Intro to Brewing Water 2.7

Make great beer by adjusting your brewing water

GTA Brews – January 2025 (9th annual)

Topics Covered

- Does Water Chemistry Matter?
- Tools Needed
- Removing Chlorine
- Intro to Brewing Minerals
- Water Sources
- Intro to Mash pH
- Residual Alkalinity
- My Approach
- Examples

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Does Water Chemistry Matter?

- Yes, but only to take good beer to great
- Master these things first to make good beer:
  - Fermentation and yeast health
  - Packaging and sanitation
- Beer is ~95% water
- Water composition influences flavour expression and certain yeast behaviour
- Brulosophy water XBMTs have been significant

Does Water Chemistry Matter?

- “Water Chemistry” is a vague term
- Refers to combination of:
  - Mineral concentration adjustment (Water Profile)
  - Mash pH adjustment

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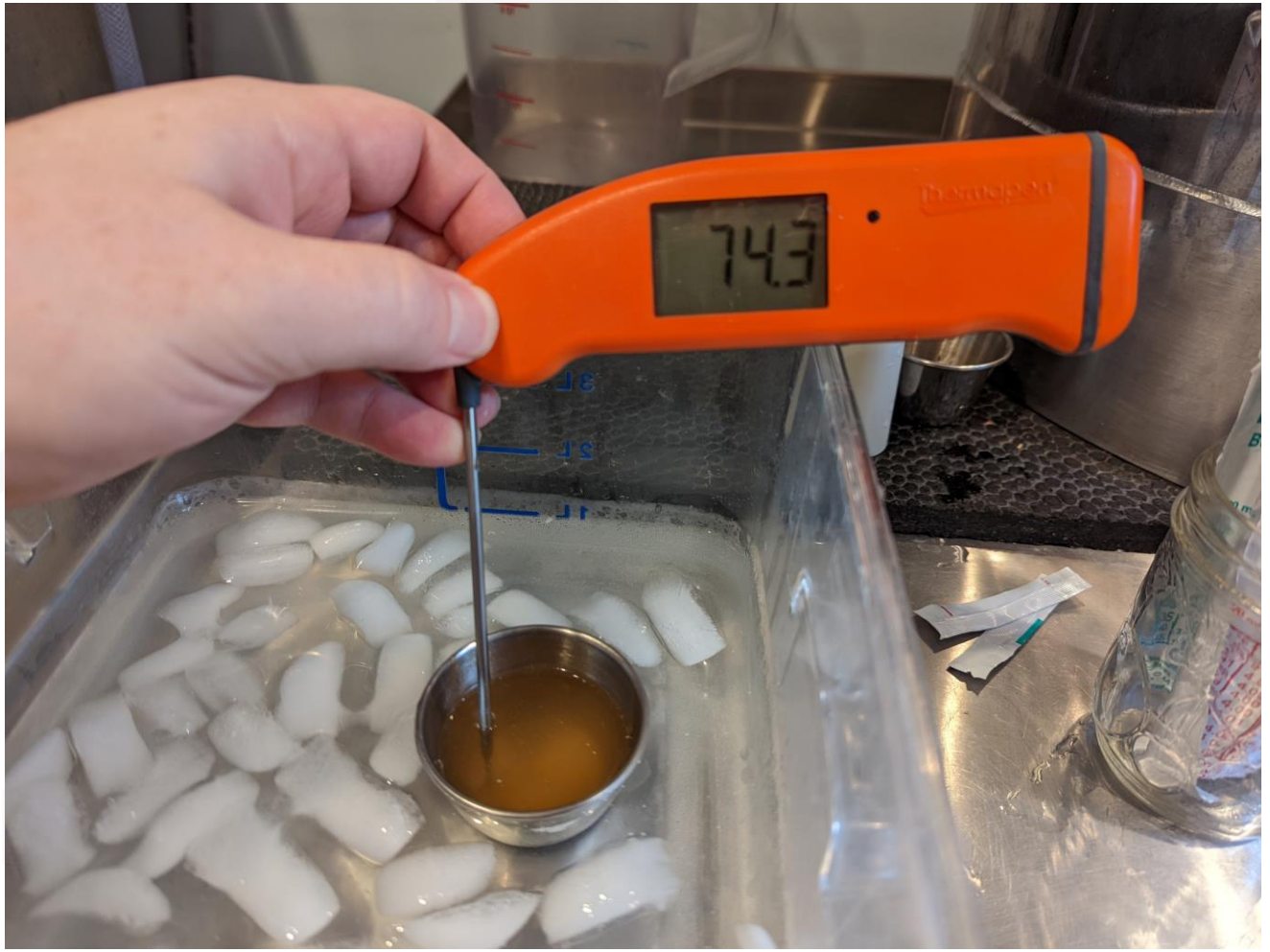
Tools Needed - pH Meter

- General Specs:
  - Reliable brand with available & affordable probes
  - 0.05 pH accuracy (or better), 0.01 pH resolution
- Recommended:
  - Milwaukee pH56 ($125 **-> $173 to $187** ☹ CAD, 0.05 pH accuracy)
    - Mi56p probe ($69 CAD on milwaukeeinstruments-ca.com)
  - Milwaukee MW102 ($165 -> **$221 to $286** ☹ CAD, 0.02 pH accuracy)
    - SE220 probe ($105 CAD on milwaukeeinstruments-ca.com)
  - **Note:** Removed Thermoworks 8689
- Calibrate every brew day!
  - Milwaukee packets are handy for this
    - Tip: Buy in boxes of 25 sachets

Tools Needed



Tools Needed

- Campden Tablets
- Accurate scale with 0.01 g resolution
  - Recommended: Amazon 500g/0.01g Pocket Scale (or similar)
- Salts and acid
  - Lactic acid 88%
  - Gypsum ($CaSO_4$) & Calcium Chloride (CaCl)
- Glass pipette and pipette pump (10 mL) (E.g. Glass, Pump)
  - Or a 10 mL plastic syringe
- Metal cup
  - Used to cool pH samples to room temp
- DO NOT USE: 5.2 Stabilizer or pH strips

Removing Chlorine

- Chlorine/Chloramine is added by the city to disinfect tap water
  - Remove from brewing water to avoid off-flavours
- These compounds react with yeast-derived phenols to form Chlorophenols
  - Flavour: medicinal, bleach, antiseptic mouthwash
- Method 1: Campden tablet addition
  - Comes in both Sodium and Potassium versions
  - 1 tablet treats up to 20 gal water (adds 9 ppm SO4)

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Removing Chlorine

- Method 2: Activated carbon filtration
  - Also removes other solids like pesticides
  - Palmer recommends a flow of rate of 0.125 L/min to remove Chloramine
    - 2.7 hrs to filter 20L!
- Eric's Recommendation for Homebrewers:
  - Use Method 1: potassium campden tablets
    - Simpler than watching filter flow rate
  - Add 1 tablet into strike water
    - No need to split between strike and sparge water
    - Round up to the nearest tablet

Intro to Brewing Minerals

- Common brewing minerals
  - Cations (+): Calcium (Ca), Magnesium (Mg), and Sodium (Na)
  - Anions (-): Bicarbonate (HCO_3), Sulfate (SO_4), and Chloride (Cl)
- Calcium (Ca) affects “everything”
  - Promotes flocculation of yeast and protein
  - Lowers mash pH (minor)
  - Limits extraction of tannins (astringency)
  - Usually Calcium (Ca) is added as one/both of:
    - Gypsum (CaSO4)
    - Calcium Chloride (CaCl)

Intro to Brewing Minerals

- Sulfate (SO_4) affects perception of bitterness
  - Helps give the beer a drier and crisper impression
  - Doesn't make a beer hoppier, but may enhance perception of hop bitterness
- Chloride (Cl) affects perception of sweetness and body
  - CaCl can pick up moisture causing you to add less
    - Tip: Consider drying in the oven to make it Anhydrous again
  - Bru'n Water recommends solution of known concentration
  - Doesn't make a beer maltier, but enhances malt perception

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Intro to Brewing Minerals

- Choose ratio (SO_4:Cl) for desired result
  - “Seasoning level” matters
  - Experiment to find your preference
- Bicarbonate (HCO_3) helps determine alkalinity
  - Acts as a buffer working against acid additions
  - Can be good to balance against acidic malt
- Magnesium (Mg) and Sodium (Na)
  - Usually you don’t aim to adjust these
  - Track them to make sure they are in range

Intro to Brewing Minerals

- Calcium (Ca) 50-150 ppm
  - Less than this is okay for lagers
- Sulfate (SO_4) 50-400 ppm
  - More than this becomes harsh and astringent
- Chloride (Cl) 50-200+ ppm
  - Mostly <50 ppm, especially with high sulfate
  - Note: NEIPA can go above 200 ppm to even 300 or 400 ppm
- Bicarbonate (HCO_3) <50 ppm
  - May need acid or acidic malt to achieve this

Water Sources

- Toronto Tap Water - gtabrews.ca/toronto-water-profile
  - Calcium (Ca) - 34 ppm
    - Note that this is <50 ppm
  - Chloride (Cl) - 25 ppm
  - Sulfate (SO_4) - 27 ppm
  - Total Alkalinity – 90.6 ppm
    - Converts to ~111 Bicarbonate (HCO_3) (multiply Alkalinity by 1.22)
  - Magnesium (Mg) - 9 ppm
  - Sodium (Na) - 15 ppm
- Toronto Water Treatment Plants:
  - East: R.C. Harris WTP (FHA)
  - West: R.L. Clark WTP (FCL)

Edit Water Profile

Profile Name

Toronto Tap Water

Type	Water	pH
Source		7.5

Cations 2.95 mEq/L — ion balance -1%

Calcium Ca^{2+} ppm	Magnesium Mg^{2+} ppm	Sodium Na^{+} ppm
32.8	8.5	14

Anions 3.11 mEq/L

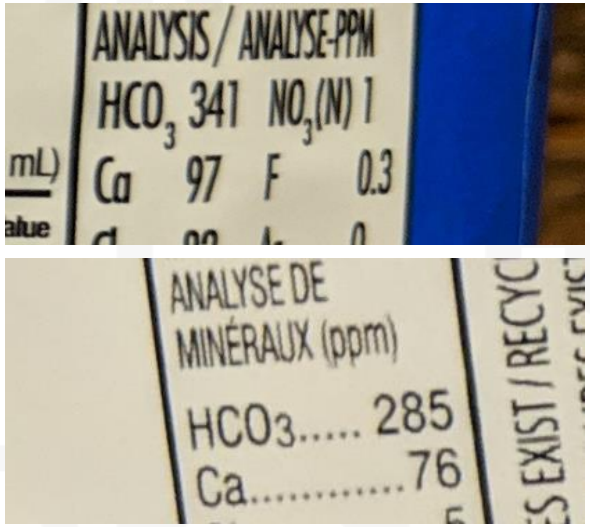
Chloride Cl^{-} ppm	Sulfate SO_4^{2-} ppm	Bicarbonate HCO_3^{-} ppm
27.3	24.7	111.4

Stats

SO_4^{2-}/Cl^{-} ratio	Hardness	Alkalinity	Residual Alkalinity
0.9	117	91	63

Water Sources

- Bottled Water
  - Don’t use bottled “spring” water in Ontario
  - Most is very high in alkalinity (HCO_3)



- Softened Water
  - Uses salt (NaCl or KCl) to remove hardness (Ca & Mg)
  - Adds significant amounts of Sodium or Potassium
  - Do not use softened water for brewing
    - Buy RO water instead

Intro to Mash pH

- Briefly, pH is:
  - Concentration of H+ ions using exponential scale
  - Less is acidic, more is basic (aka. alkaline)
  - 7.0 pH is middle of the range
- Tap water is usually around 6.8 - 7.8 pH
  - Drops when you add grain, salts, or acid
- Mash pH should be 5.2 – ~5.6 pH
- Beer pH is usually 4.0 – 4.4 pH

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Intro to Mash pH

- With mash pH in range:
  - Hop bitterness is more pleasant and doesn't linger
  - Improved break formation
  - Enzymatic activity in the mash is increased
  - Beer is crisper, fresher, and shows more character
- Always measured at room temp (~20°C)
  - pH reads 0.2 - 0.35 pH lower at mash temp
  - ATC compensates for probe, not mash chemistry
- Read this Braukaiser.com post for more detail

Intro to Mash pH

- Balancing act between
  - Alkaline: water
  - Acidic: malts, added salts, and acid additions
- Highly alkaline water needs acid additions (usually lactic acid)
- Thinner mash usually means higher pH (more water present)
- Calcium has a limited effect on mash pH
- Roast and crystal malts are more acidic than base malts

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Residual Alkalinity

- Most water chemistry info describes Residual Alkalinity
  - Describing it here for completeness only, feel free to ignore
- Reminder:
  - Hardness (Ca, Mg) lowers mash pH
  - Alkalinity (HCO_3) raises mash pH
- Residual Alkalinity (RA ppm as $CaCO_3$) is the combined effect
  - $RA = Alkalinity - (\frac{Hardness_{Ca}}{3.5} + \frac{Hardness_{Mg}}{7})$
- RA of 0 ppm is “balanced” (Mash pH = Distilled Water Mash pH)
  - Positive RA is higher than DI mash pH
  - Negative RA is lower than DI mash pH

Residual Alkalinity

- Change in mash pH per unit of RA varies by mash thickness and grain
- 0.1 pH change per RA change
  - 25 ppm at 4 qt/lbs
  - 50 ppm at 2 qt/lbs
  - 100 ppm at 1 qt/lbs
- Remember thicker mash means more grain/water

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My Approach

- Pick your software
  - Brewfather, Bru'n Water, Brewer's Friend, Beersmith, etc…
  - I currently use Brewfather
- Decide on a mineral profile
  - More than 50 ppm Calcium
  - Start balanced for most beers (SO_4:Cl ~ 1.3)
  - High sulfate for crisp/bitter beers (SO_4:Cl > 2)
  - More chloride for sweet/full beers (SO_4:Cl < 0.5)

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My Approach

- Start off with preset profiles (Eg. Yellow Dry)
  - Use colour and flavour balance
- Avoid historical brewing city water profiles
  - Most breweries treated their water
- Add enough acid to hit desired mash pH (calculated)
- Can avoid adding alkalinity in dark beers by mashing thinner
- If you need to add alkalinity:
  - Use Baking Soda ($NaHCO_3$) over Chalk ($CaCO_3$)
    - Tip: Chalk doesn't dissolve consistently
  - Pickling Lime ($Ca(OH)_3$) is banned in Canada

My Approach

- Use lactic acid instead of acid malt
  - Phosphoric is also commonly used
    - Evidence exists that phosphoric can inhibit brett fermentation
- Mash pH Target: Aim for 5.2 pH (calculated), settle for 5.4 pH (measured)
  - Some prefer to aim darker beer at 5.4 - 5.6 pH
- Adjust after measuring actual mash pH
  - Model doesn't account for differences between grains with same colour
  - Usually this means adding more acid
- Pick a consistent time in the mash to measure pH
  - ~10 mins for me

My Approach

- Rule of Thumb, if you miss your mash pH target:
  - Add 1 - 1.5 mL of 88% lactic acid per 0.1 pH point above desired mash pH
  - Assumes: 5 gal batch using Toronto tap water
- Example Mash pH Adjustment:
  - Expected 5.20 pH, Measured 5.45 pH
  - Add ~3 mL of lactic acid
  - Re-measured 5.26 pH
- Record this to include in your recipe next time

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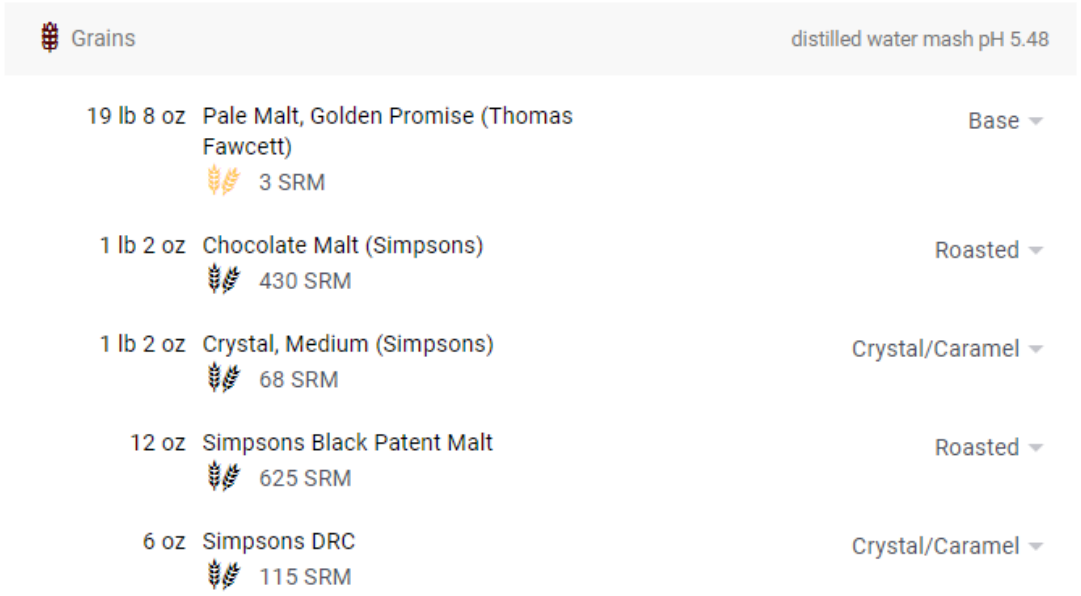
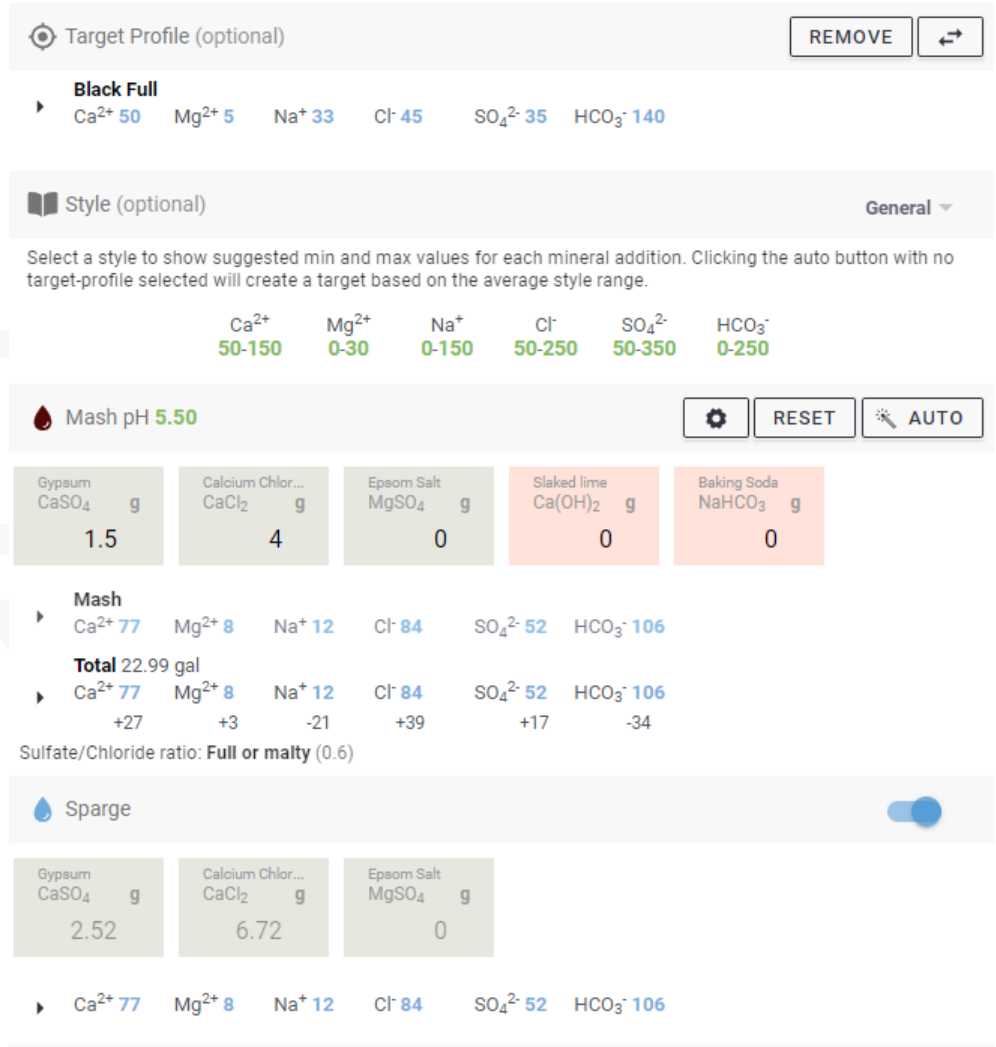
Example 1. American Porter (10 gal, Sparged)

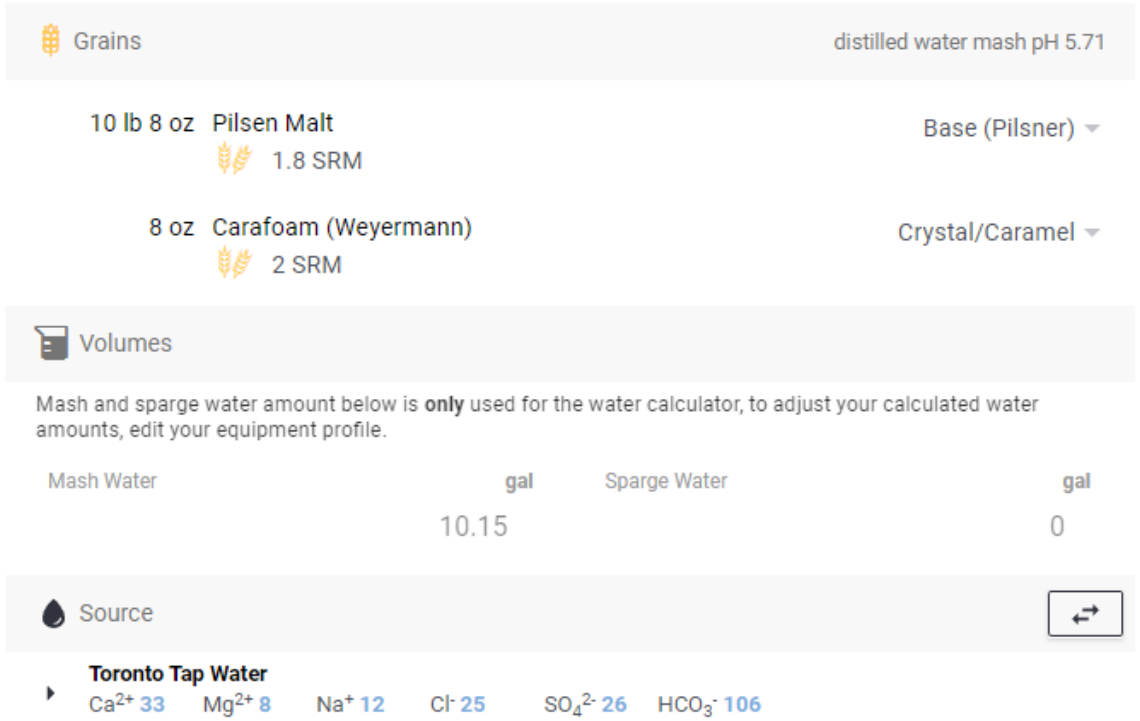
- Using Black Full profile, with significant bicarbonate and moderate Ca/Cl/SO_4
- No acid added since expecting lower than calculated mash pH
- Measured mash pH = 5.29 pH

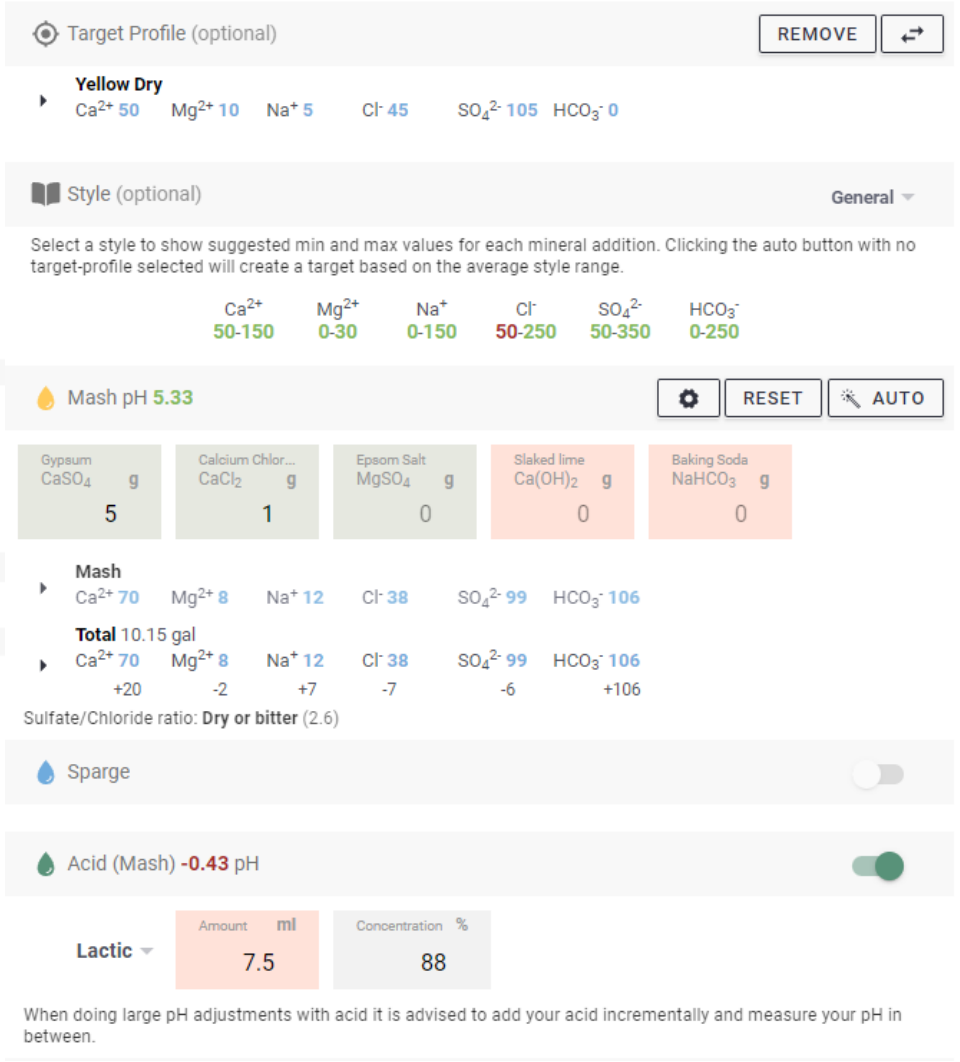




Example 2. Munich Helles (5 gal, No Sparge)

- Low seasoning, sulfate forward (SO4:Cl = 1.5)
- Measured mash pH = 5.28 pH





Example 3. Hazy IPA

- Recipe:
  - 10 lbs 2 Row (2L), 2 lbs Flaked Oats (1L), 2 lbs Wheat Malt (2L)
  - No Sparge, 10.35 gal strike
- Water Goal:
  - Chloride forward, high seasoning (~150/75)
  - SO_4:Cl = 0.5

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Example 3. Hazy IPA

- Additions:
  - $CaSO_4$ 3.6 g (strike), CaCl 7.8 g (strike)
  - lactic 5.2 mL (strike)
- Result:
  - Ca = 129 ppm, SO4 = 78 ppm, Cl = 152 ppm
  - Estimated mash pH = 5.20 pH
  - Measured mash pH = 5.44 pH
- Added 2 mL lactic to get 5.26 pH

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Questions?

- Further Reading
  - GTA Brews Toronto Water Report Page
  - Bru'n Water – Water Knowledge
  - Water Book – By John Palmer and Colin Kaminski
  - Braukaiser - Mash pH Control
  - Scrappy Hound Brewing – Brewing Water
  - Toronto Water Reports
  - Milk the Funk pH Meter Page
  - Removing Chloramines From Water – A.J. deLange