

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 – CO₃⁻² highly alkaline and minor component, (ignore this one)

Bicarbonate – HCO₃⁻¹ – 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
Pilsen	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 (CaCl₂) -> most important in NM!!!

Calcium Sulfate – “Gypsum” – (CaSO₄) -> a touch for hoppy beers in NM

Calcium Carbonate -> (CaCO₃) - never need to use this in NM

Magnesium Sulfate – “Epsom Salts” – (MgSO₄) – 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