

# **Brewing Water Effects on Beer Flavor**

**NHC 2014 – Big Rapids, MI  
John Palmer & Adam Mills**

# Serve the First Beer...

- TASTE this beer, you will need to compare it to a second one later.
- Assess the level of bitterness.
- Assess the malt character
- Assess the balance
- Assess the drinkability.
- How would you rate this beer overall?

# Palmer's Water Pale Recipe

- 85% Pale Ale Malt
- 10% Munich
- 5% Crisp Crystal 60L
- OG 1.048
- 40 IBUs
- 20 IBU - First Wort Citra
- 20 IBU – Flame Out Citra, Centennial, Cascade.
- 3 oz per 5 gallon Dry Hop (2 Citra, 1 Cent.)

# Key Concepts – A Review

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

# How 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.**

# 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.**

# 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. (Tastes Minerally)

# TDS Effect – Total Dissolved Minerals

## ○ 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.



# Alkalinity and Hardness

- Alkalinity (carbonates) acts to raise mash pH and beer pH
- Hardness (calcium and magnesium) acts to lower mash and beer pH by reacting with malt phosphates.
- Residual Alkalinity is the combined effect of alkalinity and hardness on mash pH.
- The mash pH sets up the beer pH.

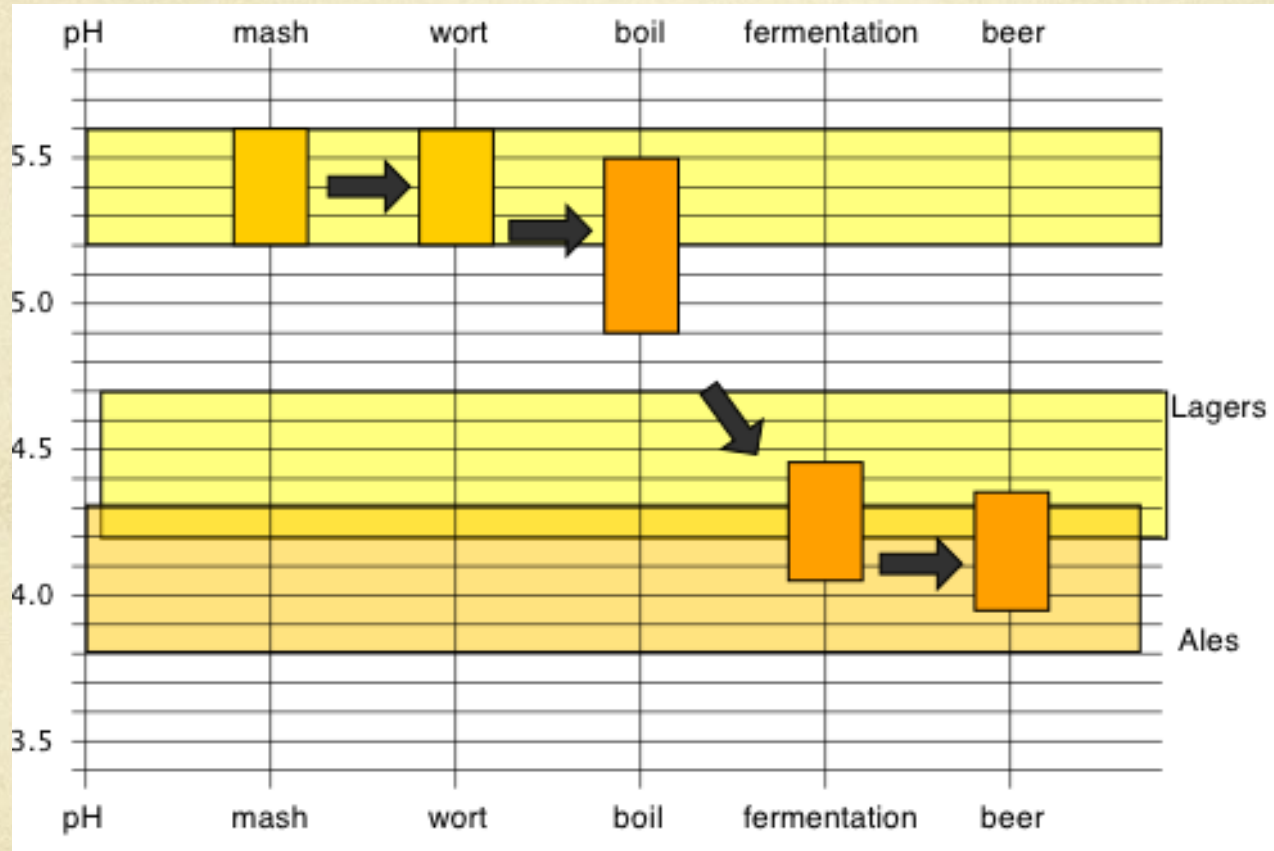
# The Mash pH Sets Up the Beer pH

- “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.

# Beer pH

- Every beer recipe has an ideal pH, where its flavors are best expressed.
  - Spaghetti sauce example
- That *particular* pH depends on the style and recipe, *i.e., water profile and grainbill.*
  - You want to be able to taste all of your ingredients.
- The brewer's art is finding that particular pH, and maintaining it, batch to batch, season to season.
- Achieving that particular pH starts with the water chemistry, and mash pH.

# Mash pH Sets Up Beer pH



5.2-5.6

3.8-4.7  
Style/recipe  
dependent

# The EXPERIMENT...

- 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 at the presentation for the audience to experience the difference.

# Serve the Second Beer

- **TASTE** this beer, and compare it to the first.
- **Assess the level of bitterness.**
- **Assess the malt character**
- **Assess the balance**
- **Assess the drinkability.**
- **How would you rate this beer overall?**

# 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

# Water Adjustment

- 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

# A vs. B

Parameter	Pale Ale A	Pale Ale B
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

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

Judge	A	B	C (B)
Dave	41	38	36
Jeff	37	41	38
Don	32	36	41
Bob	38	36	41
Phil	44	36	37

# Judges Evaluation

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 balance. 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 (B?)

- 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.
  - Which do you like better? (show of hands)
  - Adjust the water and brew the beer **YOU** like.



# Thanks To:

- Adam Mills and Andy Gallagher for doing all the brewing and packaging!
- Judges
  - Dave Houseman
  - Jeff Washeleski
  - Don Blake
  - Bob Hill
  - Phil Farrell