

Real Examples of Water Adjustment

NorCal/SoCal Joint Meeting 2014

Paso Robles



John Palmer
Palmer Brewing Solutions, Inc.

Key Concepts – A Review

- Know Your Source Water.
- Beer and Brewing is Food and Cooking.
- Water minerals are your seasoning.
- Residual Alkalinity is the Cornerstone of Mash pH.
- The Mash pH is the Equilibrium between the Water Chemistry and the Malt Chemistry.
- The Mash pH sets up the Beer pH.
- Beer pH drives the beer flavors.

Source Water

- Surface Water is typically low in minerals and high in organics.
 - Surface water generally needs more chlorination than ground water.
- Ground Water is typically low in organics but higher in minerals.
 - Ground water is typically higher in alkalinity than hardness.
- Many cities change their water source during the year.

Water Affects Beer Flavor

- Seasoning Balance: Sulfate to Chloride Ratio
 - More Sulfate = drier, more assertive hops
 - More Chloride = rounder, fuller, sweeter malt
- Amount of Seasoning
- Water Residual Alkalinity drives Mash pH,
Mash pH drives Beer pH,
Beer pH drives beer flavor expression.

Sulfate to Chloride Ratio

- The Ratio can affect the balance of the beer
 - Dryness vs. Fullness
- It is not magic – 40:10 \neq 400:100
- Useful range is 9:1 to 0.5:1
 - Maximum suggested sulfate is 500 ppm
 - Maximum suggested chloride is 200 ppm
 - Recommend not to exceed 100 ppm chloride for high ratios.
 - Recommend to not exceed combined sum of 500 ppm.

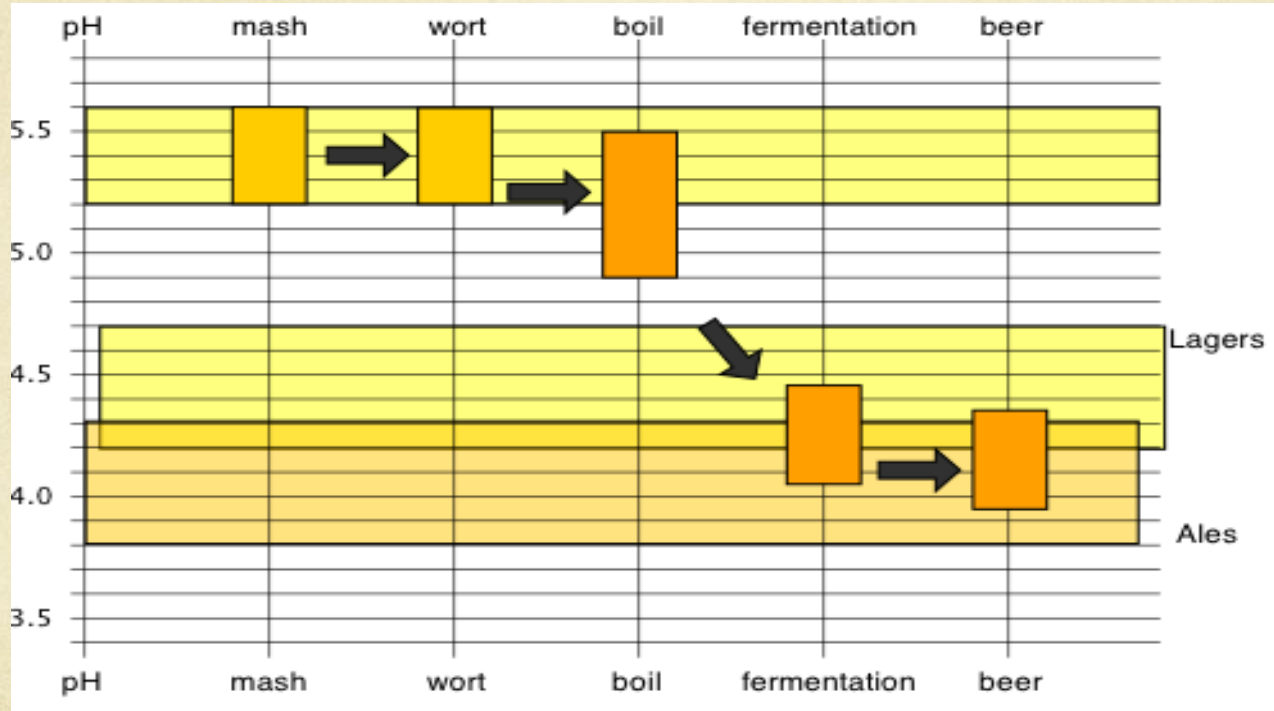
TDS Effect – Total Dissolved Solids

- Light vs Heavy Seasoning
- Bohemian Pilsner
 - Rich, malty beer backed by large soft bitterness. Smooth finish balanced between malt and hops. No sharp edges.
- German Pils
 - Crisp and bitter hop forward character, followed by clean malt and dry finish. This is a beer defined by clean edges.
- Dortmunder Export
 - Balanced rich malt and firm dry bitterness. A “castle” of beer structure.

Why Do We Care About Mash pH?

- “The key point for control of pH throughout the brewing process is during mashing. This is due to the major influence that can be exerted at this stage on the content and format of the buffer systems that will operate subsequently in the wort and beer.”
- Taylor, D.G., The Importance of pH Control during Brewing, *MBAA Tech. Quart.* 27:131-136, 1990.

Mash pH Sets Up Beer pH



5.2-5.6

3.8-4.7
Style/recipe
dependent

What Does Beer pH Do?

- The beer pH affects how the beer flavors are perceived by the palate.
- Spaghetti Sauce Example
 - pH is too acidic: It's bright but not rich, one dimensional.
 - pH is too basic: It's rich but dull, boring.
 - pH just right: Bright, Rich, Complex flavors.
- Beer Flavor is the same:
 - pH is too high, malt character is dull, bitterness is heavy.
 - pH is too low, malt flavor is sharp, but one dimensional, hop character is reduced.

Mash pH is the Equilibrium between Water Chemistry and Malt Chemistry

- The affect of water chemistry can be quantified by Kolbach's Residual Alkalinity.
- The affect of malt chemistry can be quantified by
 - The distilled water mash pH of the malt (ie., Congress Mash pH)
 - The titrated acidity of the malt for the pH range in question.
 - The buffering capacity of malt ($\Delta\text{mEq}/\text{kg}/\Delta\text{pH}$) is not linear.

Cranker's Brewery, Big Rapids, MI

- Brew the same pale ale recipe with 2 different waters:
 - Big Rapids Water (High Residual Alkalinity)
 - Water designed for Pale Ale (Low Residual Alk)
- Serve the beers to BJCP Master Judges to experience the difference.
- Would they prefer the Low RA pale ale over the High RA pale ale?

Big Rapids Water

Parameter	Big Rapids	Pale Ale Suggestion
Calcium	40	50-150
Magnesium	19	0-30
Total Alkalinity	180	40-120
Sulfate	10	100-400
Chloride	10	0-100
Sodium	15	<100
Residual Alkalinity	140	(-30) - 30

The Water Adjustment Plan

- The Water was adjusted with Gypsum to raise the calcium and sulfate levels
 - 15 grams per 10 gallons
- The water was acidified with lactic acid to reduce the total alkalinity and the residual alkalinity
 - 7 milliliters of 88% Solution per 10 gallons
- This treatment was done to all brewing water in the hot liquor tank.

Adjusted Pale Ale Water

Parameter	Adjusted	Pale Ale Suggestion
Calcium	130	50-150
Magnesium	19	0-30
Total Alkalinity	70	40-120
Sulfate	230	100-400
Chloride	10	0-100
Sodium	15	<100
Residual Alkalinity	-35	(-30) - 30

Big Rapids vs Adjusted

Parameter	Big Rapids	Adjusted
OG	1.048	1.048
FG	1.011	1.011
IBU	40	40
Mash pH	5.5	5.25
Beer pH	4.6	4.5

Judges Evaluation of Pale Ale

Triangle Test of 3 Beers were presented to 5 Master judges.

Judge	Big Rapids	Adjusted	Adjusted
Dave	41	38	36
Jeff	37	41	38
Don	32	36	41
Bob	38	36	41
Phil	44	36	37

Judges Scores for Pale Ale

Category	A	B	C (B)
Aroma	8.6	8.6	9.2
Appearance	3	3	3
Flavor	15.2	14.4	14.8
Mouthfeel	4.2	4	3.6
Overall	7.4	7.4	7.6
Total	38.4	37.4	38.6

Comments for Beer A

- I really like the grainy malt character...lower bitterness than B or C.
- This was the best of the bunch for me...medium dry finish has a nice blend of resin and malt.
- Needs more hop presence all around for style. Needs to be (more) dry and crisp.
- Malt (slightly dominates)...more late hop additions will bring balance to the beer
- Needs more attenuation...could use more malt backbone.

Comments for Beer B

- ...there is a touch of harshness that hurts the dry finish...bitterness adjustment would help.
- Beer is IPA-like in bitterness.
- Hops dominate more like IPA than APA. Finish a bit sweet but balanced. Bit minerally in finish.
- Beer is very quaffable. Hops balance malt.
- Hop expression is muted and finish is a bit sweet for style.

Comments for Beer C

- Moderate hop bitterness balances but finish is fleeting.
- Balance favors bitter, but just slightly. High end of style.
- Finishes with lingering bitterness that clears quickly.
- ...just enough malt to keep it from being a hop bomb.
Finish is a bit chalky.
- Bitterness is medium and balances the very attenuated malt well. No flaws (off-flavors)

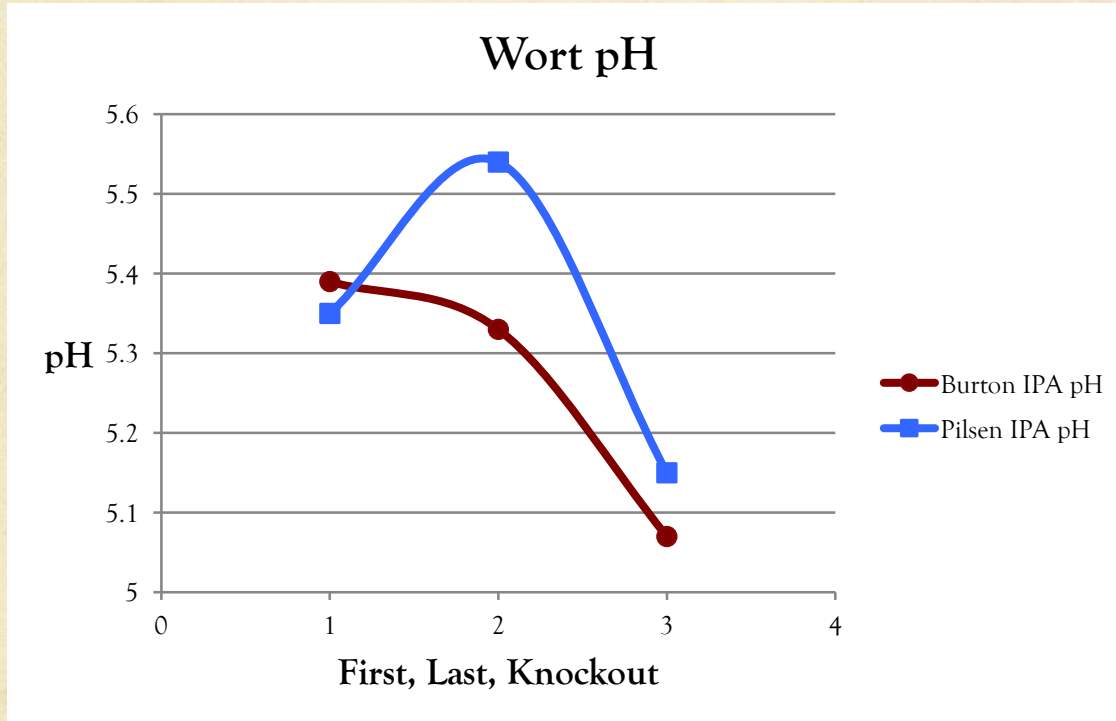
Judging Summary

- No statistical difference between beers in terms of adherence to style.
- However, people have their own preferences, and the judges were split over which version they scored highest.
- What does this mean to you?
 - You can taste the difference between these two beers.
 - Adjust the water and brew the beer YOU like.

Ballast Point Pilot Batches

- Two pilot batches of single hop variety Azacca IPA were made:
 - Burtonized Water built from RO
120 Ca, 22 Mg, 0 Total Alk, 272 SO₄, 76 Cl, 0 Na, **-99 RA**
 - “Pilsen” IPA water (using CaCl₂, MgSO₄)
54 Ca, 9 Mg, 0 Total Alk, 34 SO₄, 96 Cl, 0 Na, **-44 RA**

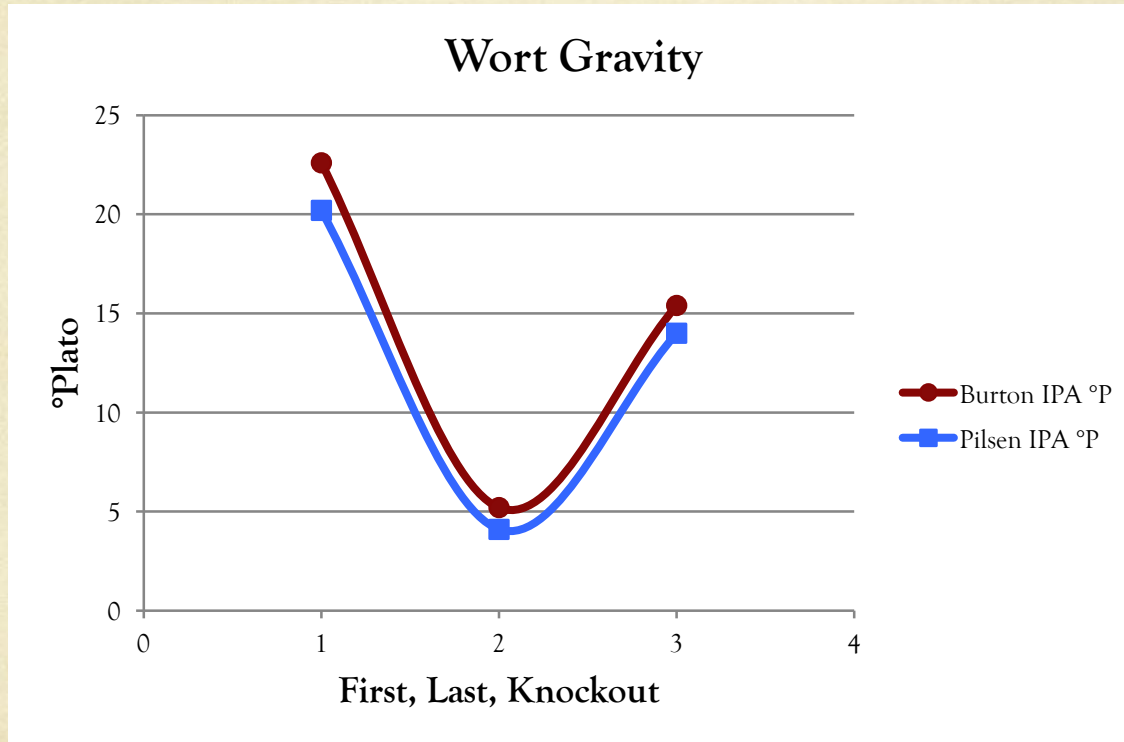
Wort pH vs Time



- Burton
120 Ca
-99 RA
- Pilsen
54 Ca
-44 RA

- Significant pH rise during lautering for Pilsen water.

Wort Gravity vs Time



- Burton
120 Ca
-99 RA
- Pilsen
54 Ca
-44 RA

24

○ 82% Efficiency vs. 74% Efficiency

Summary of Trends

- Limited Data - Take with a grain of salt.
- Water Adjustment can make significant differences in the flavor of the same recipe.
- Water Adjustment can affect yield of the same recipe.

Questions?