Hop Overview

- Hops are the spice of beer!!
- Provide bitterness via the isomerization of alpha acids (resin)
- Provide flavor compounds
- Provide aroma compounds via hop oils (very volatile)
- Anti-microbial properties
Let’s Drink!

- Stone Mojay Hazy IPA
- East-West Hybrid
- 7.6% ABV, 68 IBU
- Slight FWH w/ German Noble Hop
- Minor 10 min late hop addition
- Large, single addition at start of WP
- Single dry hop on Day 7
- Tasting notes: Mo-OJ-y, med bitterness
Cross-section of Hop Cone

- **Strig** – foot stalk; contain high levels of polyphenols & tannins
- **Bracteole** – lupulin gland support structure; also contains polyphenols
- **Bract** – protects whole cone; also contains polyphenols
- **Lupulin glands** – contains resins & essential oils
  - 10% aromatic compounds
  - 20-30% of cone’s weight
  - Highest polyphenol contributor
Hop Aromas/Flavors

- Citrus
- Fruity (apple, berry, tropical fruits, etc)
- Floral (potpourri, rose petals)
- Herbal
- Dank
- Spicy (Cinnamon, black pepper)

- Grassy
- Catty (black currant, Sauvignon Blanc)
- Sulfur (onion, garlic, late season hops)
- Bitter
- Astringent
- Cheesy (aged cheese, Isovaleric)
- Rancid fat
Specialized Equipment

- Hop Spider - works well to keep kettle and pumps free of hop trub. PITA to clean if SS version used, slightly less hop utilization.

- Strainer - great for racking un-fined beer to keg on closed-transfer system.

- Racking tube strainer - works well to prevent hop matter from clogging the racking cane and keg post/tube.

- Hop bags for dry hopping - great for keeping hops from clogging keg, can keep trub clean if want to reuse yeast, slightly less extraction.
Types of Hops
Bittering Hop Extracts

- CO2 hop extract (un-isomerized) - contains α-acids, β-acids, essential oils. Can replace hop pellets and whole cone hops, must be used in kettle (Pliny, MT)
- Tetra Iso-Extract (Tetra, isomerized) - Pure aqueous solution of the potassium salts of the tetrahydro α-acids derived from CO2 extract. Added post-primary. Can improve head retention and is light stable if used as sole bittering compound or used in conjunction with other light-stable compounds.
- There are other isomerized and un-isomerized extract products on the market, but not available to homebrewers
Pelletized Hops (Type 90)

- Fresh hops are kilned and pressed into cubes, then ground and pelletized after hop selection.
- Standard hop form used in American craft breweries and homebrewers.
- Good storage qualities as long as hops are purged of oxygen and stored cold.
- Cannot be used in hopback.
- Easy to handle, compact storage.
- Higher quality hops will feel crumbly and not hard and dry.
Wet Hopping

• General guidelines for wet hops: 6-8 oz wet hop = 1 oz processed hops
• Add them all in the last ~5 minutes or WP because 1) It's hard to estimate the IBU contribution and 2) Lock in as much of the hop character as possible.
• Don't recommend wet hops for dry hopping due to the amount of bugs and dirt and stuff that come off when picking them. (Lost Abbey workers were covered in spiders after hop picking local hops a few years ago)
• Build the bittering/mid-hop profile with processed/pellet hops then add the wet hops in the last 5 min/whirlpool. You'll get an intense hop character and I find a spicy/vegetal note from the wet hops that's characteristic of all wet hopped beers I've sampled.
• Several commercial examples use wet hops in a sort of loose hop back (minimal filtering ability) due to difficulties with using it on normal brewing tanks.

*Special thanks to Derek Springer for his wet hop advice*
Whole Cone Hops

- Fresh hops are kilned and pressed into cubes
- Utilization of α-acids are slightly lower than T-90 pellets, less surface area and reduced exposure to hot wort
- Does not store as well, also less compact
- Inefficient extraction for dry hopping
- Some say the hop aroma is more refined than pellets (the Sierra Nevada “It” character)
- Can be used in a hopback
- Higher quality hops will feel nimble and not crusty and dry
Cryogenically Processed Hops (Cryo)

- Kilned hops are cryogenically frozen and separated from the leafy matter.
- Contains less vegetal “green” matter, and finished beer has a less “grassy” character (lower polyphenols)
- ~ Double the resin and oil content of T90 pellets
Cryogenically Processed Hops (Cryo)

- Very high AA% (mid-20s%, depending on varietal)
- Higher yield due to less absorption from green matter
- Hop character is more “fruity”, giving a more pure impression of the hop than T90
- Should be combined with >50% T90 to make the beer taste like beer still
- Should only be used for late hopping, WP, or dry hopping
- Comes in powder and pellet forms, pellet form is recommended as it breaks up better during dry hopping. Powder can form clumps which act as icebergs and don’t dissolve into the beer.
De-bittered Pellets (Yakima Chief’s American Noble Hops)

• All the leftovers from the Cryo process
• Very low AA% (~2-3%)
• Appropriate for styles with lower hop intensity but when you still want some polyphenol character to balance the beer (or for clarity reasons), and want the hop character to have an American twist to it
• Some are reporting unsatisfactory results with American Noble hops, but may be using them outside their sweet spot
Adding Hops
Bitterness

• The alpha acids found in the hop resin glands are not soluble in wort.
• Hot wort causes the isomerization of alpha acids into soluble iso-alpha acids. These iso-α-acids provide the majority of the bittering compounds in beer.
• Isomerization is very inefficient, and efficiency is further reduced by high iso-α-acid saturation and higher sugar extract concentrations in wort.
Bittering Hops

• Bittering hops still provide some flavor contributions and are not totally neutral. Use varietals that are appropriate for the style.

• Magnum for instance is not a neutral hop when used for bittering. Its spicy/herbal qualities just work well with a lot of styles, and the intensity is low enough not to be distracting.
First Wort Hopping

• Method: add hops to kettle during lautering or shortly afterwards when wort is 170-180°F
• Common old school German and Belgian brewer technique
• Benefit: ~10% better α-acid utilization, smoother & more rounded perceived bitterness*, lower perceived bitterness intensity*, more hop aroma and flavor than 60 min addition*, reduced kettle foaming at start of boil.

• *Debatable
Late Hopping (Flavor, Bittering)

- Pellet and cone hops added late in the boil (30-5 min remaining)
- Typically the final (“finishing”) hop addition in European beer styles
- Using in boil will give the polyphenols a chance to bind to proteins, hop character will be less “green” (needs 5-10 min)
- Aromatics will be lower intensity than WP or dry hopping, but flavor and bitterness will be higher
- Good technique for layering flavor and adding complexity to a hoppy beer
- Bittering character is different. “Beers that are heavily hopped in the beginning of the boil exhibit a cleaner krausen fermentation head and are more stable than beers hopped later, but the hop bitterness will be coarser and less pleasant.” - Greg Noonan New Brewing Lager Beer
Whirlpool Hopping (Flavor/Aroma)

- Will focus on hot whirlpool (WP)
- The main purpose of whirlpooling is to remove the protein break and hop solids from hot wort
- Whirlpooling has 2 distinct periods:
  1. Establishing a vortex by vigorously stirring or pumping tangentially (3-5 min)
  2. Settling period for hop and protein break matter to settle on bottom (15-40 min). Longer settling times will give tighter trub pile.
- Can take advantage of this time spent by adding hops or other flavor adjuncts, which preserves aromatics
Whirlpool Hopping (Flavor/Aroma)

• Hops should be added while wort is still moving for better dispersion and clearer wort
• WP hops typically added to wort at flameout at boiling temps, dropping a few degrees as wort settles
• Will give high flavor contribution and some bitterness, the AA utilization # though is hard to quantify
• A hot whirlpool period will increase the bitterness contribution of your late hops, so design your recipe accordingly
• The longer the WP duration, the more the bitterness and the less the aroma.
• Homebrewers can easily drop temp to ~180°F to maximize aroma from WP addition and minimize bitterness (common technique for commercial NEIPAs)
• Wider kettles with shallower wort will outperform taller kettles in general
Let’s Drink!

• Alesmith .394
• San Diego Pale Ale
• 6.0% ABV, 13 IBU!
• Uses hop back and dry hopped
Hop Back (Flavor/Aroma)

- Historically used to separate whole hops and hot break from wort in lieu of a WP
- Nowadays typically used to add hop aroma to wort
- Better to be used with hot wort for sanitation purposes and to prevent clogging with cold break
- Must be whole cone hops, pellets will clog
- Several types are available to homebrewers, including the Blichmann Hop Rocket (pictured to the right), Stout Tanks, homemade, tiny lauter tun
- Hop Rocket less likely to clog with high-flow insert
- Will give high flavor contribution and some bitterness, the AA utilization # though is also hard to quantify (less than WP hops)
Hop Back

- Braukon: “BrauKon HopBack significantly increases yield when compared with the hop dosing in the whirlpool. HopBack also acts as a depth filter when dosing additional pellets into the whirlpool. In contrast to dosing in the whirlpool, all of the hop oil compounds can be transferred into the wort without evaporation losses.”
Hop Back

• If using a pump with Hop Rocket (my method):
  Kettle -> Pump -> Throttling Valve -> Hop Rocket (upright) -> Wort Chiller -> Fermenter

• Tasty Method:
  Kettle -> Hop Back (inverted) -> Wort Chiller -> Pump -> Fermenter

• No-Pump Gravity Fed Method:
  Kettle -> Hop Back -> Wort Chiller -> Fermenter
Mash Hopping

• Don’t waste your time or $$ 😊
Dry Hopping (Aroma/Some Flavor)

• Basically adding hops to cold beer for extended contact time.

• Look for high AA, high oil varietals to maximize aroma and yield

• Use your freshest, most pungent hops for dry hopping, save your older or already opened bags for the hot side

• Take a small sample of hops and rub them in palms to warm up the oils, then cup your hands and smell. If it smells “off” then don’t use them
Dry Hopping

• Whole hops have relatively poor extraction, T90 pellets have better extraction, Cryo hops have best extraction (in pellet form, use ½ as much)

• Avoid poorly storing varietals (e.g. Centennial, Columbus, etc.) which can stale quickly in beer too

• Look for vacuum sealed (and hard packed), with a nitrogen purge if possible for the freshest hops
Dry Hopping
Dry Hopping
When to Dry Hop

• For most beers, best to dry hop with .002-.004 gravity points left so the yeast can scrub any O2 added in the process.

• Some advocate for an early, small biotransformation addition, but hop character is limited compared to later addition. Monkish head brewer says early addition makes the hops “muddled”.

• Remove settled yeast from fermenter if possible before dry hopping (esp with warmer dry hopping), not doing so may result in diacetyl issues with some strains (e.g. Chico).

• Capping the fermenter (if it can hold pressure) is ideal after dry hopping to prevent the scrubbing of hop aroma.
Dry Hopping Quantities

• For homebrewed American IPAs, the general rule of thumb is 1oz/gallon (2lb/bbl).

• Can go higher but be careful of grassy character common with intensely dry-hopped beers. Can cut in dry hops with Cryo hops, hop hash, or distilled hop oils to get high aroma without the grass.
Gravity Drops and Diacteyl

• Hops have been found to have slight amounts of glucose and amylase enzymes, which can convert more complex sugars into simple, fermentable sugars.

• Fermentation may kick back up again. Homebrewed Mojay consistently has a .002 gravity drop from day 10 to 14 after 2\textsuperscript{nd} dry hop.

• Renewed yeast activity causes increase in VDK levels (diacetyl precursor), which may need to be conditioned out. This depends on strain and dry hopping temp

• Forced diacetyl test
Dry Hopping Temperature

- 60-70°F: Emphasis on fruity, juicy, citrusy compounds. Best extraction. Increased VDK levels.
- 50-60°F: Balance between fruity, juicy, citrusy and earthy, grassy, piney compounds. Moderate extraction. Moderate VDK levels.
- Below 50°F: Harsher grassy, vegetal character. Lowest extraction. Lowest VDK levels.
Dry Hopping Duration

• For warm dry hopping, 5-7 days contact time allows for proper extraction and conditioning. With low-VDK strains this can be expedited.

• Can use a double dry hop if using extremely high quantities of dry hops. Fermenter geometry specific, carboy or other flat bottomed fermenter may not benefit from this.

• Some commercial breweries recirculate dry hops with a pump (Alpine, Burgeon) but process is not practical for homebrewers without specialized equipment, and then there may not be a benefit

• 2-3 day cold crash to settle trub.

• After cold crash period immediately remove beer from trub to reduce pickup of grassy notes from cold hop matter.

• You won’t get best results if you dry hop in the cold serving keg and leave it.
Oxidation Prevention

• For optimal hop expression, absolutely must keep as much oxygen out as possible.
• Closed CO2 transfers to kegs
• Minimize transfers between vessels
• Cold crash with CO2 top pressure or other system
• Completely purge keg with CO2, preferably by filling with sanitizer and pushing out with CO2
• Purge transfer lines with CO2
References

• 2017 HomeBrewCon seminar on Dry Hopping by Blaze Rudd from Yakima Chief
• 2018 HomeBrewCon seminar on MBAA studies by Doug Brown and Chris Hotz
• Craft Beer and Brewing Magazine (https://beerandbrewing.com/hopback-vs.-knockout-hops/)
• Brulosophy
Thank You!

Questions?