

The Effect of Late Kettle Additions and Dry Hopping on IBUs

By Santiago Gomez



www.apoteksolutions.com

About Apotek Solutions

- Apotek Solutions is based in Plymouth with 20+ years experience in liquid egg processing:
 - Heat Exchangers
 - Pasteurization Systems
 - Pneumatic Conveyors
 - CIP Systems



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IBU

- 1955 Rigby and Bathune published their research on isomerized alpha acid isomerization as the hop compound responsible for beer bitterness.
- 1968 Brewing organizations agreed on a test method to measure beer bitterness (IBU) = ASBC 23a
- IBU and Conversion Rate Calculation formulas by Tinseth, Rager, Garetz, etc. use a primary utilization factor based on boil time.

Conversion Rate



DIPA:

- OG: 1070 (17.1°P)
- Projected Saturation: 93.9 IBU

Batch	Addition	Calculated AA to IBU	Actual AA to IBU	% Saturation
Control	0 min EoB	1%	39.1%	41.6%

Conversion Rate



DIPA:

- OG: 1080 (19.3°P)
- Projected Saturation: 106.7 IBU

Batch	Addition	Calculated AA to IBU	Actual AA to IBU	% Saturation
Control	20 min EoB	17%	32.9%	30.8%

Conversion Rate



Session IPA:

- OG: 1042 (10.5°P)
- Projected Saturation: 45.9 IBU

Batch	Addition	Calculated AA to IBU	Actual AA to IBU	% Saturation
Control	20 min EoB	17%	41.2%	56.7%
ApoWave	20 min EoB	17%	57.0%	73.0%

Conversion Rate



Session IPA:

- OG: 1042 (10.5°P)
- Projected Saturation: 45.9 IBU
- 12bbl batch

Aroma hops were added at end of boil:

- 6.6lb of Skyrocket
- 4.4lb Amarillo

Batch	Addition	IBU
Control	0 min EoB	190
ApoWave	0 min EoB	192

Conversion Rate

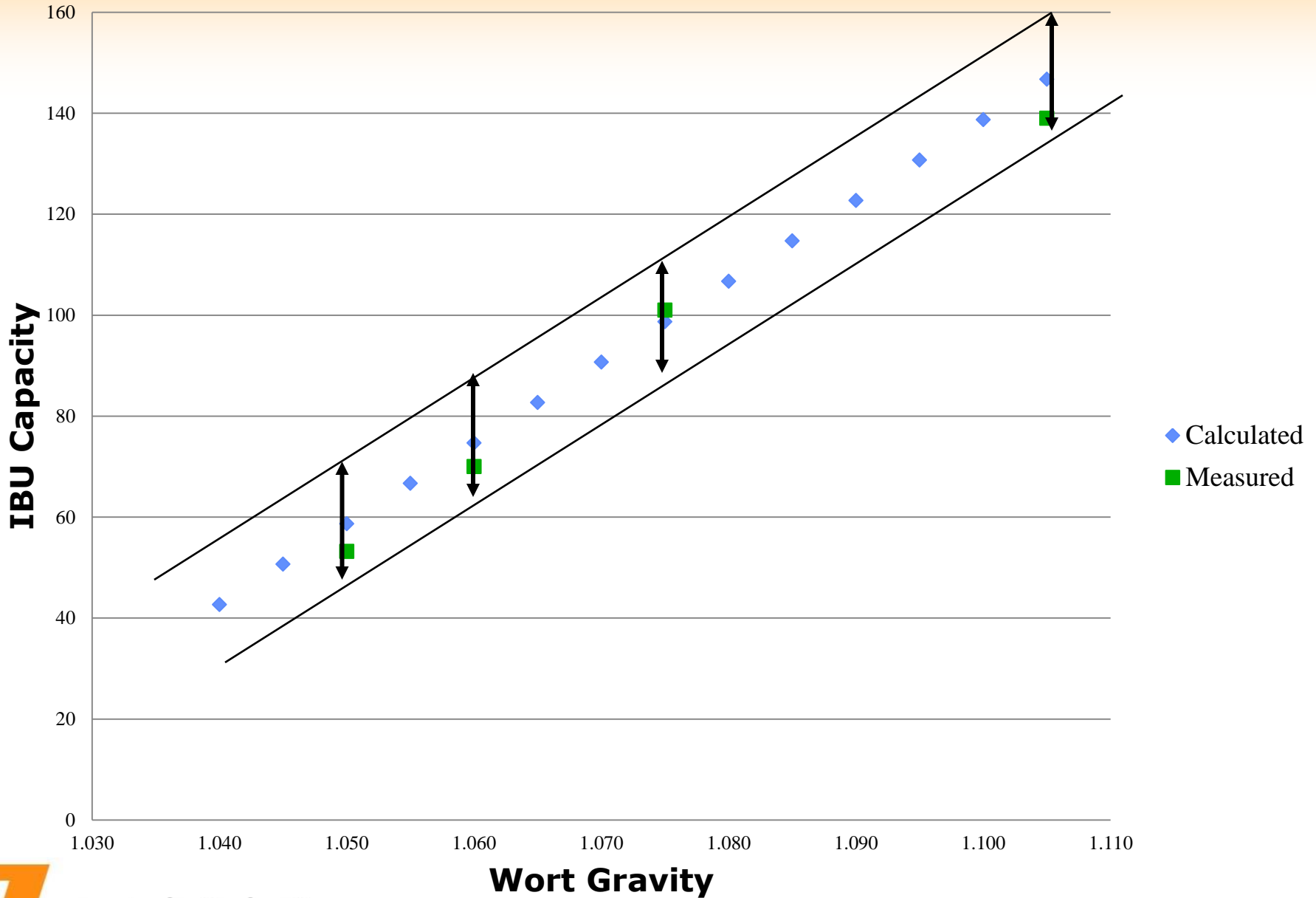


NEIPA:

- OG: 1059 (15.5°P)
 - Projected Saturation: 73 IBU
 - 12bbl batch
- All kettle hops were added at end of boil
 - Dry hopped with ApoWave using a combination of pellets and Lupulin Powder.

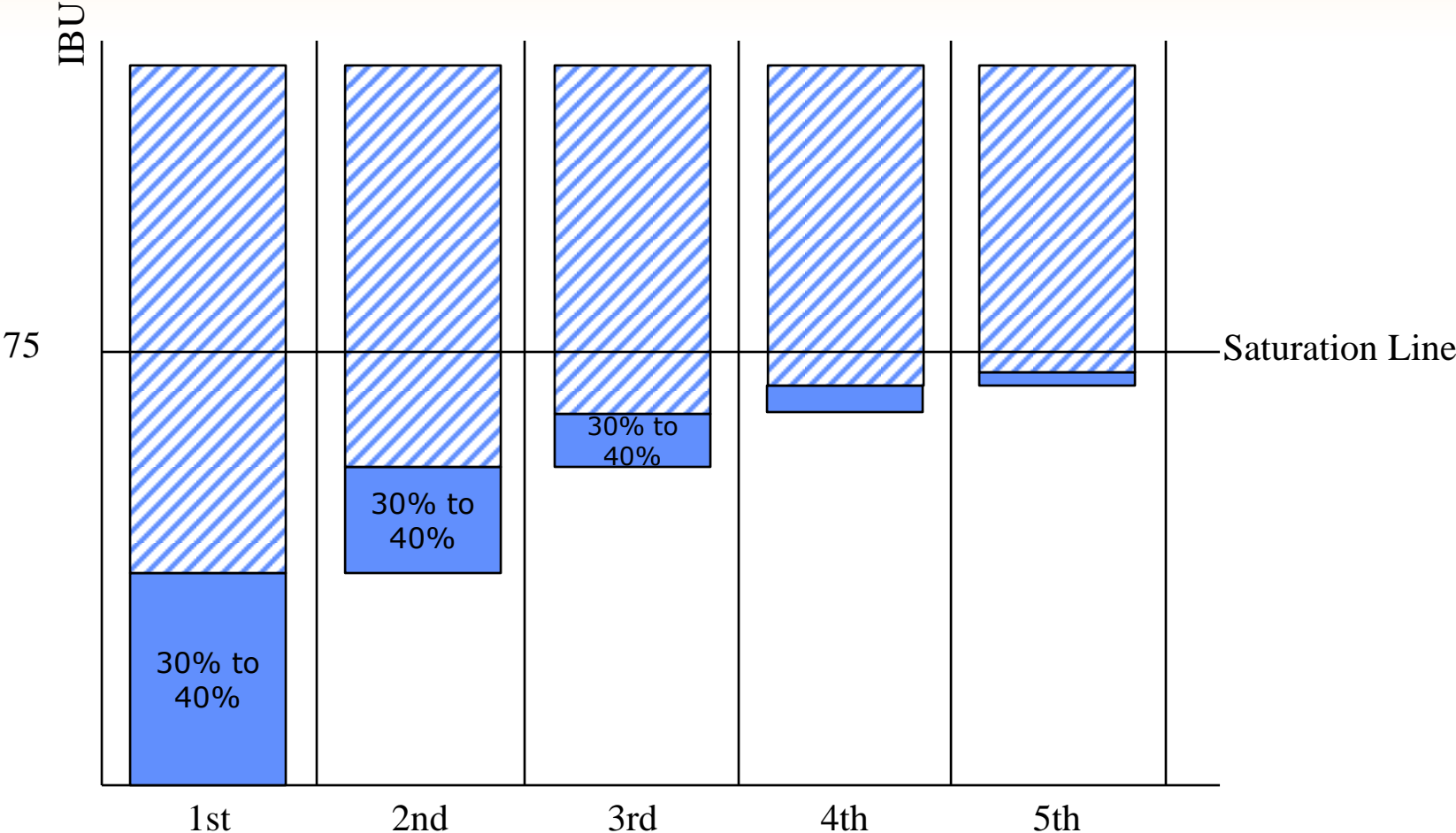
Batch	IBU - ASBC	Notes
End of Primary before DH	33.3	Un-settled sample
End of Primary before DH	28.8	Centrifuged sample 4k rpm 1 minute
Packaged Beer	162.6	Un-settled sample
Packaged Beer	49.7	Centrifuged sample 4k rpm 1 minute

IBU - Wort Gravity

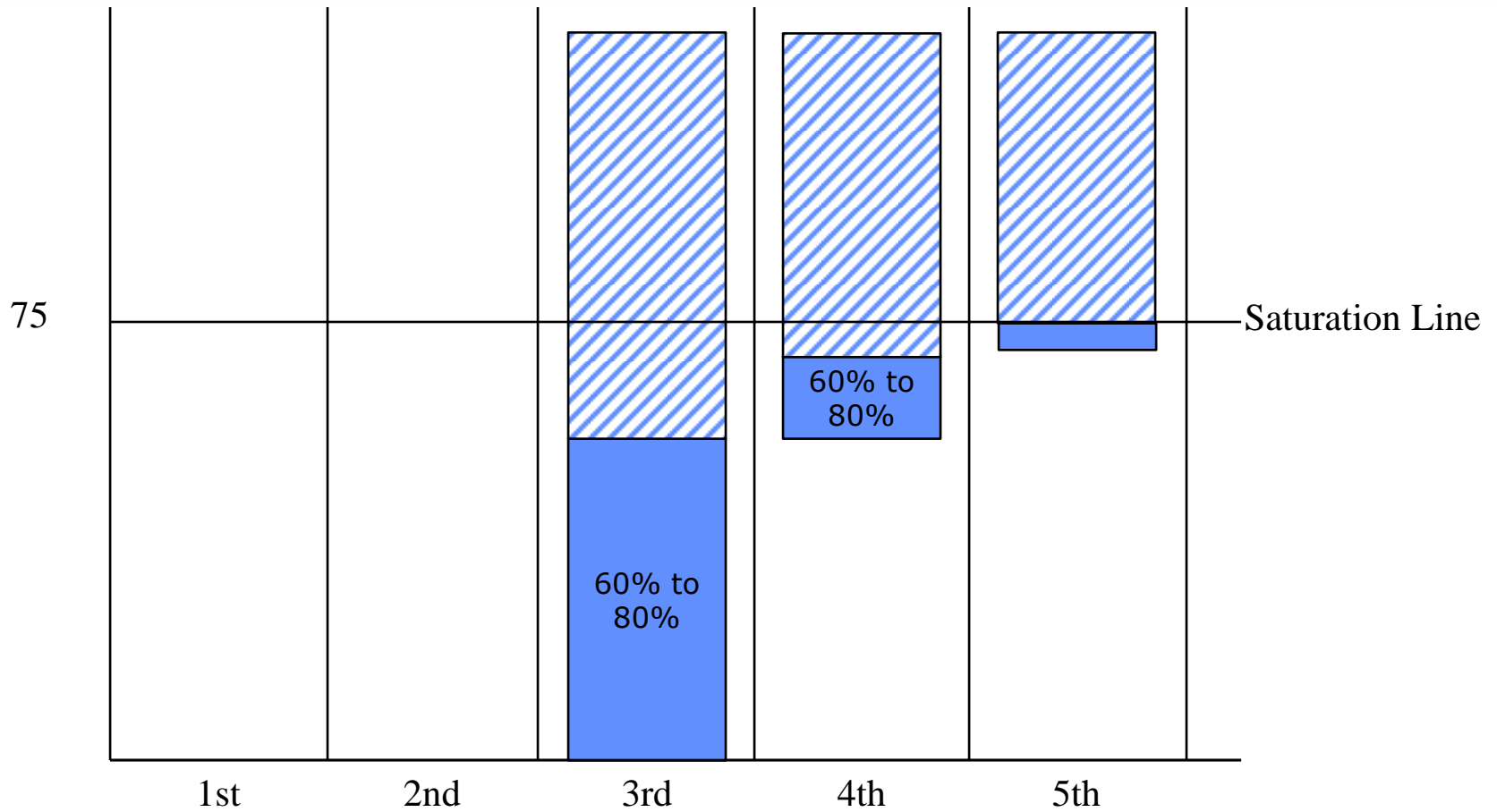


◆ Calculated
■ Measured

Hop Additions - Conventional



Hop Additions - Cavitation



MBAA Webinar: The IBU and Perceived Bitterness

Kurt Driesner of Urban Chestnut Brewing Co.

- **pH:**
 - Range manipulated between 4.1 and 4.9
 - Lower pH = lower perceived bitterness and reduced linger
 - Higher pH = higher perceived bitterness and increased linger
- **Alpha Acids:**
 - Ethanol increases solubility of AA
 - No increase in perceived bitterness up to 12ppm of AA
- **Hop plant material:**
 - Spent hops (after CO2 extract) were added to the beer
 - Raised pH from 4.4 to 4.6
 - IBU's and bitter score dropped at 2 lb/bbl or higher
 - Possible removal of Iso-Alpha by plant material

MBAA Webinar: The IBU and Perceived Bitterness

Kurt Driesner of Urban Chestnut Brewing Co.

- **Dry hopping:**
 - At 2.0 lb/bbl there was an increase in bitterness perception but lower linger.
 - Test showed an increase in ASBC IBU's after dry hopping.
- **Effects of storage:**
 - At 7 days perceived bitterness increased and reduced linger
 - At 60 days perceived bitterness dropped and increased linger
- **Ethanol:**
 - No significant change in perceived bitterness in relation to ABV

Dry Hopping study by John Paul Maye and Robert
Smith from S.S. Steiner, Inc.
TQ vol. 53, no. 3, 2016

Batch	ASBC	HPLC
Before Dry Hopping	40	51
After Dry Hopping (11b per bbl)	49	40.5

- ASBC IBU Test:
 - Measures ppm of iso-alpha-acids, humulinones and alpha acids
 - Does not differentiate between them.
- Alfa acids do not contribute to bitterness below 14ppm
- Humolinone:
 - Oxidized alpha acids, 2/3 the bitterness of iso-alpha-acids
- High Performance Liquid Chromatography (HPLC) differentiates all three compounds and IBU's can be calculated based on concentration level of each.

Before Dry Hopping



Iso AA

= Bitterness = ASBC IBU

After Dry Hopping



+



+



= ASBC IBU

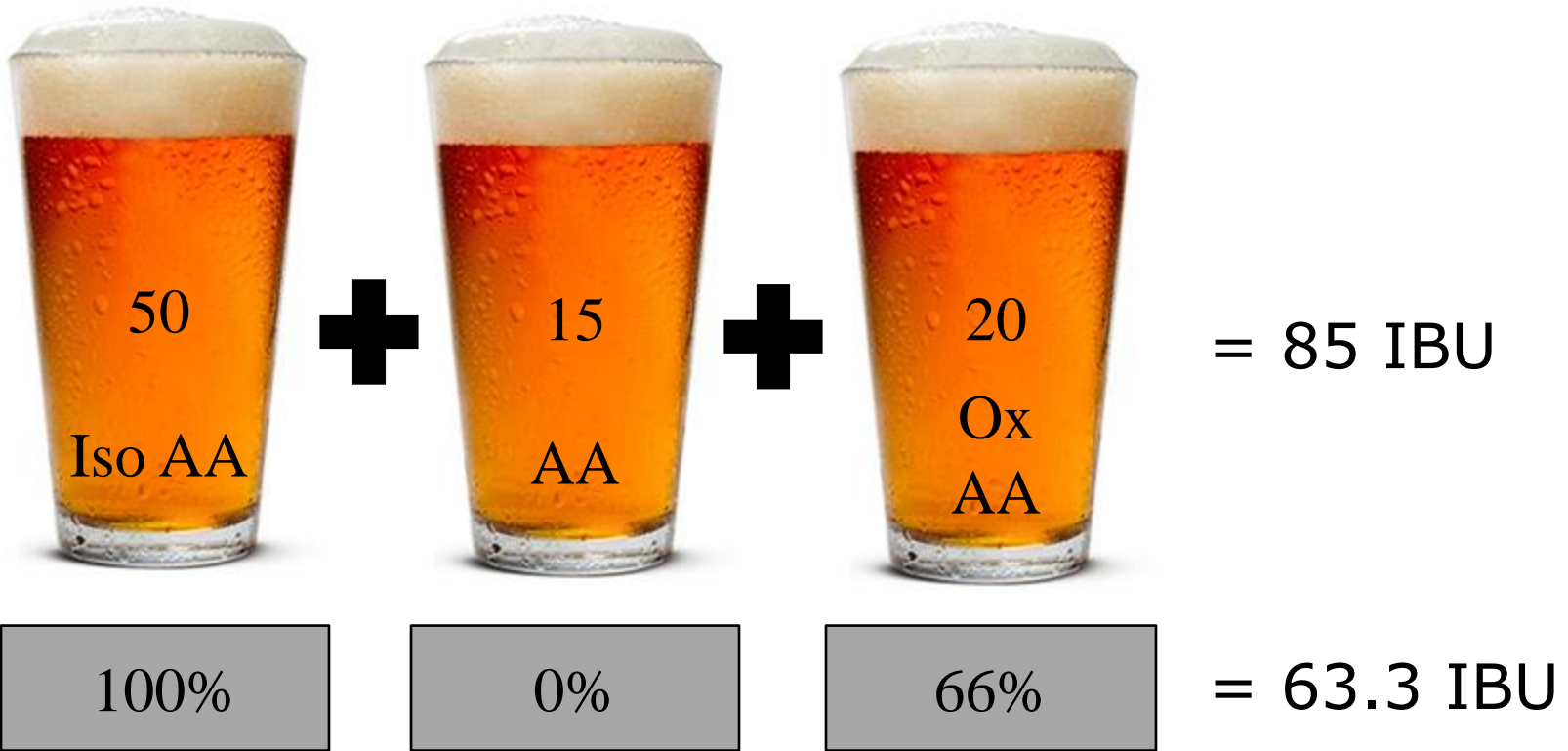
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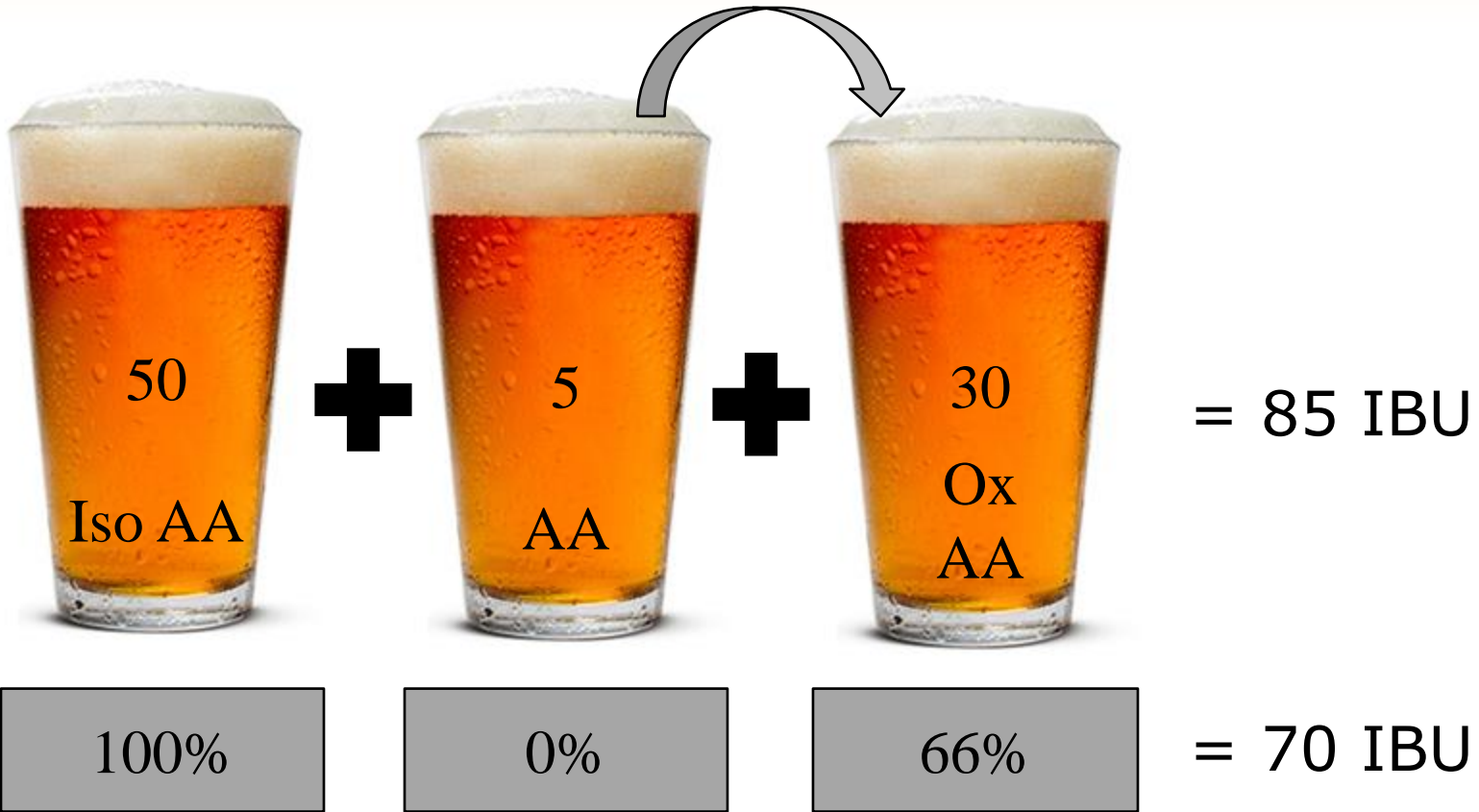
66%

= Bitterness

After Dry Hopping



After Storage



Conclusions

- IBU estimation formulas based on boil time are not a reliable method to determine beer IBU's.
- ASBC 23a is no the correct method for dry-hopped beers
- Bitterness of packaged beer will change overtime depending on TPO (Total Packaged Oxygen).
- Alpha Acid extraction during whirlpool additions and dry hopping:
 - Do some of the alpha acids from whirlpool additions carry over? If so, what happens when wort is oxygenated?
 - Is Lupulin powder more prone to oxidation?
 - What are the effects of Pasteurization?

What do IBU's mean to you and your customers?



Hoppy



Bitter

Questions?