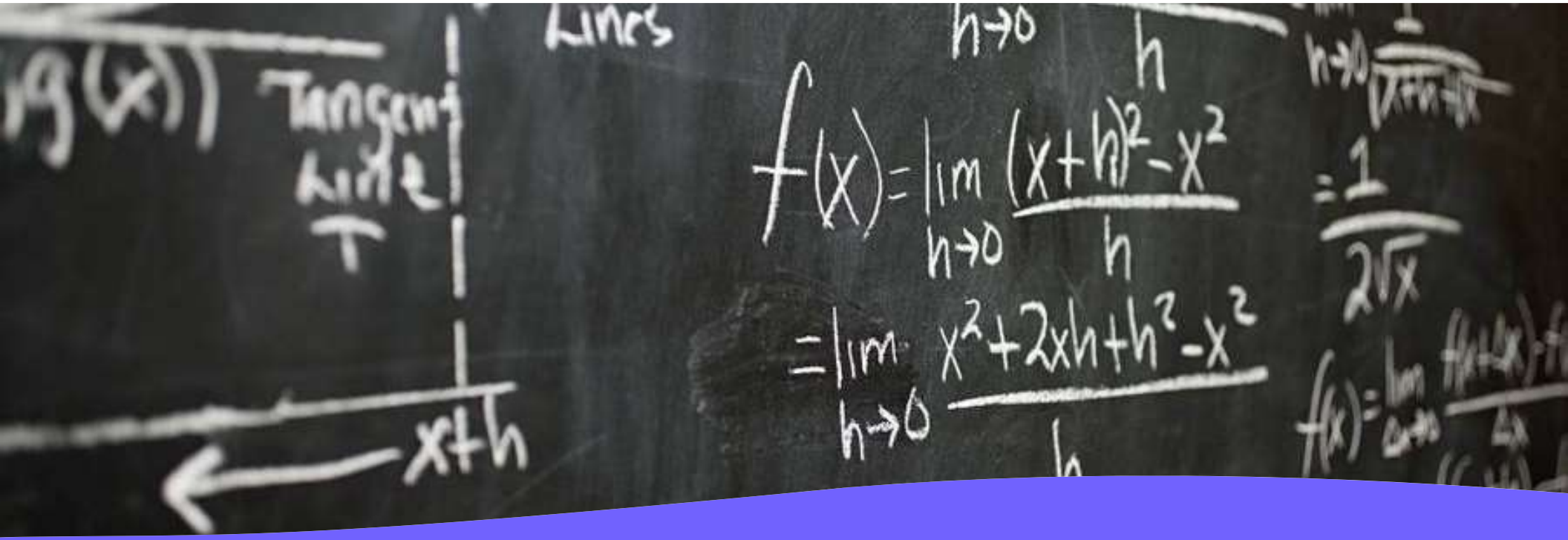



# Hops

Colin Crowley

# Raison d'Etre/Caveats

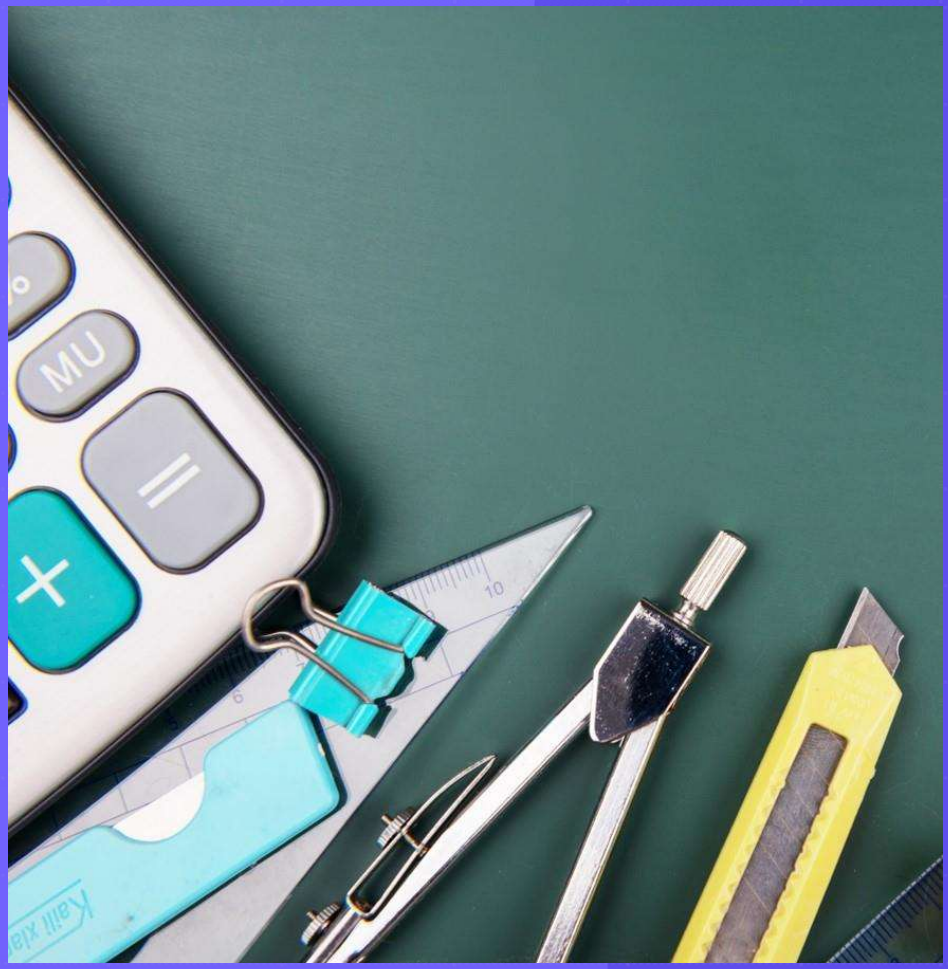
Would like to have baseline comprehensive club presentations on core brewing elements

- Water
- Carbonation (Draft)

I have been homebrewing for 32 years seen a huge improvements in knowledge and quality

I am not a hophead

Plagiarism alert:  I will list references at end – but not cite in the slides

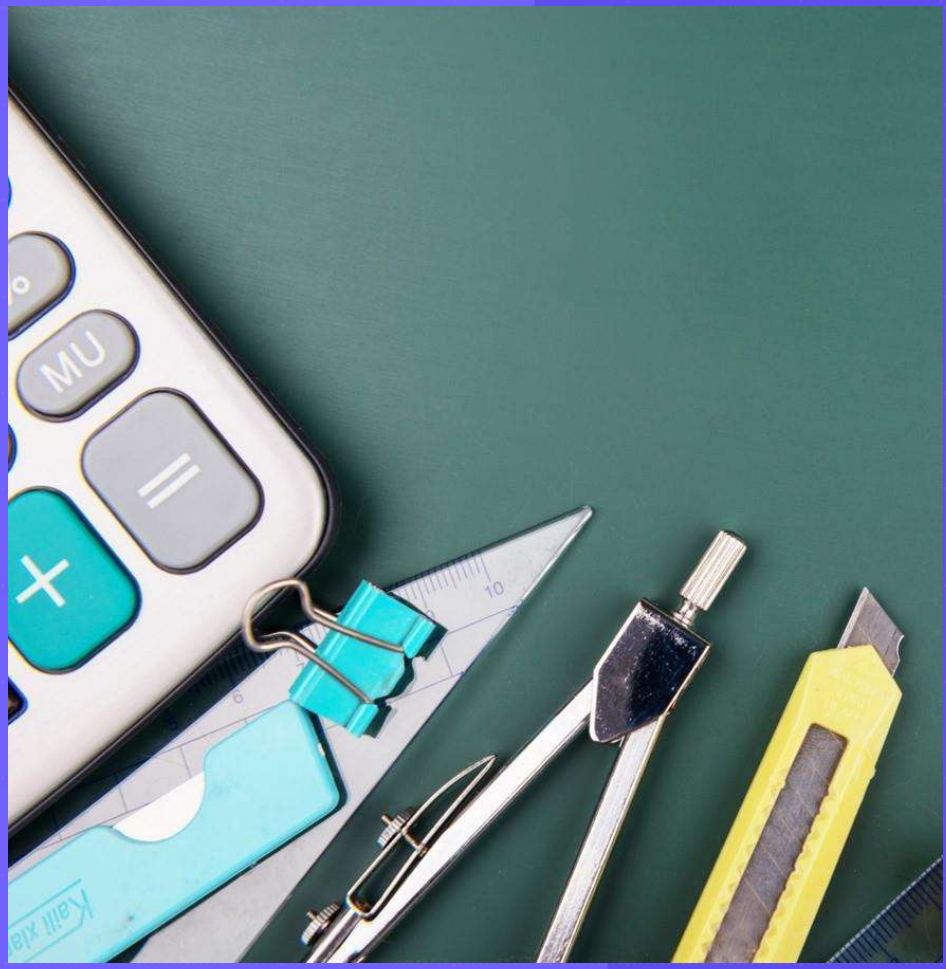


# Incentives

| Beer | O.G. | F.G. | ABV | IBU | BUGU | RBR |
|---|---|---|---|---|---|---|
| Vintage Brewing<br>Sun D'Appled Orchard Ale<br>*Apple Ale* | 1.063 | 1.013 | 6.6% | 11 | 0.175 | 0.178 |
| Potosi<br>Tangerine IPA<br>*IPA* | 1.065 | 1.016 | 6.5% | 55 | 0.846 | 0.830 |
| Doc Crowley's Brewhouse<br>Kveik Fest<br>*Festbier* | 1.043 | 1.006 | 4.8% | 21 | 0.488 | 0.532 |

# Introduction

Hops are a wonderful resource for the brewer. They provide bitterness to counteract the sweetness of malt, thus making the beverage more palatable. They also provide some antibacterial properties that at one time increased the safety and potability of beer. Today this quality still aids in the preservation of beer. And hops contribute to head stabilization and kettle break formation.[2]

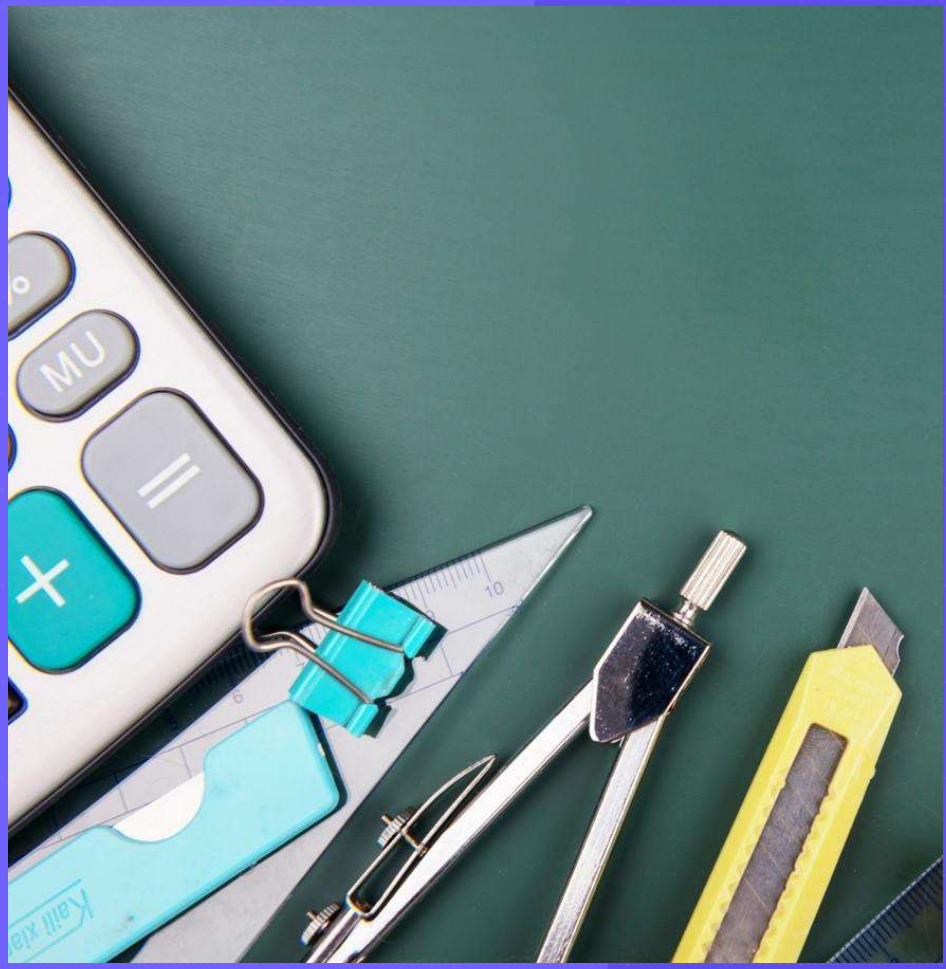



## 7 Attributes of Hops

1. Bitterness
2. Aroma
3. Flavor
4. Mouthfeel
5. Foam and Lacing
6. Flavor Stability
7. Antimicrobial

# Hop Composition

| Hops Components | Percentage |
|---|---|
| Vegetative material (cellulose, lignin, etc.) | 40 |
| Proteins | 15 (0.1 amino acids) |
| Total resins | 15 |
| Water | 10 |
| Ash | 8 |
| Lipids, wax, pectin | 5 |
| Tannins | 4 |
| Monosaccharides | 2 |
| Essential oils | 0.5-2 |



# Hop Resins – aka Bitterness

***Figure 9.1***

***Profile of Hop Resins***

I. Soft Resins

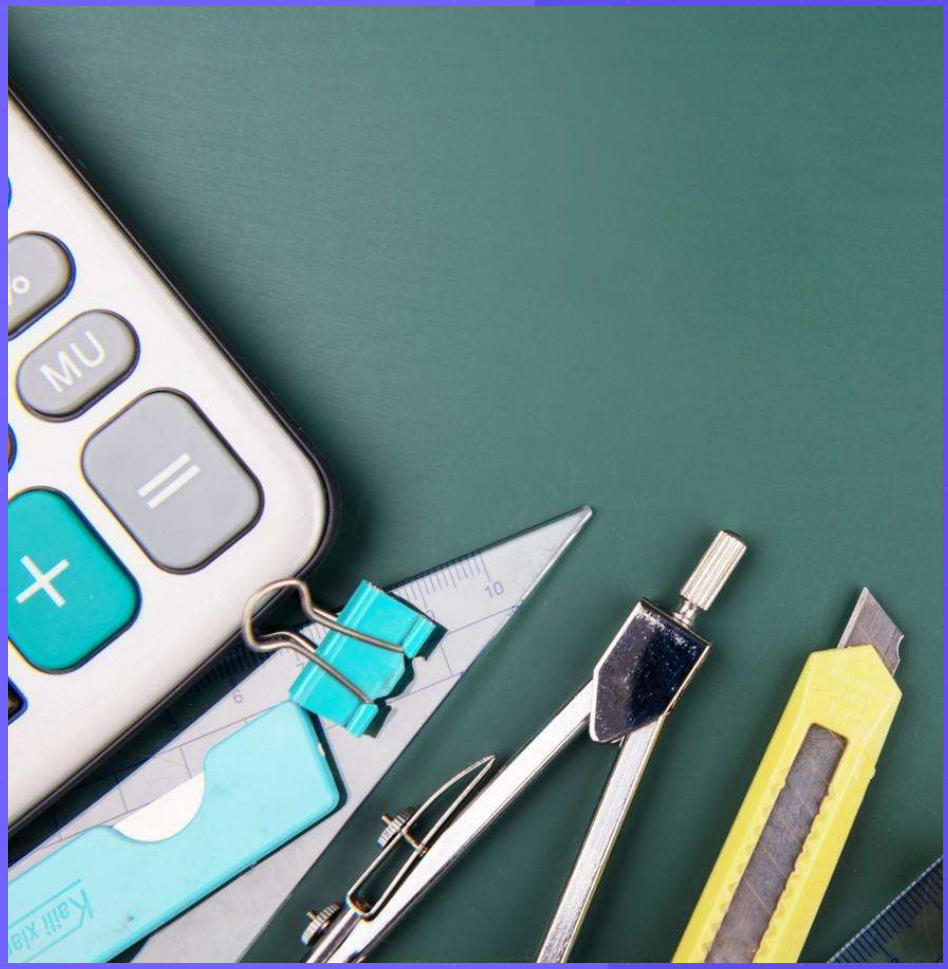
A. Alpha acids (2% to 16% of total hop weight)

1. Humulone
2. Cohumulone
3. Adhumulone

B. Beta acids: lupulone, colupulone and adlupulone

C. Uncharacterized soft resins

II. Hard Resins



# Hop Oils – aka Hoppiness

***An Overview of Hop Oil Constituents***

**I. Hydrocarbons**

1. Oxygen-free terpenes
    1. Monoterpenes (contain 2 isoprene units)
        a. Aliphatic
            i. Myrcene
            ii. Isobutene
            iii. Ocimene
        b. Cyclic
            i. Alpha- (and beta-) pinene
    2. Sesquiterpenes (3 isoprene units)
        a. Aliphatic
            i. Farnesene
        b. Cyclic
            i. Humulene
            ii. Caryophyllene
    3. Diterpenes
        a. Aliphatic
            i. Dimyrcene
2. Other oxygen-free compounds: isoprene

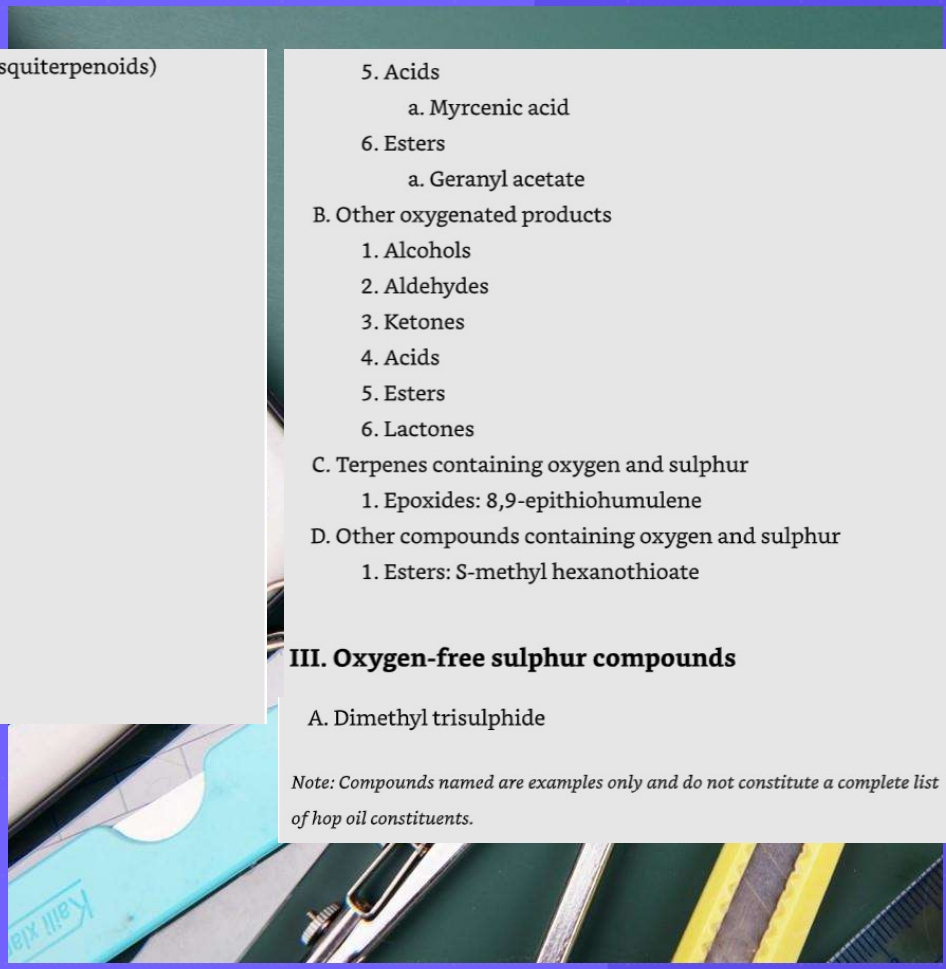
**II. Oxygenated substances (polar)**

A. Oxygenated terpenes (terpenoids, sesquiterpenoids)
    1. Epoxides
        a. Myrcene epoxide
        b. Farnesene epoxide
        c. Humulene epoxide
        d. Pinene epoxide
        e. Caryophyllene epoxide
    2. Alcohols
        a. Linalool
        b. Myrcenol
        c. Pinenol
        d. Farnesenol
        e. Caryophyllenol
        f. Humulenol
        g. Nerol (from myrcene)
    3. Aldehydes
        a. Geraniol
    4. Ketones
        a. Humuladienone
    5. Acids
        a. Myrcenic acid
    6. Esters
        a. Geranyl acetate
B. Other oxygenated products
    1. Alcohols
    2. Aldehydes
    3. Ketones
    4. Acids
    5. Esters
    6. Lactones
C. Terpenes containing oxygen and sulphur
    1. Epoxides: 8,9-epithiohumulene
D. Other compounds containing oxygen and sulphur
    1. Esters: S-methyl hexanothioate

**III. Oxygen-free sulphur compounds**

A. Dimethyl trisulphide

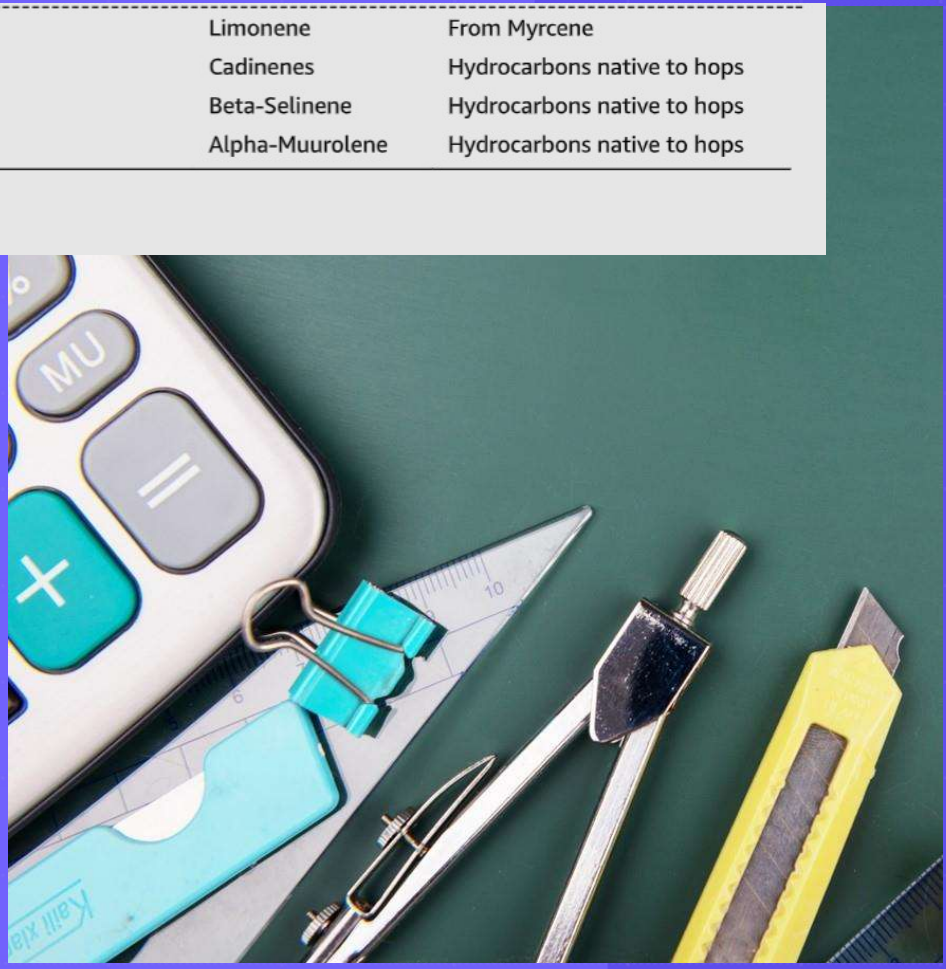
*Note: Compounds named are examples only and do not constitute a complete list of hop oil constituents.*



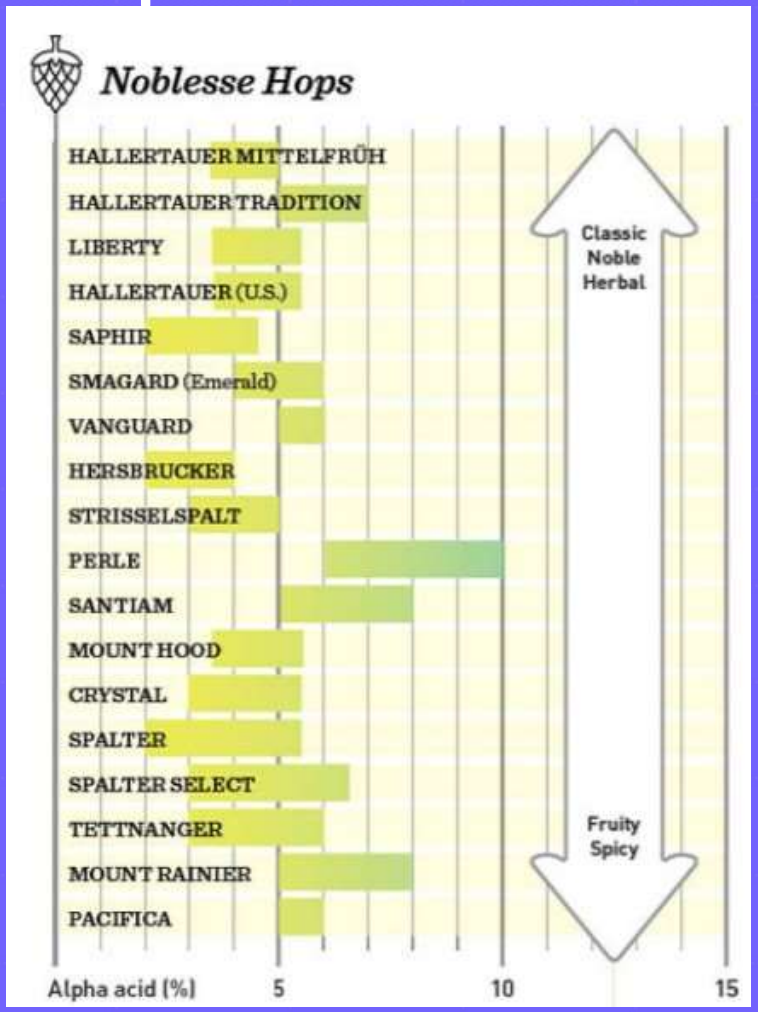
# Hop Flavors

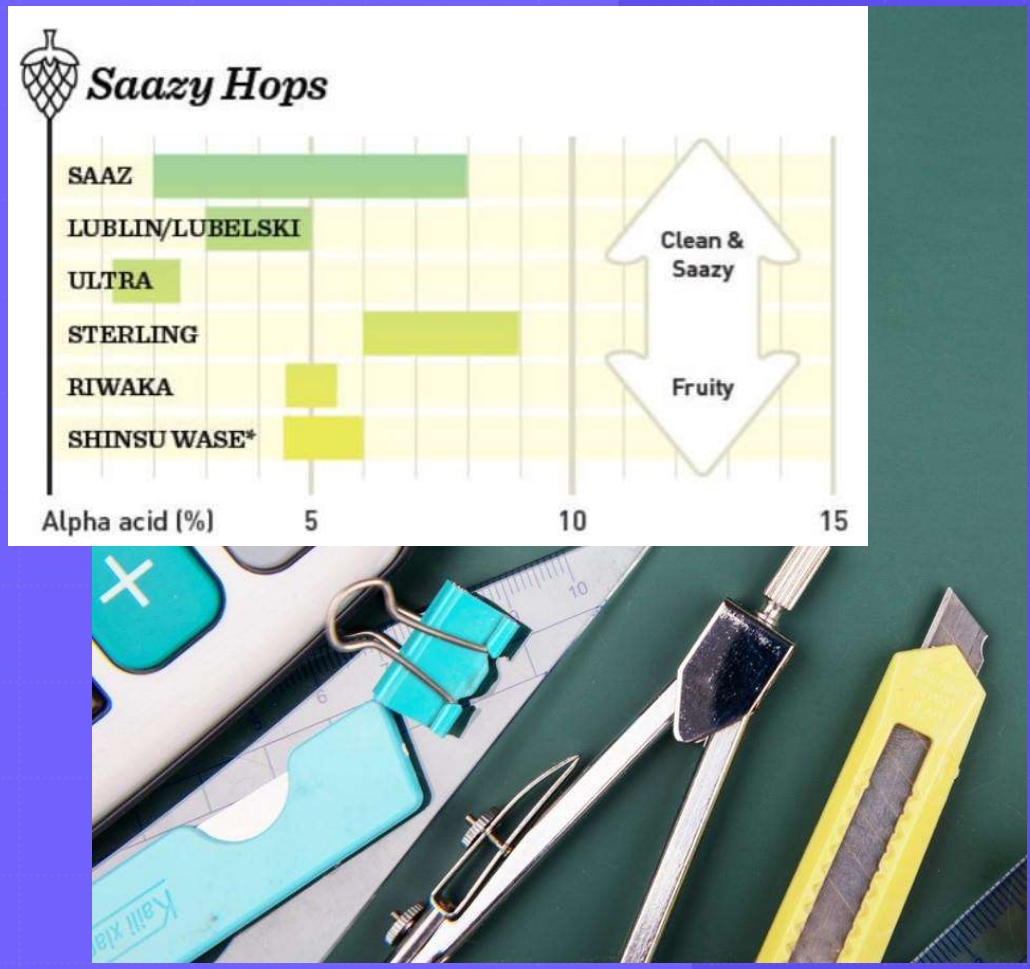
***Hop Flavors and Their Related Compounds***

| Flavor | Compound | Source |
|---|---|---|
| Spicy | | |
| | Humulene epoxides | Humulene oxidation products |
| | Humulene diepoxides | |
| Herbal or European | | |
| | Humulol | Humulene oxidation product |
| | Linalool oxides | From linalool |
| Floral or Flowery | | |
| | Linalool | Myrcene oxidation products |
| | Geraniol | Myrcene oxidation products |
| | Geranyl acetate | Myrcene oxidation products |
| | Geranyl isobutyrate | Myrcene oxidation products |
| Citrus and Piney | | |
| | Citral | From Myrcene |
| | Nerol | From Myrcene |
| | Limonene | From Myrcene |
| | Cadinenes | Hydrocarbons native to hops |
| | Beta-Selinene | Hydrocarbons native to hops |
| | Alpha-Muurolene | Hydrocarbons native to hops |

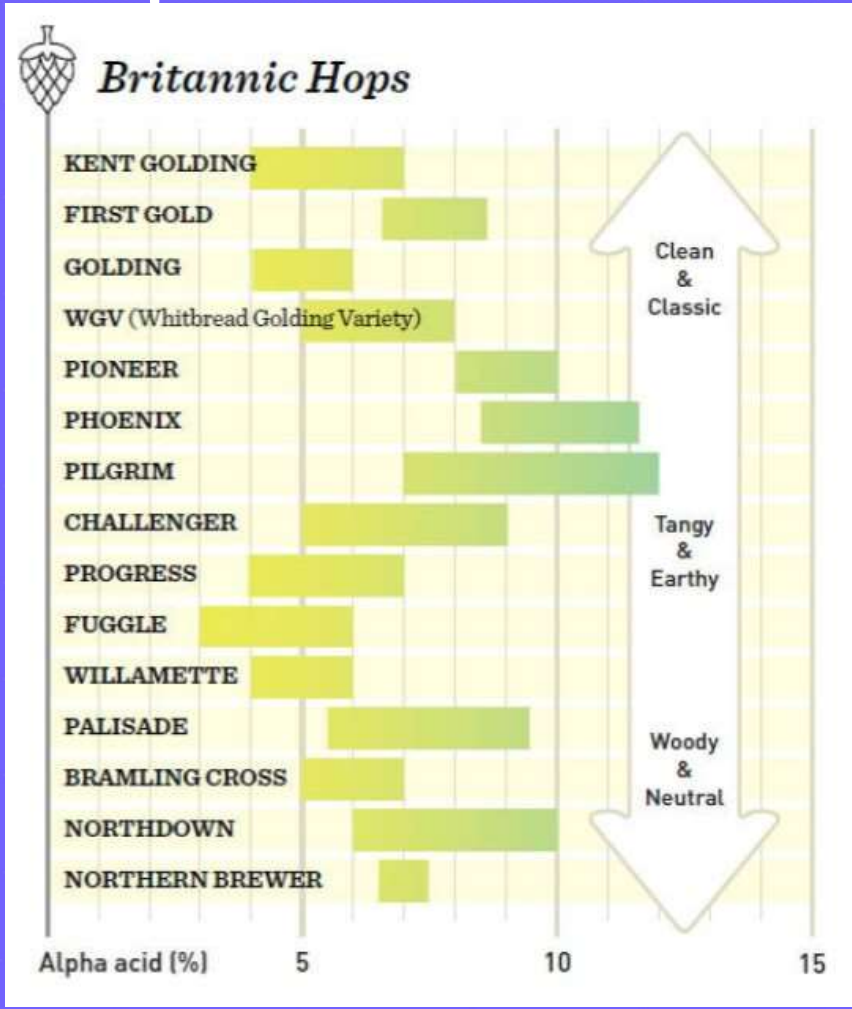


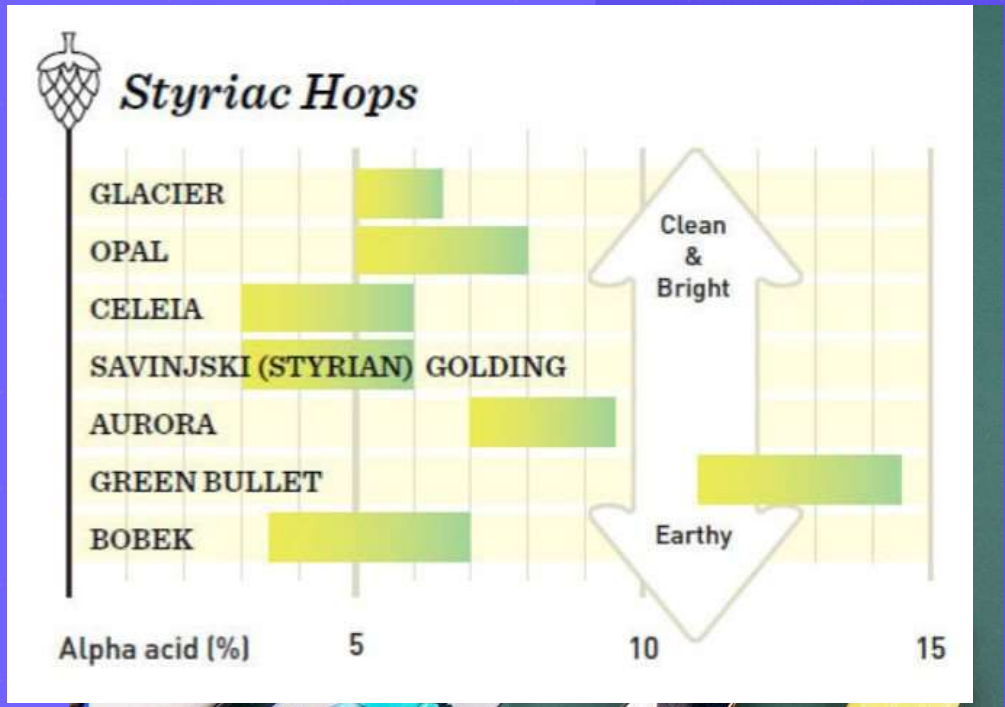
# Hop Classes


Noblesse Hops
HALLERTAUER MITTELFRÜH
HALLERTAUER TRADITION
LIBERTY
HALLERTAUER (U.S.)
SAPHIR
SMAGARD (Emerald)
VANGUARD
HERSBRUCKER
STRISSELSPALT
PERLE
SANTIAM
MOUNT HOOD
CRYSTAL
SPALTER
SPALTER SELECT
TETTNANGER
MOUNT RAINIER
PACIFICA
Classic
Noble
Herbal
Fruity
Spicy
Alpha acid (%)
5
10
15

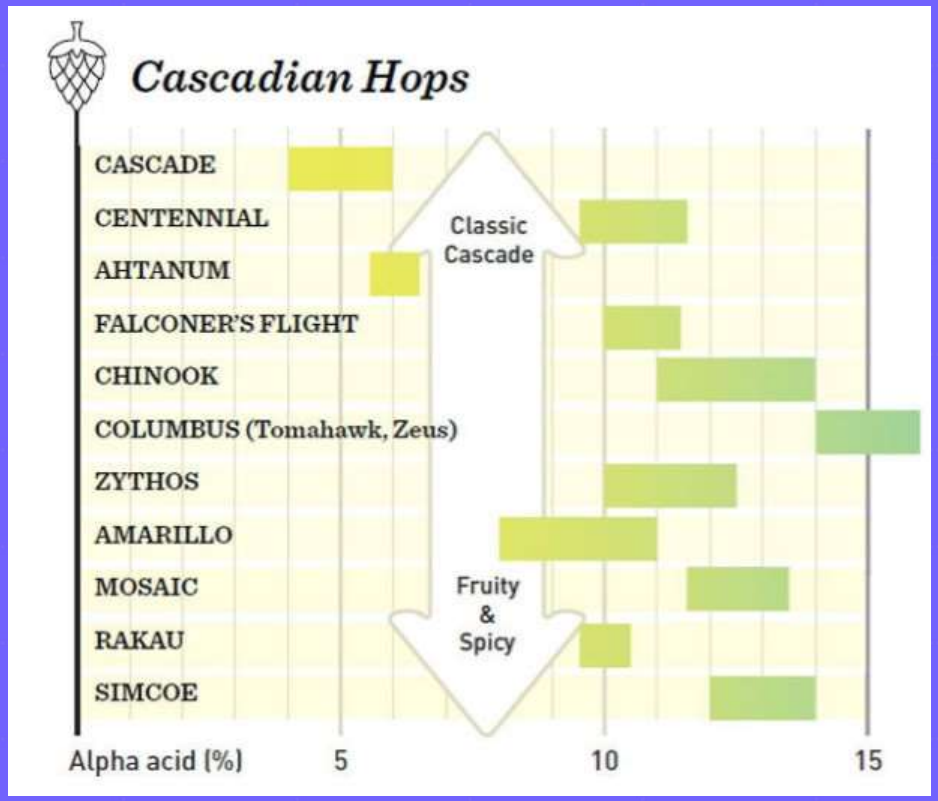

Saazy Hops
SAAZ
LUBLIN/LUBELSKI
ULTRA
STERLING
RIWAKA
SHINSU WASE*
Clean &
Saazy
Fruity
Alpha acid (%)
5
10
15

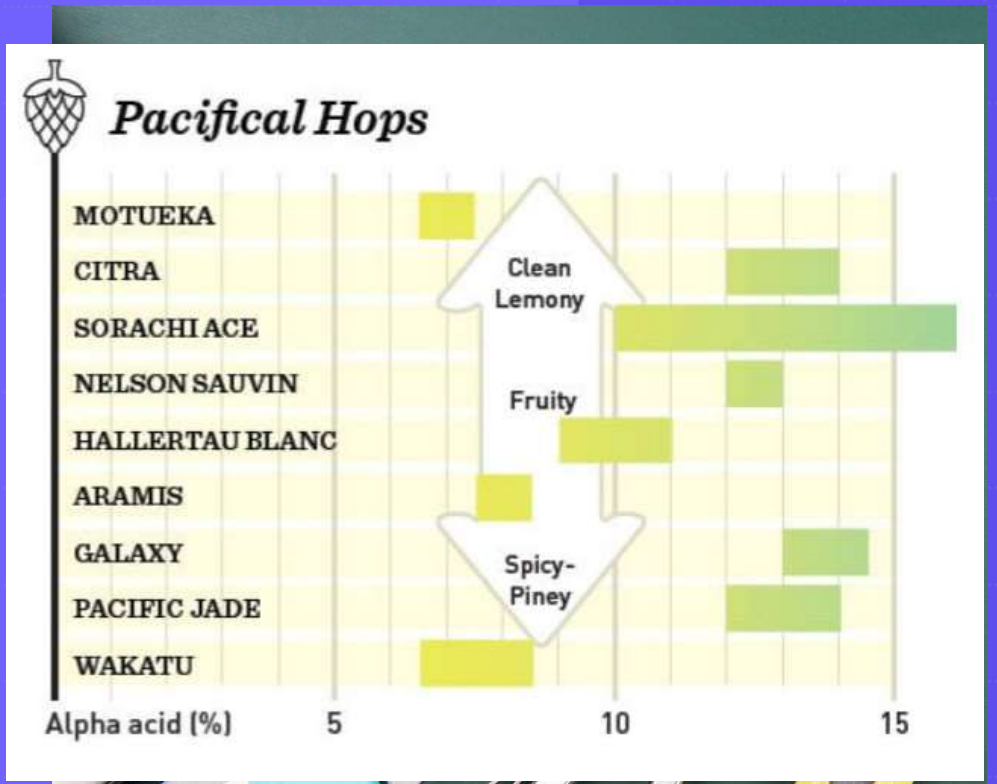
# Hop Classes II



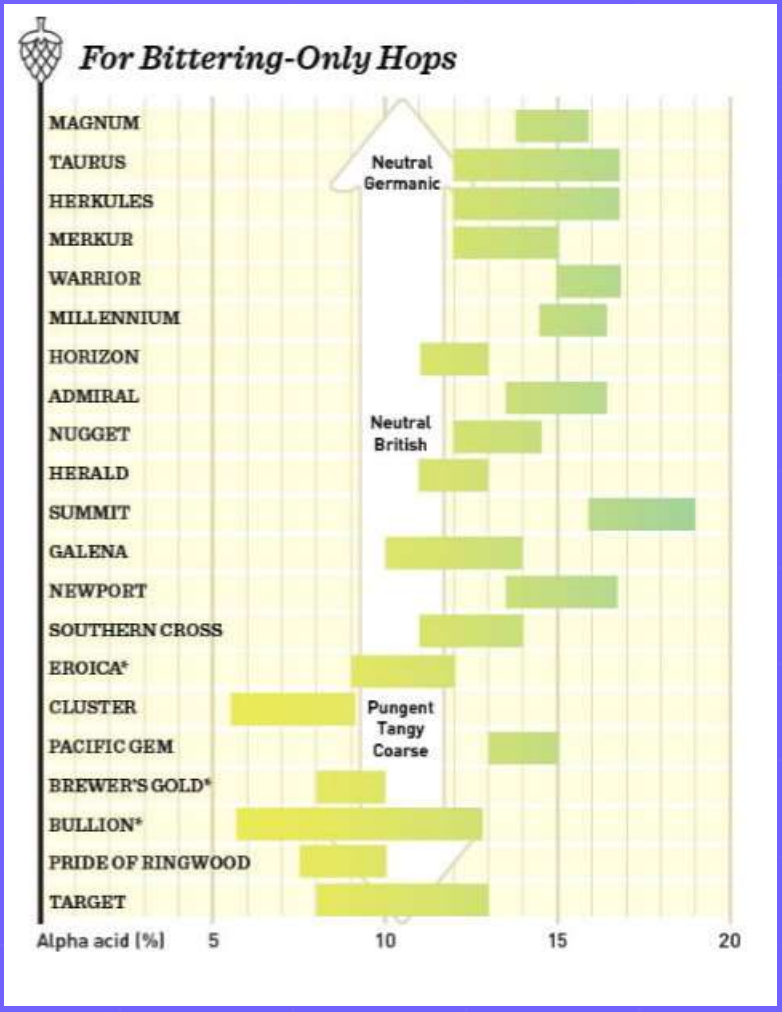



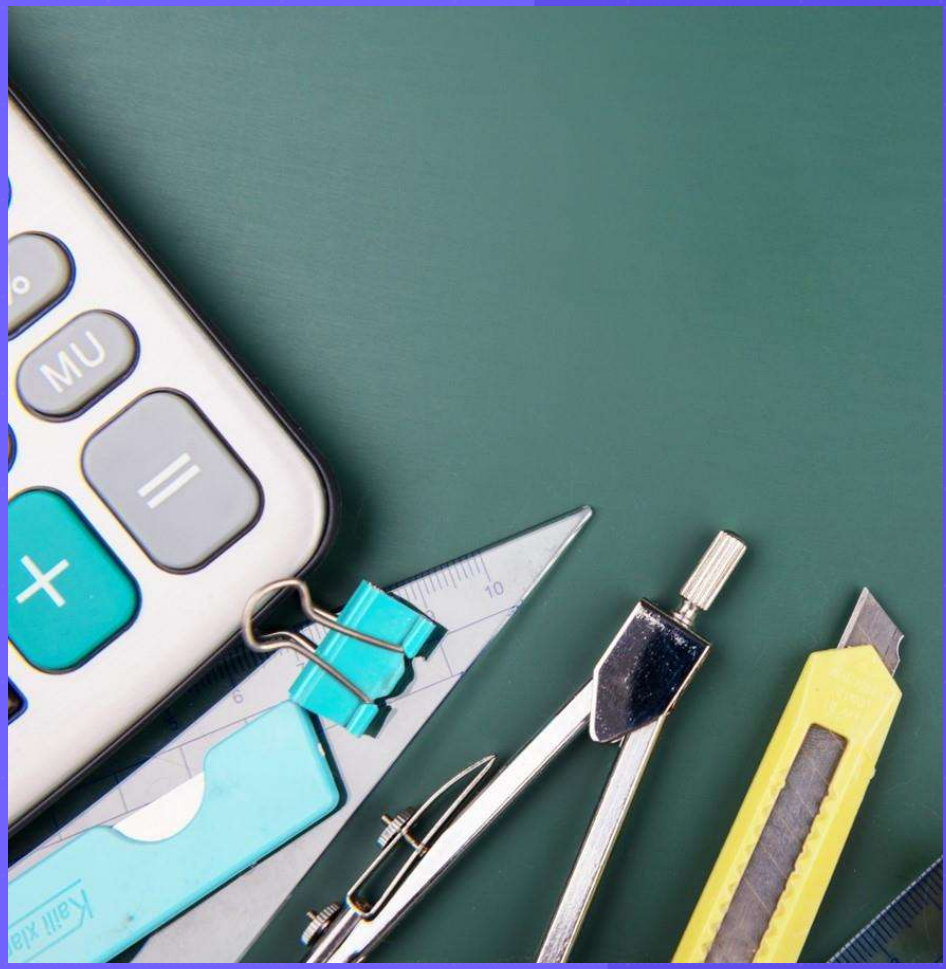

# Hop Classes III




# Hop Classes IV

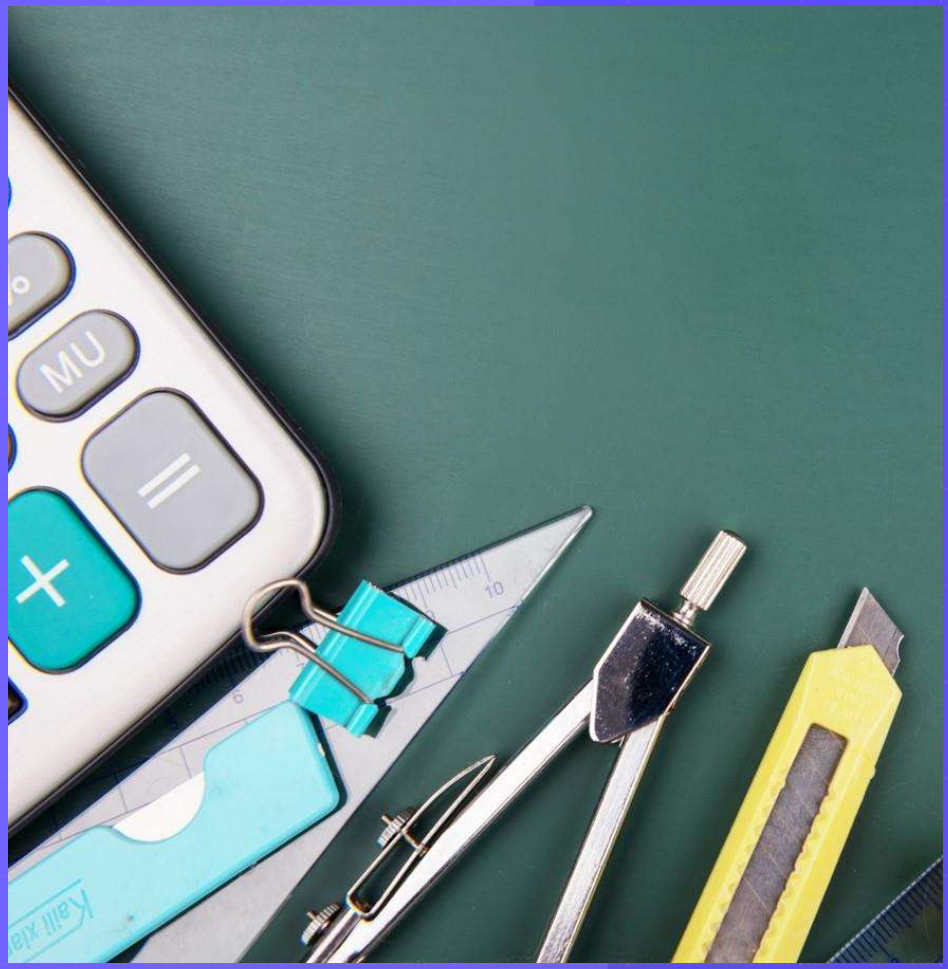


# Brewing with Hops

What's going on

1. Extraction
2. Solubilizing
3. Transformation (Isomerization)
4. Transformation (Oxidation)
5. Transformation (Compounding)
6. Evaporation
7. Biotransformation

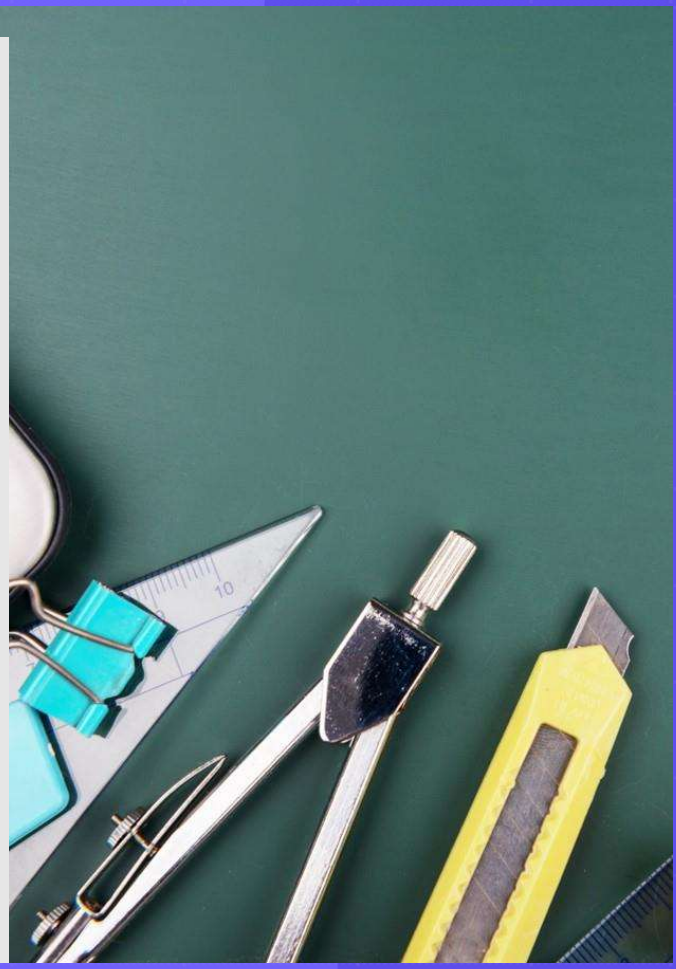


# Hop Utilization

***Table 9.3***

***Basic Hops Utilization Values***

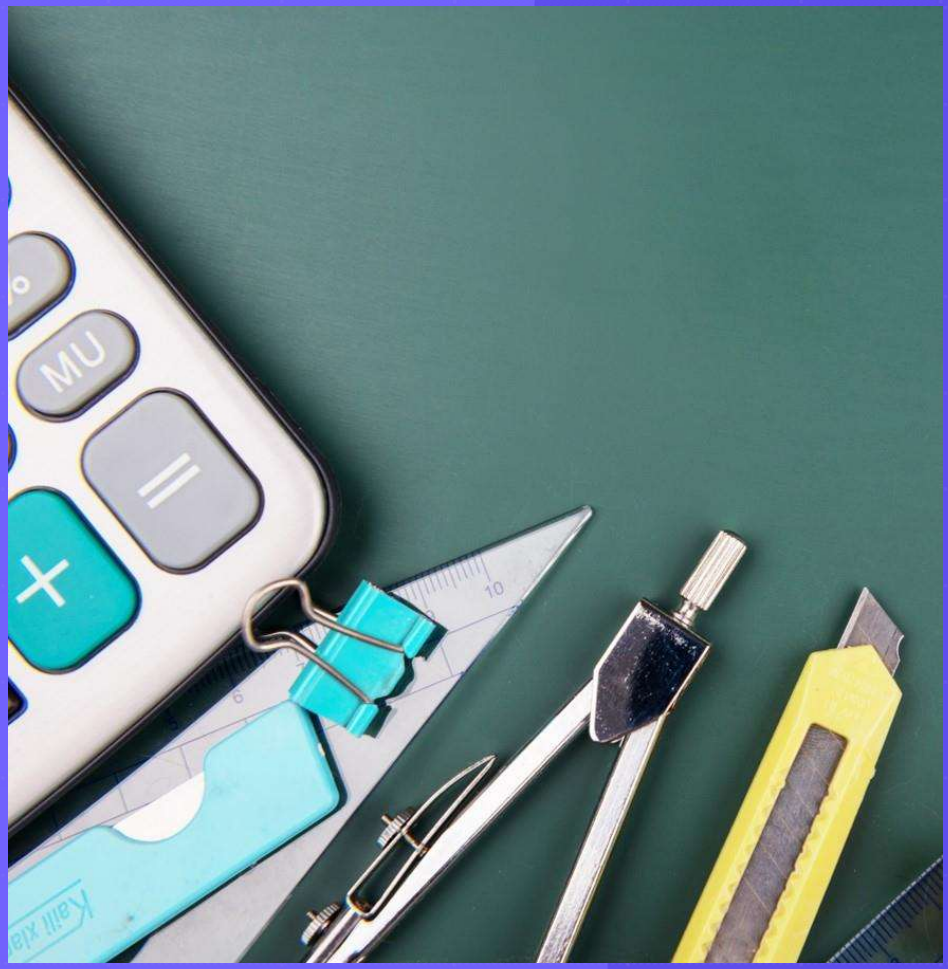
| Boil Time (minutes) | Whole-Hop Utilization (%) | Pellet-Hop Utilization (%) |
|---|---|---|
| Dry hop | 0 | 0 |
| 0 to 9 | 5 | 6 |
| 10 to 19 | 12 | 15 |
| 20 to 29 | 15 | 19 |
| 30 to 44 | 19 | 24 |
| 45 to 59 | 22 | 27 |
| 60 to 74 | 24 | 30 |
| 75 or longer | 27 | 34 |



# Measuring Bitterness

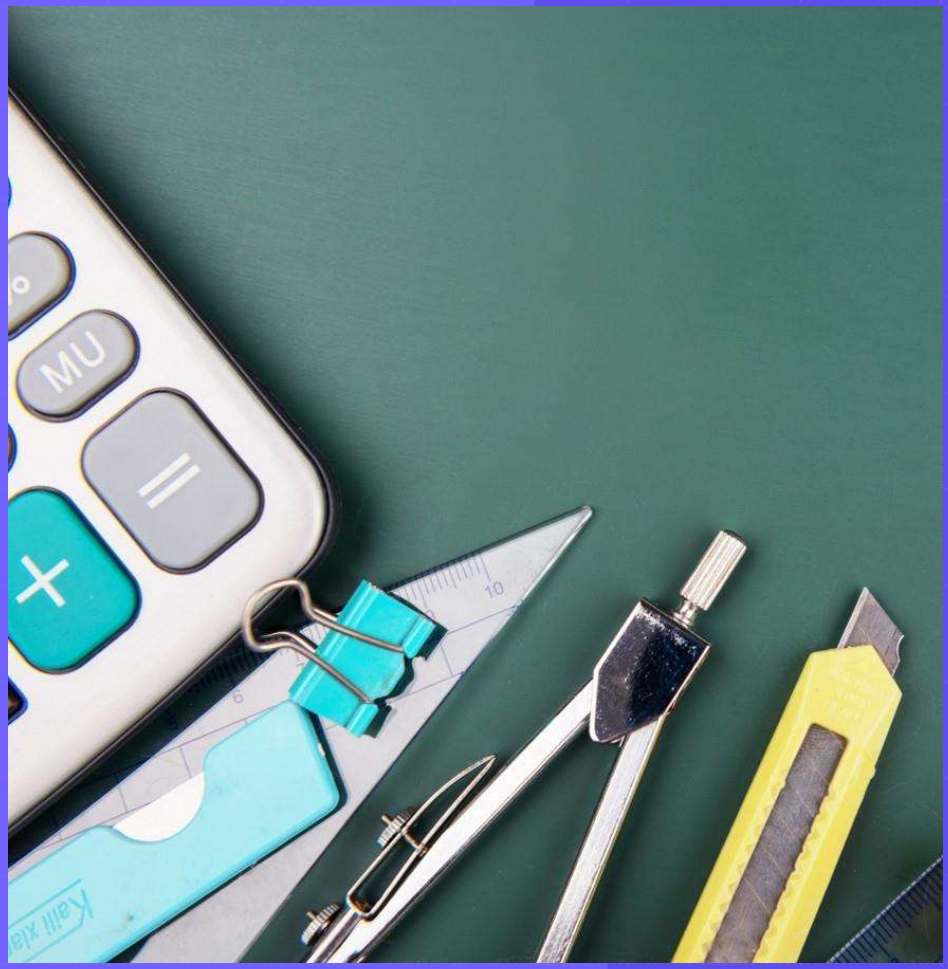
IBU (International Bitterness Units)

- Corresponds to analytical test that measures isomerized alpha and beta acids and other compounds
- Calculators have been developed to convert listed hop alpha acid level and contact time to IBU's
- IBU's are dependent on the brewing conditions (equipment, geometry, heat input, etc.)
- Tinseth is the typically the best but was developed for whole hops and didn't include non boil hop additions
- See Joe Walts' presentation for more in depth coverage.



# Measuring Bitterness

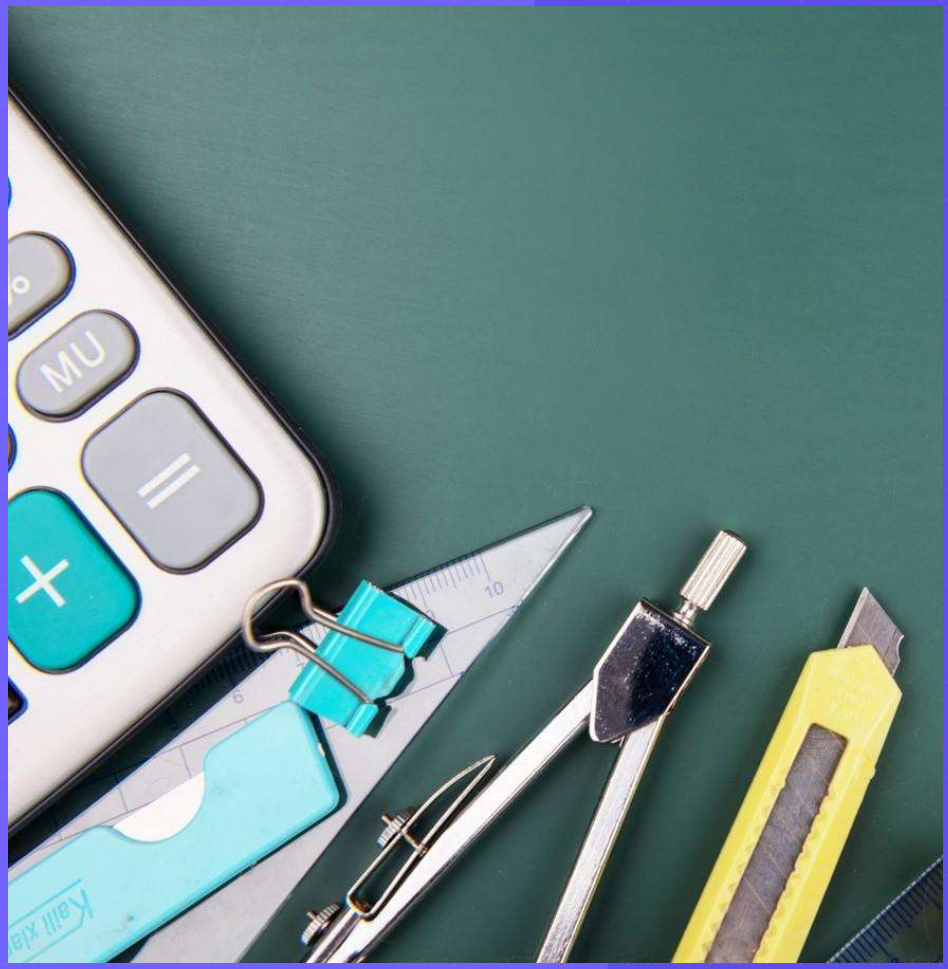
What were the five bitterest beers at the Friday GT Homebrew?



# Measuring Bitterness

What were the five bitterest beers at the Friday GT Homebrew?

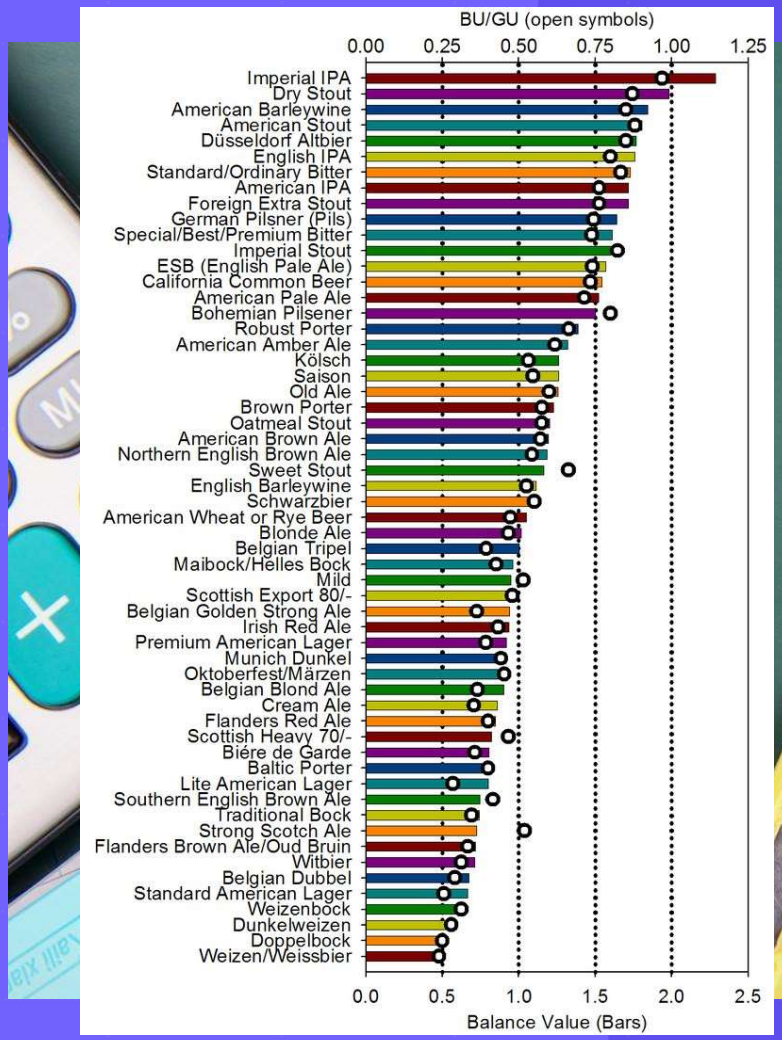
| Beer Name | IBU | BUGU |
|---|---|---|
| Risky Business | 89.4 | 1.077 |
| 14 day IPA | 79.6 | 1.694 |
| Bitter Earl Ooling | 56 | 1.018 |
| Floofer APA | 45 | 0.882 |
| Bathtub Pale Ale | 40 | 0.755 |
| Brexit | 35.2 | 0.880 |



# Measuring Bitterness

Bitterness Ratio BUGU & RBR

- IBU's don't measure the perceived bitterness of a beer, but the ratio of bitterness to maltiness
- BUGU is the IBU/GU (OG X1000-1000)
- RBR is a correction to BUGU to account for dryness of fermentation (it corrects it based upon ADF/FG)
- BUGU is a standard value in Beersmith



# Incentives

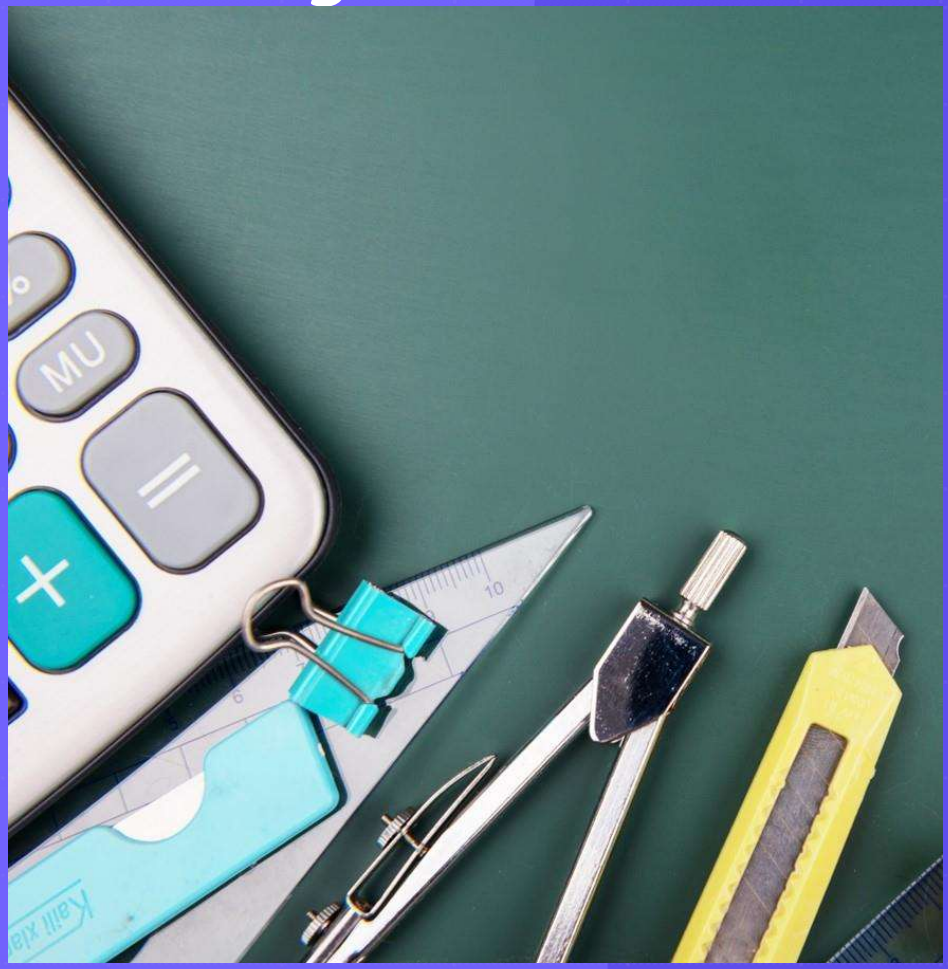
| Beer | O.G. | F.G. | ABV | IBU | BUGU | RBR |
|---|---|---|---|---|---|---|
| Vintage Brewing<br>Sun D'Appled Orchard Ale<br>*Apple Ale* | 1.063 | 1.013 | 6.6% | 11 | 0.175 | 0.178 |
| Potosi<br>Tangerine IPA<br>*IPA* | 1.065 | 1.016 | 6.5% | 55 | 0.846 | 0.830 |
| Doc Crowley's Brewhouse<br>Kveik Fest<br>*Festbier* | 1.043 | 1.006 | 4.8% | 21 | 0.488 | 0.532 |

# Measuring Hoppiness – Tasting Methods

<u>Hot Extraction</u>
- Steep hops in hot water
- Create a hop tea
- Drink

<u>"Dana Method"</u>
- Get sample of mild American beer
- Dose with hop pellets

(Beer cans and sippy covers work well)
- Drink



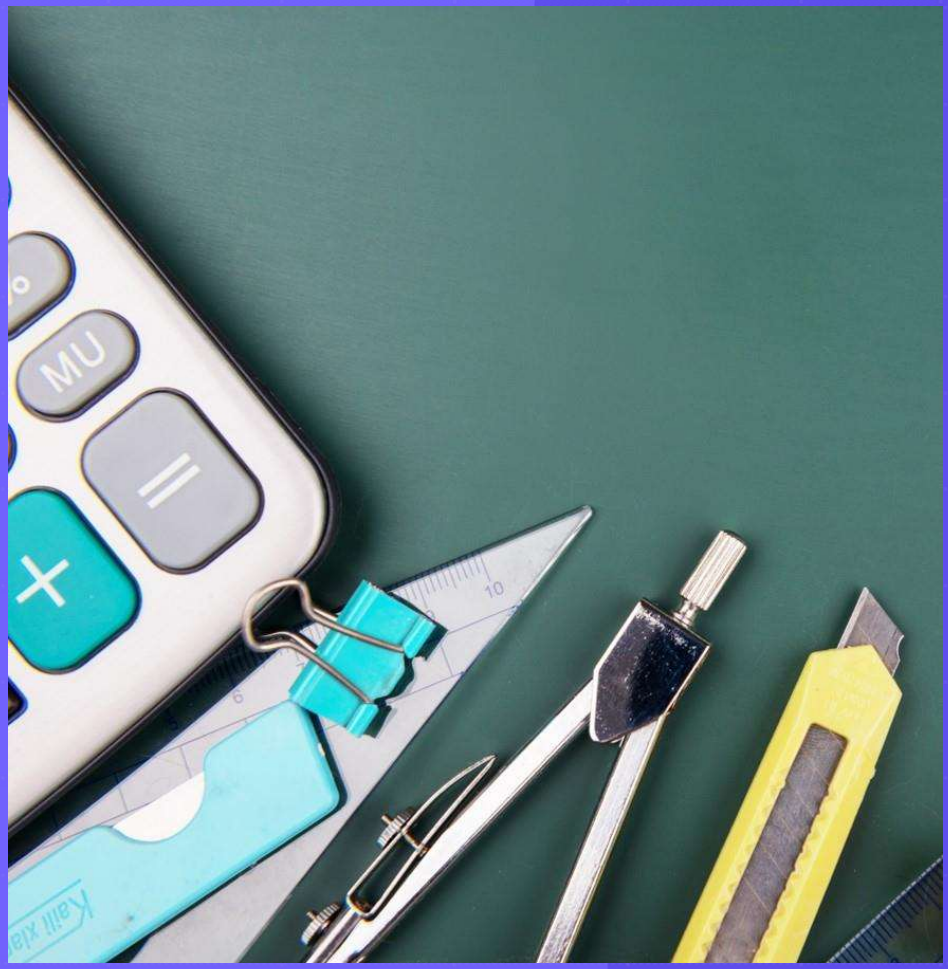
# Measuring Hoppiness – Post-Boil Calculations

Post Boil – Not a lot of IBU's are generated, but can track dosages via IBU calculator

Essential oils do not appear to vary as much as alpha acids do; so total mass of hops is a better measure of essential oil addition

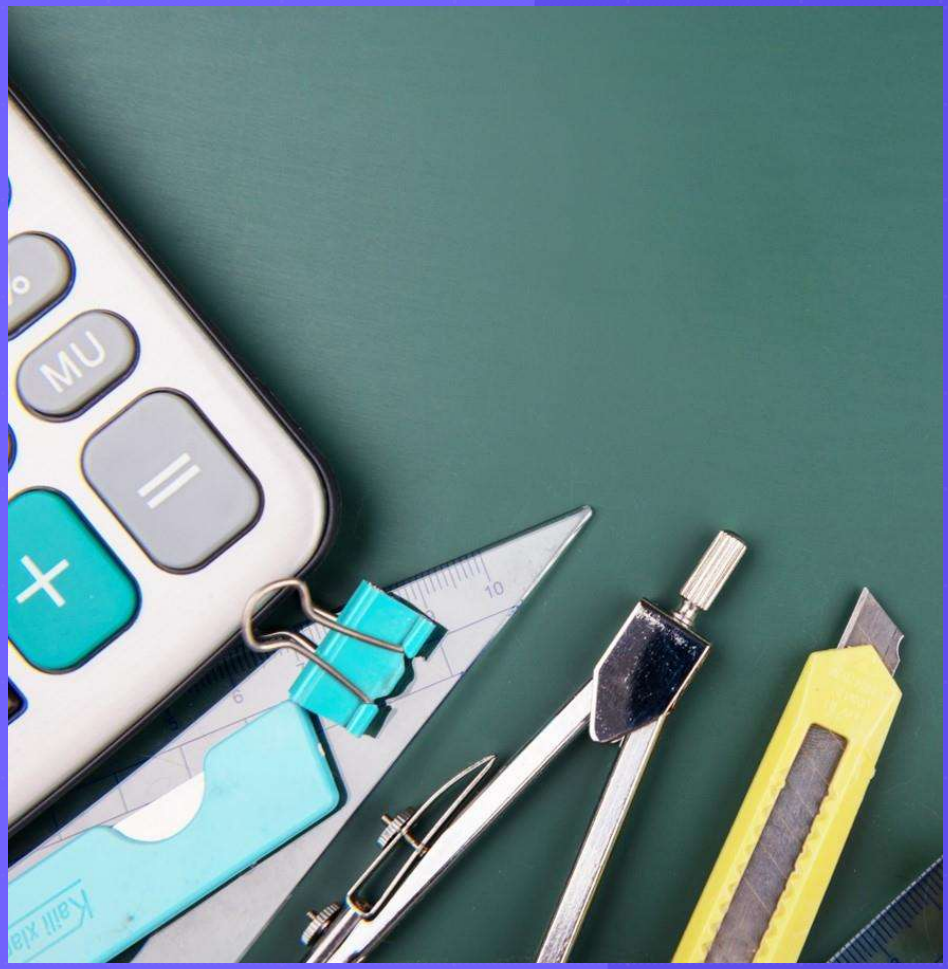
HBU (I would say HHU) might be a good measure of post boil additions for recordkeeping, calibrating future batches, etc.

HBU= mass of hops x steeping time



# Measuring Hoppiness – Post-Boil Calculations

- Each step should be kept distinct, but development is ongoing
- E.g. WHBU (whirlpool bitterness units – I would try to incorporate whirlpool temperature as well)
- PHBU (primary bitterness unit)
- SHBU (secondary bitterness unit)
- DHBU (dry hop bitterness unit), etc.



# Measuring Hoppiness – Survivability


## 1. USE HIGH SURVIVABLES HOPS EARLY (OR LATE)

Hops with higher concentrations of survivable compounds have a better likelihood of being successful when used earlier in the brewing process than hops with low concentrations of these same compounds. Early additions include late kettle, whirlpool, and active fermentation dry hopping (AFDH).

**EXAMPLE**

Idaho 7® is likely a better choice for high-impact whirlpool hopping than Cascade.

This is because Idaho 7® contains higher concentrations of beer soluble compounds that can survive heat and fermentation activity.

## 2. USE LOW SURVIVABLES HOPS LATE

Similarly, we can say that hops with lower concentrations are likely to find better success and a more positive impact in beer when used later in the process, such as post fermentation dry hopping (PFDH).

**EXAMPLE**

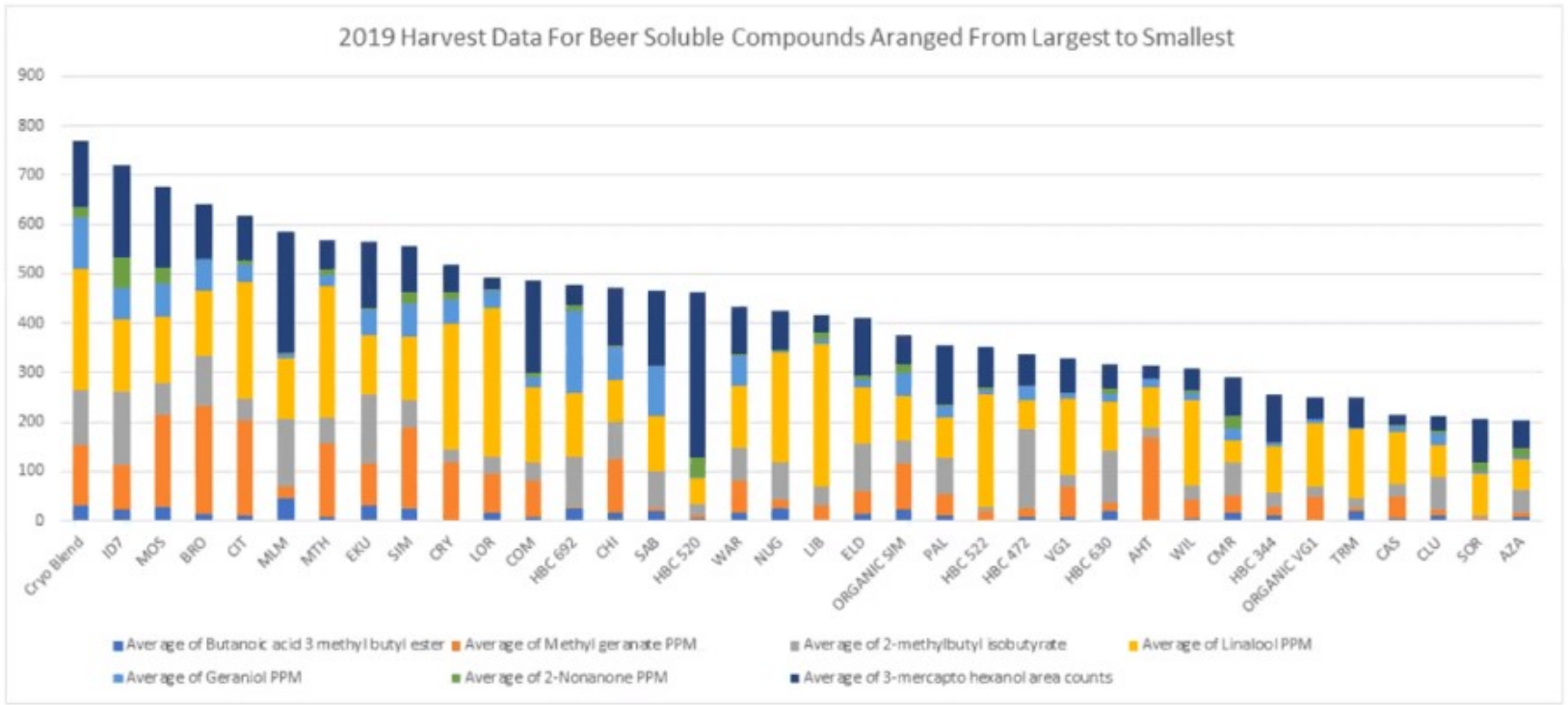
Cashmere will likely make a higher impact in finished beer if used later in the brewing process.

This is because Cashmere contains smaller concentrations of beer soluble compounds that can survive heat and fermentation activity.

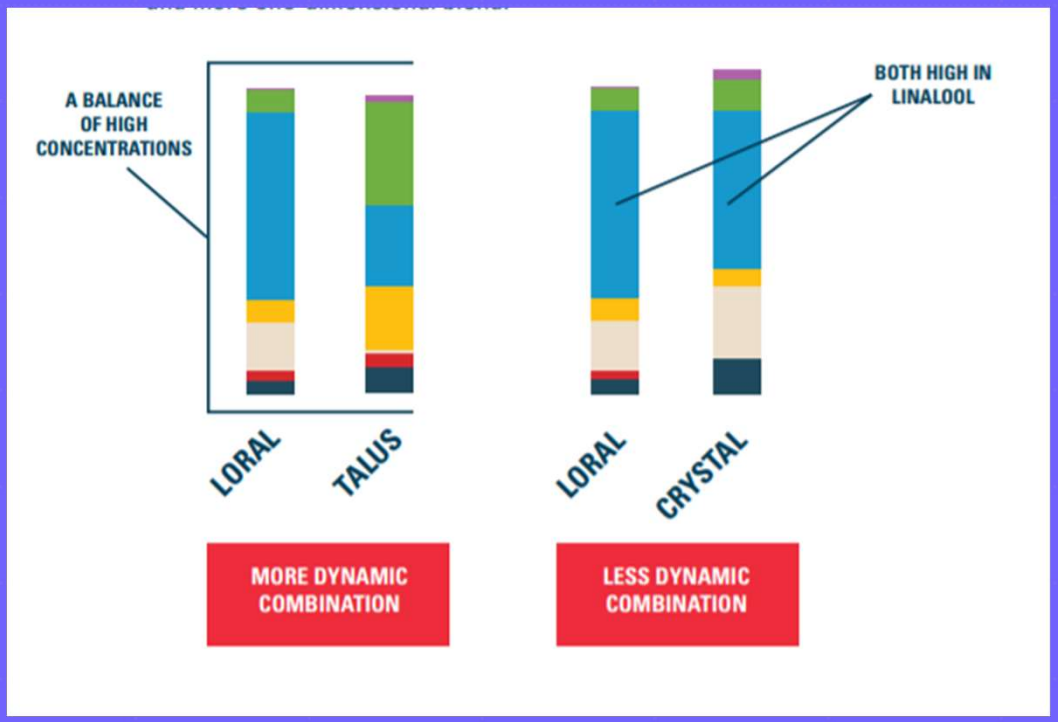
# Measuring Hoppiness – Survivables

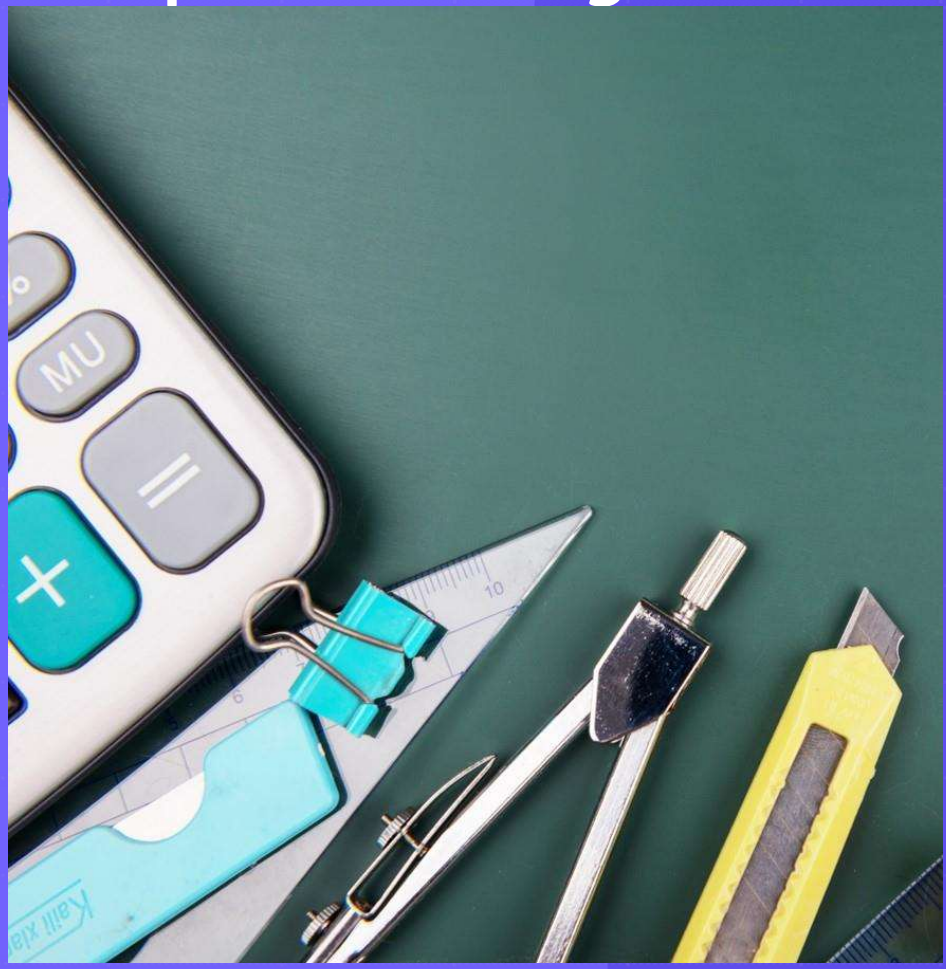
YAKIMA CHIEF HOPS

## "SURVIVABLES"



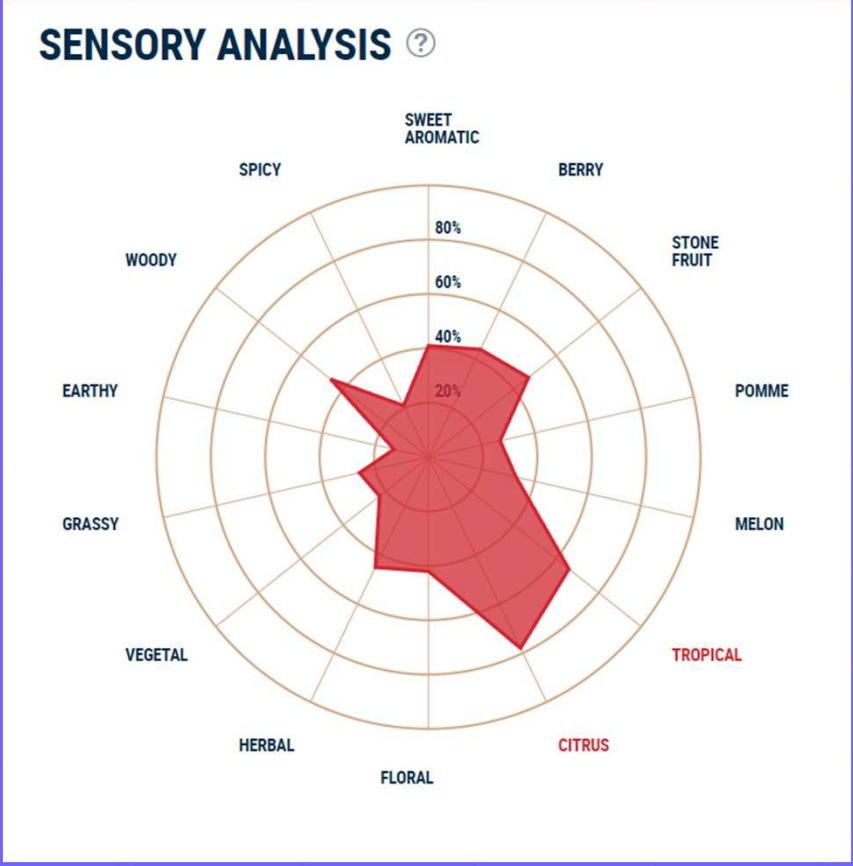

# Measuring Hoppiness – Hop Blending

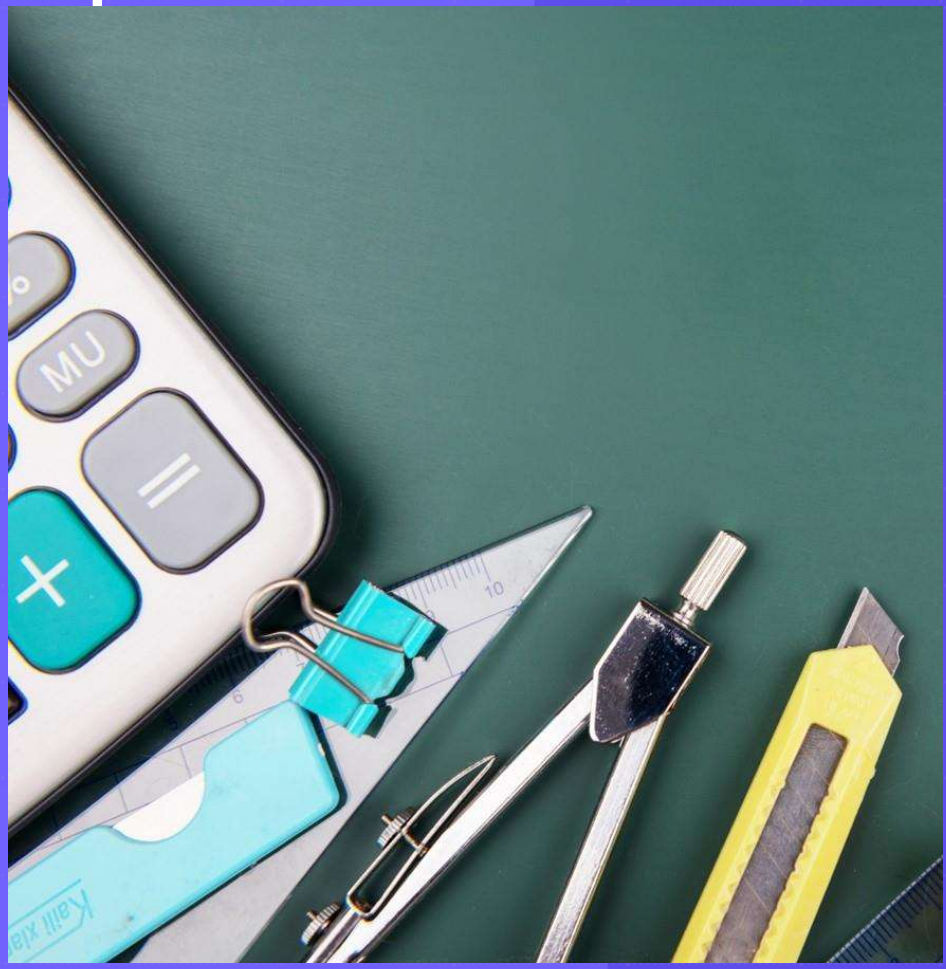


# Measuring Hoppiness – Spider Plots

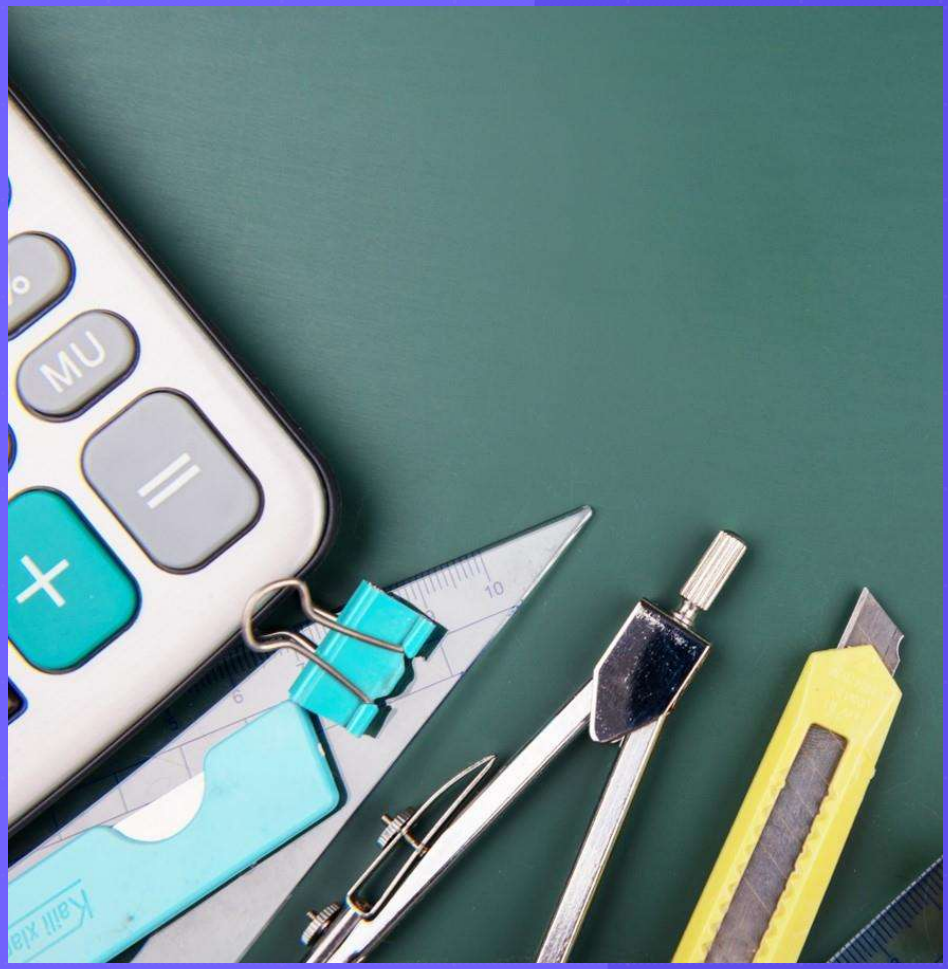
Ekuanot



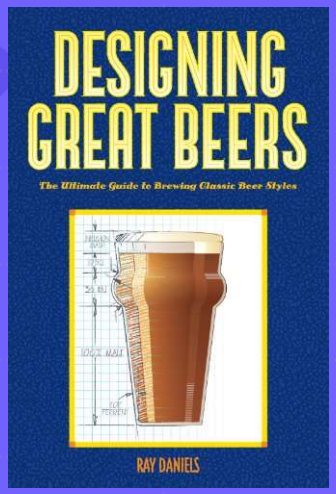
# Measuring Hoppiness – What's next

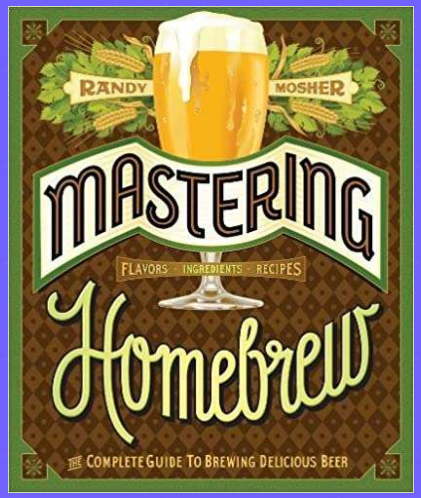
- Hopefully we can schedule YCH for a follow-up education night with more details on survivables, blending, using their spider plots, and cryo hops, and cryo hop blends

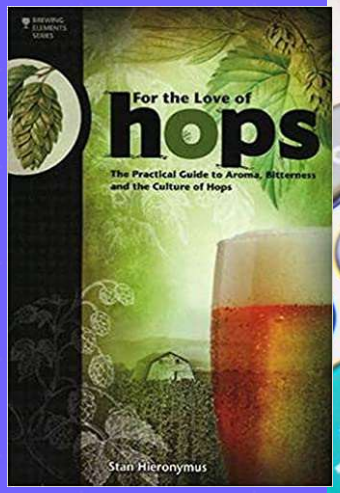


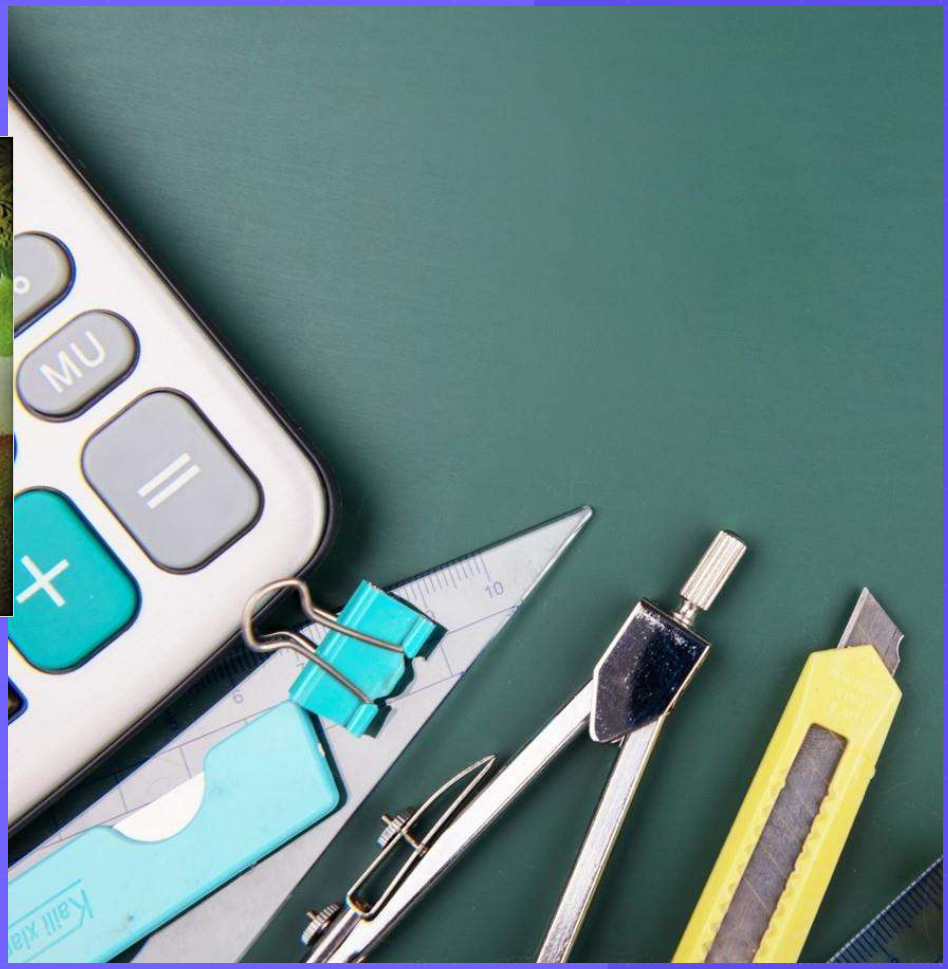
# Who I stole from

- Books



- Joe Walts Club Presentation
- YCH Hop Website

https://www.yakimachief.com/

https://cryopopblend.com/wp-content/uploads/2021/05/Survivable-Compounds-Handbook.pdf