Brewing Formula List

Malt Grist Calculation

Ingredient	Potential Extract (L°/kg)	Colour (°Lovibond)
Pale Malt	305	2-5
Lager Malt	300	1-2
Wheat Malt	300	1.5-3
Light Crystal Malt	265	10-40
Crystal Malt	268	60-120
Amber/Brown Malt	280	25-70
Chocolate Malt	268	350-450
Black Malt	265	500-600
Roasted Barley	260	650

Extract

To design a malt bill a number of variables must be known. Firstly, the desired **specific gravity** of the brew. In the case of a British ordinary bitter, this might be around 1.038. From this figure we can work out the **excess gravity**: this is simply the remaining figures of the specific gravity if we remove the 1 and decimal place. Eg. 1.038 becomes just 38.[1]

As well as the excess gravity we must also define the **volume** of beer we are making. If you are homebrewing, this will usually be between 20 and 100 litres.

Lastly, we must also know our mashing efficiency as a percentage of the potential extracts listed in the chart above. This is more of an issue for homebrewers than commercial brewers, as in homebrewing the figure is typically much lower. If you haven't brewed on your kit before, you might predict an extract of 75% of lab evaluated extracts (potential extract). Commercial brewers would be unhappy with less than 90%, but you can always dilute the beer to gravity before fermentation, end up with more beer and adjust your calculations for next time.

So, to calculate how much malt we need for a given volume of beer at a given excess gravity, we first calculate the total extract required. This is expressed as L°, and represents the total fermentable material in the wort. The total extract can be calculated as follows:

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[1] The actual calculation here is the specific gravity minus 1 and mulitplied by 1000. In this instance, 1.038 - 1 = 0.038. 0.038 x 1000 = 38.

$$\text{Total Extract (L°)} = \frac{\text{Excess Gravity} \times \text{Volume (L)}}{\text{Mash Efficiency (\%)}}$$

To take the example of 20 litres of bitter at 1.038 specific gravity with a mash efficiency of 75%, the extract would be calculated thus:

$$\text{Total Extract (L°)} = \frac{38 \times 20}{0.75}$$

(Note that the mash efficiency is expressed as a decimal percentage.)

The desired total extract, then, would be 1013.3 L°.

Now that we know the total extract desired from the mash, then, we can work out the **weight** of fermentables necessary to achieve the extract. This is because, as can be seen in the table at the top of the first page, the potential extract of each ingredient is a known value. (Note: information for any ingredients not listed above is easily searchable or may be obtained from the supplier.)

At its simplest, all we need to do is divide the desired extract as L° by the known value of the malt used in L°/kg to calculate the weight of malt required in kg. So, if our beer requires 1013.3 L° of extract and is brewed using pale ale malt, which yields 305 L°/kg, we just need to divide the total extract by the expected extract per kilo of pale malt.

$$\text{Weight Malt (kg)} = \frac{\text{Total Extract (L°)}}{\text{Potential Extract (L°/kg)}}$$

Or

$$\text{Weight Malt (kg)} = \frac{1013.3}{305} = 3.32 \text{ kg. Pale Malt}$$

So, mashing 3.32 kg of pale malt would give 20 litres of wort at 1.038° SG based on a 75% mash efficiency. HOWEVER, there are few beer recipes that contain only one malt variety or fermentable. Because of this we usually have to divide the total desired extract on a percentage basis before the weight of each ingredient is calculated individually.

For example, we may also want to put crystal or even black malt in our ordinary bitter. A typical percentage for these ingredients might be 7% crystal malt and 2% black malt along with 91% pale malt. Once this break-down has been finalised, we can first divide the total extract appropriately:

Pale Malt - 0.91 x 1013.3 = 922.1 L°
Cystal Malt - 0.07 x 1013.3 = 70.9 L°
Black Malt - 0.02 x 1013.3 = 20.3 L°

And then calculate the necessary weight of each ingredient based on its potential extract.

Pale Malt - 922.1 / 305 = 3.023 kg
Cystal Malt - 70.9 / 268 = 0.265 kg
Black Malt - 20.3 / 265 = 0.076 kg

This final weight gives us the make-up of our grist.

Colour

As Ray Daniels explains in an excellent chapter on colour in *Designing Great Beers*, a unified system of colour calculation does not exist as does the above system for calculating extracts and grain weights. This is for two reasons- firstly, commercial brewers do not need to predict final beer colour often as they brew the same products every day. Secondly, as colour, especially in light beers, is affected by process as much as recipe (a longer, more powerful boil will increase darkening due to Maillard reactions, as will hot side aeration), an exact calculation would be impossible. Because of this most brewers will estimate colour based on prior experience and trial and error.

Nevertheless, to assist homebrewers and craft brewers likely to brew one-off beers where colour is important, Daniels suggests a calculation based on **Malt Colour Units** (MCUs). This calculation is made for each ingredient in a malt bill thus:

$$\text{MCU} = \frac{°\text{ Lovibond Rating x Weight in pounds}}{\text{Volume of batch in gallons}}$$

The value for each ingredient is then added to calculate a total MCU value for the beer.

Obviously, this creates an initial problem to those of us working in metric units, but conversion isn't too hard using an online calculator. The 20 litre (5.3 Gallon) recipe from our malt grist conversion would be calculated as follows.

$$\text{MCU} = \frac{°\text{ Lovibond Rating x Weight in pounds}}{\text{Volume of batch in gallons}}$$

= Pale Malt: 5 x 6.66 / 5.3 = 6.28
Crystal Malt: 60 x 0.58 / 5.3 = 6.56
Black Malt: 500 x 0.17 / 5.3 = 16

(Based on theoretical Lovibond values- for exact values check the packaging of your ingredients.)

At this point we can add the value of each ingredient- ie 6.28 + 6.56 + 16 to calculate a total MCU value in this instance of 28.84.

Here a problem arrises in that, for the reasons listed above of processing differences etc., MCUs cannot be directly converted into a final SRM or EBC colour rating in a finished beer. However, Daniels provides us with a rough conversion chart which I have reproduced below. On it we can see that our working example of the bitter with an MCU value of 28.84 would roughly equate to a final SRM of around 10, giving a ‘dark amber’ colour. Although again it should be kept in mind that, depending on process, this could end up significantly higher or lower. It is worth noting too that the lower the MCU value (ie the lighter the beer), the more colour is effected by process rather than malt colour, and thus the less accurate this table will be.

MCU	SRM	Colour
1-10	1-10	Pale to Light Amber
11-20	8-12	Amber to Dark Amber
21-30	11-15	Dark Amber to Copper
31-40	14-17	Copper
41-50	17-20	Light Brown to Brown
50-85	20-30	Brown to Black
> 85	> 30	Black to Opaque Black