Introduction.

Although brewing beer from kits, and from malt extract, can produce some excellent results, many brewers would like to progress to another level by going all-grain. This final step is not as difficult as many would have you believe; In fact it can be made quite simple as can be shown at the "BREWDAY-SUNDAYS" we hold each month. This booklet has been produced for brewers participating in our "BREWDAY" to assist them in brewing world class beers at home using the most elementary of mashing techniques coupled with very basic equipment. We are not implying that you should not try more sophisticated equipment and techniques; Just that you can be successful with these basic methods. Perhaps it will even encourage you to advance to that higher plane of sophistication.

Mashing Procedure.

The Mash.

We use a double bucket system that can be either copied, or modified to suit equipment that you have. The basic method can be related to pretty well any system you will find in the myriad of brewing books available.

First is to make sure all equipment is clean. Heat the mash water to about 80c and add to the mash tun. We use about 3 litres per kilo of grain. Adjust the temperature to "strike water" temperature (usually about 72C - see calculations on page 4) Next stir in all of the grain, stirring to make sure it is all evenly wetted.

The temperature will now be at 65-66c. You need to now try to maintain this temperature for 90-120 minutes. This can be achieved by the addition of small quantities of boiling water every 15 minutes and stirring; or by turning on the heater element for a couple of minutes if you have a similar system to ours.

A temperature drop of a few degrees over the period of the mash is not too much of a problem, but initial "strike" temperature is important. (See page 4 under "Mash Temperatures")

The Sparge.

While the mash is under way we can heat the sparge water to about 80C. (Calculation of quantity of sparge water is on page 7 under "Batch Sparging")

Sparging is best carried out at between 76-78C, at which temperature the enzymes are destroyed ("mash-out"), the sweet wort is thinned down to flow better and the sugars are more soluble, but the temperature is not high enough that excess tannins are extracted from the husks. To do this effectively the mash must be heated by the heater element, or by the addition of hot water. (Some of the sparge water works fine)

Sweet wort can be now slowly run off into a jug and returned gently to the top of the mash until the wort begins to clear. This way the grain bed is used to effectively filter out the trub.

The wort can now be run into the boiler and the actual sparge can proceed. There are two common methods:

(1) Fly sparging where the heated sparge water is gently sprayed onto the top of the grain bed as the wort is being run into the boiler. (Trying to keep a thin layer of liquid on top of the grain bed until the sparge water is all used.)

(2) Batch sparging, which is our preferred method. (See page 6 to 8 for an article by Steve Nicholls)

The Boil.

Bring the sweet wort to the boil. Be ready to stir as it reaches boiling point so as not to boil over. Allow to boil for 30 minutes and then add the bittering hops. At this addition it is imperative that you stir as it will want to boil over. Once it has settled down to a good even rolling boil, it can be left to boil for a further 60 minutes. Whirlfloc kettle finings can be added 15 minutes before the end of the boil, and the flavour hops at 5 minutes. Note that if you are using a wort chiller, you need to put this in for about 5 minutes.

Cooling.

The bitter wort must now be cooled to about 30C. The quicker you do this the better. You can stand the boiler in a trough of cold water, or you can use a cooling coil. The wort can now be transferred to the fermenter, stirring and splashing it to dissolve oxygen, and the yeast can be pitched

Fermentation.

Your beer can now be fermented as normal.

Let us talk about malted grains.

We assume that you know enough about malted barley to be familiar with types, colours and mashing requirements. This note is about calculating amounts and types.

Grain quantities.

If a recipe calls for a particular original gravity, final gravity and/or %age alcohol by volume (ABV) then the following formula are needed:

Extract figures for well modified malted barley are expressed in "Brewers Degrees per Kilogram Litre" (BD/KL).
Brewers Degrees are a simplified version of Specific Gravity in that 1BD = .001SG

eg SG 1.050 = 50 BD and
SG 1.012 = 12 BD

Kilogram per Litre refers to the maximum extract that it is possible to produce when 1 kilogram of well modified malt is mashed to give 1 litre of wort.

The BD/KL for Australian malts is generally considered to be 307 for ale malts, and 302 for lager (pilsner) malts
This information can be used 2 ways: Either "Extract Efficiency" or "Quantity of Malt"

Extract Efficiency:- To establish how much of the possible sugar your mashing & sparging system gets you can use the formula:-

$$\text{Extract efficiency} = \frac{\text{Original Gravity in BD} \times \text{Volume} \times 100}{\text{BD/KL} \times \text{Weight of Malt in Kilograms}}$$

For example: A brew of 25 litres made from 5 kg of malted grain achieves a final gravity of 1.050.

$$\text{Extract Efficiency} = \frac{50 \times 25 \times 100}{307 \times 5} = 81.43\%$$

This is about the required efficiency, and if you can maintain this figure over a number of brews, then you c an use it to calculate the required amounts of malt to achieve a required Original Gravity.

Quantity of Malt:- Once you know the efficiency of your system the formula for quantity is:-

$$\text{Quantity of Malt} = \frac{\text{OG in BD} \times \text{Volume} \times 100}{\text{EBC Extract} \times \text{Mash Efficiency}}$$

For example: To achieve an Original Gravity of 1.050 using Ale Malt (EBC Extract = 307) in a 25 litre batch if your efficiency is 82%, the equation becomes:-

$$\text{Quantity of Malt} = \frac{50 \times 25 \times 100}{307 \times 82} = 4.96 \text{ kg. (Say 5 kg)}$$

Let Us Talk About Malted Grains. (Contd.)

Strike Water Volumes:-

There are various theories about the best water/grist ratios for mashing particular beers. Some require a very thick mash of 1.5 litres of water per kilo of grain while others are more liberal at up to 5 litres per kilo. We generally use 3.0 to 3.5 litres per kilo simply because it suits our system. Thus, for 5 kg. Of grains, we would need 15 to 17.5 litres.

Mash Temperatures:-

Diastatic conversion takes place between the temperatures of 61C to 70C. Most brewers aim for around 65C to get a good balance between fermentable and non-fermentable sugars. Lower temperatures give higher fermentables and lower final gravities (ie Drier beers) Higher temperatures give more non-fermentables and higher final gravities. Generally a mash temperature of 64C will give a final gravity of 1006, while a mash temperature of 67C will give a final gravity of 1012.

Due to high enzyme content of modern malts you will find that the most of conversion happens in the first 5 minutes. It is critical to get the strike temperature right.

Strike Water Temperature Calculation:-

To calculate the strike temperature you require the following
Malt mass in kilograms (Malt)
Malt temperature ie. Room Temperature (R/T)
Volume of water in litres (Vol)
Desired mash temperature. (Mash Temp)

$$\text{Strike Water Temp} = \frac{\text{Mash Temp.} \times (\text{Vol} + \{0.4 \times \text{Malt}\}) - (0.4 \times \text{Malt} \times \text{R/T})}{\text{Vol}}$$

Thus, if you are mashing 5 kg malt in 15 litres of strike water with a room temperature of 20C and you wish to achieve a mash temperature of 66C, then the calculation is:

$$\text{Strike water temp.} = \frac{66 \times (15 + 0.4 \times 5) - (0.4 \times 5 \times 20)}{15}$$

$= 1122 - 40 / 15$
$= 72.13\text{C}$ Say 72C

Colour of Wort:

Although colour is an important consideration in brewing beers to style, there does not seem to be any simple formula to calculate the expected colour using colour rating of grains. It seems that colour does not develop on a proportional basis, so I can only suggest that you follow existing recipes for trial brews and alter quantities on subsequent brews to suit your requirements.

Calculating Hop Quantities.

There is a formula that will estimate hop quantities for given recipes, based on International Bitterness Units (IBU) as specified by the European Brewing Convention (EBC). Bitterness is expressed in milligrams of Alpha Acid per litre of beer, and Alpha Acid is expressed as a percentage of AA in a particular batch of hops. Note that as AA rating vary from crop to crop it is essential that your supplier should be able to give you the actual AA % of hops that are being offered.

To give you an idea of bitterness figures for commercial beers, some are listed below:

Victoria Bitter 26IBU
Coopers Sparkling Ale 24IBU
Guinness Stout 47IBU
Bass Pale Ale 30IBU
Lowenbrau 24IBU
Pilsner Urquell 43IBU
Cascade Premium Lager 25IBU
Emu Bitter 29IBU

The weight of hops needed to achieve the bitterness levels we require can be calculated by the formula:

$$\text{Weight in grams} = \frac{10 \times \text{IBU} \times \text{Batch Volume}}{\text{Utilization Factor} \times \text{AA}}$$

Where :

IBU = The required IBU of the beer.

Batch Volume = The actual volume in the boiler at the end of the boil (including trub left in the boiler)

Utilization Factor = The amount of AA that is actually utilized in the boil. (see chart below)

AA = Alpha Acid %age of the hop being used.

Utilization Factor Applicable for different boil times

BOIL TIME	PELLETS	FLOWERS
Less than 5 minutes	5.0%	4.2%
6 – 10 minutes	6.0%	5.0%
11 – 15 minutes	8.0%	6.7%
16 – 20 minutes	10.1%	8.4%
21 – 25 minutes	12.1%	10.1%
26 – 30 minutes	15.3%	12.7%
31 – 35 minutes	18.8%	15.7%
36 – 40 minutes	22.8%	19.0%
41 – 45 minutes	26.9%	22.4%
46 – 50 minutes	28.1%	23.4%
51 – 60 minutes	30.0%	25.0%

This formula is quite accurate for normal strength beers, but needs a correction factor for worts with an OG of more than 1.050 before the boil. See next page for this adjustment.

Hopping Rate Corrections For Higher Gravities.

Where the gravity of the wort to be boiled is above 1.050,(or where the boiler is too small to boil all the wort and you are boiling all the malt in a smaller quantity of water) the following correction can be used.

$$\text{Gravity Adjustment} = \frac{[\text{Gravity of wort to be boiled} - 1.050] \times 100}{0.2} \%$$

This gives the %age increase in hop rate required. Eg.

$$\text{Gravity adjustment for } 1.090 = \frac{[1.090 - 1.050] \times 100}{0.2} = 20\%$$

Thus if you calculate that 60 gms of hops are required by the original formula then 72 gms would be required if the wort to be boiled was 1.090 gravity

Hop Substitution

Often hop varieties called for in recipes are not available and it is necessary to substitute with another hop of similar characteristics but different Alpha Acid ratings. In this case the formula is:

$$\text{Quantity of substitute hops} = \frac{\text{Alpha Acid Recipe Hops}}{\text{Alpha Acid Substitute Hops}} \times \text{Quantity recipe hops}$$

Thus if the recipe calls for 40 gms Perle at 6.5% and your substitute is Spalt at 4.6% then :

$$\text{Quantity of Spalt} = \frac{6.5}{4.6} \times 40 = 56.5 \text{ gm}$$

Note that you also need to adjust where you change between hop pellets and whole hops (flowers). To do this you need to use the utilization factors on the previous page.

Note also that the above calculations are for bitterness only and do not apply for flavour and/or aroma hopping, where you usually go gram for gram.