Custom Excel Brewing Spreadsheet
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This spreadsheet is custom-built for our brewing system. We usually mash and boil on an electric stove top with a 7.5-gallon stainless steel kettle, and lauter and sparge with a Phil's Lauter Tun. After boiling, we whirlpool the wort hot to separate the hops and hot break. However, many of the other system specifics are included as input variables, so this spreadsheet should be applicable to other homebrewing systems.

Input Data (for each brew)

- Brew size, in gallons (normally 3 gallons)
- Grain bill (pounds and special color – yields and normal color, in °L, are built in)
- Extraction efficiency (usually assumed to be 75% to 80%)
- Ratio of water to grain for first infusion mash step (usually 0.9 or 1.0 quarts per pound of grain)
- Grain temperature (usually ambient – 70°F in winter or 80°F in summer)
- Water temperature (usually ambient or 136°F (hot tap water))
- Amount of boiling water for second infusion mash step (water is assumed to be 200° to account of heat loss)
- Amount of boiling water for a third infusion mash step, if necessary)
- Wort left in grain after lautering and sparging (usually 0.17 gallons per pound of grain)
- Wort boiled off during brewing (usually 0.7 gallons per hour for me)
- Wort for Speisse (unfermented wort saved for priming wheat beers in place of corn sugar)
- Hop bill (ounces - % alpha acid is built in, and when the hops are added)
- Amount of DI water (total water needed is calculated from above information)
- Salt additions (if any), in grams
- Starting time of brew
- Cold water temperature, ˚F
- Minutes for first infusion mash step (usually protein rest, 10-20 minutes)
- Minutes for second infusion mash step (usually starch conversion, 50 to 80 minutes)
- Minutes for third infusion mash step (usually starch conversion, but normally not used)

Data built into the program

- Tap water cation and anion concentrations, and pH
- Stove duty (heating capability of the stove, in Btu/minute)
- Heat capacities of water, grain, and kettle (in Btu/lb-°F)
- Hop alpha acid concentrations (in %)
- Grain yield (gravity points-gallons/pound)
- Specific gravity temperature corrections
- Appropriate molecular and atomic weights, and other physical properties

The program calculates

- Original gravity (OG) prediction
- Pre-boil gravity (specific gravity of wort after sparging and before boiling)
- Color prediction, in SRM
- Amount of hot water needed for first infusion mashing step, in gallons
- Resulting temperature of first infusion mashing step
- Amount of boiling water needed for second infusion mashing step, in gallons
- Amount of sparge water needed, in gallons
- Time when sparge water should be heated
- Time when mash-out should start
- Resulting temperature of second infusion mashing step
- Hop bitterness prediction, in IBUs (with a gravity adjustment)
- BU/GU (bitterness units to gravity units ratio)
- Amount of time to heat water up to a desired temperature
- Amount of time to heat the wort up to boiling
- Cation and anion concentrations of mixed DI and tap water
- Mash pH (not used much)

Important Equations

Infusion Mashing

First Step Mix Temperature, $T_1 = (w_k c_{pk} T_a + w_g c_{pg} T_a + w_w c_{pw} T_w)/(w_k c_{pk} + w_g c_{pg} + w_w c_{pw})$

w_k, w_g, w_w = weights of kettle, grain, and water, respectively, in pounds (8.3 pounds of water/gallon)

c_{pk}, c_{pg}, c_{pw} = heat capacities of kettle (0.12 Btu/lb-°F), grain (0.40 Btu/lb-°F), and water (1.00 Btu/lb-°F)

T_a = ambient temperature (70-80°F) T_w = water temperature (usually 135-140°F)

Second Step Mix Temperature, $T_2 = ((w_k c_{pk} + w_g c_{pg} + w_{w1} c_{pw})T_1 + w_{w2} c_{pw} T_{wb})/(w_k c_{pk} + w_g c_{pg} + (w_{w1} + w_{w2}) c_{pw})$

T_1 = temperature of first step (usually 120-125°F) T_{wb} = boiling water temperature

w_{w1} = water added in first infusion mash step w_{w2} = water for second infusion mash step

First-Run Wort Volume = water added in each mash step - water remaining in sparged grain (0.17 gallons/pound)

Volume at Start of Boil = Brew size + Water boiled off + Wort losses + Wort for Speisse

Wort losses = 0.45 gallons + 0.1 gallon per ounce of hops (to account for wort left in brew kettle)

Wort boiled off = 0.7 gallons per hour of boiling

Sparge Water = Volume at Start of Boil – First-Run Wort Volume

Stove Heating Time in minutes = $(T_f - T_i)(w_w c_{pw} + w_g c_{pg} + w_k c_{pk})/Q$

T_i, T_f = initial and final temperatures, respectively, in °F Q = stove duty in Btu/minute

Original Gravity prediction = $1+((\Sigma w_{gi} y_{gi})E + \Sigma w_{ei} y_{ei})/V_w$

w_{gi} = weight of each grain mashed y_{gi} = OG yield of each grain (in gravity points-gallon/pound)

w_{ei} = weight of each extract added to boil y_{ei} = OG yield of each extract (in gravity points-gallon/pound)

E = mash extraction efficiency (assumed to be 80%. It ranges from 70 to 90%.)

V_w = volume of wort at end of boil (volume for fermenter + wort losses)

Color prediction

Malt color units (MCU) = $((\Sigma w_{gi} C_{gi}) + \Sigma w_{ei} C_{ei})/V_w$

If MCU is 10 or less, SRM = MCU

If MCU is 10 to 15, SRM = 0.6MCU + 4

If MCU is 15 or higher, SRM = 0.22MCU + 9.7

C_{gi} = Color of each grain, °Lovibond C_{gi} = Color of each extract, °Lovibond

Hop bitterness prediction

Bitterness extraction factor versus boiling time, $b_t = 0.62(t_b^{0.83})/(31.3+t_b^{0.83})$

t_b = minutes left in the boil

Gravity adjustment factor, $G_f = 1 - 78.2(OG - 1)^{2.44}$

IBUs = $G_f(\Sigma h_{i,t} aa_i h_c b_t)$

The summation is each hop quantity in ounces ($h_{i,t}$) times it alpha acid (aa_i) times the hop correction factor (h_c, 1.0 for pellets or 0.8 for whole hops) bitterness extraction factor (b_t) corresponding to the time the hops are added.

Steps in Developing a Recipe

Develop a list of key malt and hop ingredients. (I usually do this in my head or check the BJCP style guidelines.)

Enter estimated quantities of grains and extracts into the grain window (Worksheet #1). This is an iterative process where I change quantities of various grains and extracts to hit desired OG and SRM numbers.

Enter estimated quantities of hops into the hop window (Worksheet #3). This is also an iterative process where I enter quantities of hops into specific time slots to meet IBU targets. Hop quantities entered at 10 to 15 minutes contribute hop flavors, while hops added at 10 minutes or less contribute aromas. (Flavor and aromas are not quantified, but bitterness is.)

Decide whether to use 0.9 or 1.0 quarts of mash water per pound. Usually, lighter beers use 1.0, while heavier beers use 0.9. Decide whether only tap water is used, or a mix of tap water and DI (for Belgian or Bohemian Pilsners, for example). Specify water and ambient temperatures in the mash window (Worksheet #2).

Enter an estimated quantity of water for the second mash step. This is an iterative process where I enter the gallons of boiling water to hit desired mix temperature for the saccharification rest.

Enter the amount of DI water used in the water window (Worksheet #5). This worksheet is only used if DI water is used to emulate soft water. This sheet calculates ion concentrations.

Enter the start time and the durations of the infusion steps into the recipe notes window (Worksheet #7). This worksheet summarizes the various brewing steps on a single sheet. I use this sheet in the kitchen while brewing.

Start brewing!

The stove window (Worksheet #4) is used to calculate how long it will take the collected wort to boil. The temperature correction window (Worksheet #6) is only used for looking up temperature correction factors for original gravity measurements.