates, chlorides, fluorides and nitrates
The taste of soft water tends to be slightly soapy

☐**Water treatment for bacterial inhibition**

Chlorine / chloroamine -> medicinal taste if not removed
Removal by boiling -> removes only chlorine not chloroamines
Remove by carbon filtration -> run water very slowly, removes most >90%
Potassium metabisulfite 100mg / 5 gallons, Campden tablets one per 20 gallons
-note this will increase the sulfate level in the water, do not use in excess!!!-

☐**Sources for water quality information**

City of Albuquerque Public Works Department
Ward Labs - private

☐**Major mineral players in water**

Flavor ions
pH ions

☐**Flavor ions in water**

Sulfate
Sodium
Chloride

☐**pH ions in water**

Calcium
Magnesium
Bicarbonate

☐**Flavor ions in water**

Sulfate (anion -)
combines with calcium -> calcium sulfate -> permanent hardness
combines with magnesium -> magnesium sulfate -> permanent hardness
accentuates hop bitterness -> “crisp”, “dry”
50ppm – low hop
75ppm – moderate hop
175ppm – hoppy
>400 – astringent
>750 – diarrhea

Sodium (cation +)
Enhances the malt sweetness when balanced with sulfate
“rounds out beer flavors”
75ppm – malty / sweet
50ppm – moderate malt/hop balance
30ppm – hoppy
High level of sodium with high levels of sulfate gives harsh bitterness

Chloride (anion -)
Accentuates the flavor and fullness of beer
100ppm – low hoppy
75ppm – moderate hoppy
50ppm – hoppy

☐pH is a measure of the acidity or basicity of a solution; pH1 - pH14

Measures concentration of hydrogen ions; pH1 many H+ ions, pH 14 less H+ ions
pure water has a pH 7
acid
- lemon juice
- carbonated beverages
- vinegar
- orange juice

alkaline
- ammonia
- bleach
- lye

☐In brewing beer, pH is determined by a combination of water hardness, water alkalinity, and the buffering of the malts - especially dark malt acidity.

☐**pH ions**

Calcium (cation +)
Big dog (cation) on the front porch
Principal ion that determines water hardness
Combines with bicarbonates -> calcium bicarbonate -> temporary hardness
Most important ion for yeast, enzymatic reactions, protein reactions
Gives clarity and stability to beer
50 – 150 ppm

Magnesium (cation +)
Similar to calcium but less potent
Contributes to water hardness
Important yeast nutrient
10 – 30 ppm
> 50 ppm sour / bitter taste
> 125 ppm strong laxative

Bicarbonates (anion -)
Biggest dog (anion) on the front porch
Carbonate – CO_3^{-2} highly alkaline and minor component, (ignore this one)
Bicarbonate – HCO_3^{-1} – very alkaline and major component, important!!!!!!
Raises the mash ph
Neutralizes dark malt acidity
0 – 50 ppm for light SRM beer – maybe, about
50 – 150 ppm for medium SRM beer – maybe, about
150 – 250 ppm for dark SRM beer – maybe, about
Water must be treated to achieve proper mash / wort pH
Proper mash / wort pH is the goal!!! pH 5.2 – pH 5.7 for the mash
- Aeration & boiling the decant off the precipitate, -> temporary hardness
- Acid rest – enzymatic degradation of phytin to phytic acid at 86˚- 128˚
- Acid addition – lactic or phosphoric acid or other acids
- Bicarbonate precipitation with calcium hydroxide, -> temp/perm hardness

☐**Famous Brewing Waters**

Mineral	Calcium	Magnesium	Sodium	Sulfate	Bicarbonate	Chlorine
Pllsen	7	2	2	5	15	5
Dortmund	225	40	60	120	180	60
Munich	75	18	2	10	150	2
Vienna	200	60	8	125	120	12
Burton	275	40	25	450	260	35
Dublin	120	5	12	55	125	20
Edinburgh	120	25	55	140	225	65
London	90	5	15	40	125	20

☐London, Dublin, Munich
Moderately high bicarbonate
Porter, Stouts, Bocks -> balances acidic dark & roast malt

☐Burton
High bicarbonate
High sulfate
English Bitters, Pale Ales, India Pale Ales

☐Pilsen
Low everything!!!
How are enzymatic reactions going to take place? -> decoction mash, acid rest

☐**Water adjustments -> 2 + 2 ≠ 4 with water ion additions!!!**
Calcium Chloride ($CaCl_2$) -> most important in NM!!!
Calcium Sulfate – "Gypsum" – ($CaSO_4$) -> a touch for hoppy beers in NM
Calcium Carbonate -> ($CaCO_3$) - never need to use this in NM

Magnesium Sulfate – "Epsom Salts" – ($MgSO_4$) – no thanks, not really in NM

Sodium Chloride – "table salt" – (NaCl) – a touch for malty, sweet beers
Use non-iodized table salt
Iodized table salt has a minute amount of potassium iodide, sodium iodide or iodate. It is used to prevent and remedy iodine deficiency.

Burton Water Salts
Mixture of calcium sulfate (gypsum), magnesium sulfate (Epson salts), potassium chloride. Suppose to mimic Burton water. I don't recommend this product.

Lactic Acid
Phosphoric Acid
Buffer 5.2
1ppm = 1 mg/L