The Mashing Process -

Reasons for Mashing

Mashing is the most important process in wort production. During mashing the crushed grains and hot water are mixed together, the contents of the malt are brought into solution and an extract obtained. The enzymes within the malt are activated and thus breakdown the starch into sugars which can be fermentable or non-fermentable. Certain other substances required by the fermentation process, inorganic materials and some proteins are extracted. However some materials such as tannins from the husks are not required and have to be controlled.

Factors Affecting Mashing

The composition of the wort is very dependent on the mashing procedure and of course the wort composition will effect the beer flavour. The factors which influence starch degradation during mashing are of importance to the brewer. These factors are:

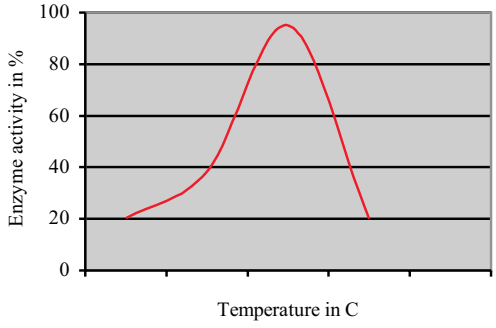
- temperature during mashing
- mashing time
- pH during mashing
- mash concentration

1. Temperature during mashing

Temperature has a two-fold effect, first on the rate of enzyme activity and secondly which enzyme is most active at a given temperature and the effect this has on the starch degradation.
Each enzyme within the malt has a given temperature at which it is most active (fig. 1).
Specific enzymes each have a temperature at which they are most active.

- β-gluconase 45 to 50°C
- β-amylase 62 to 65°C
- α-amylase 70 to 75°C

Fig. 1



By mashing for a long time at 62 to 65°C beer with a high attenuation limit is obtained (high fermentability, dry palate). By mashing for a long time at 70 to 75°C beer with a low attenuation is obtained (low fermentability, sweeter palate).

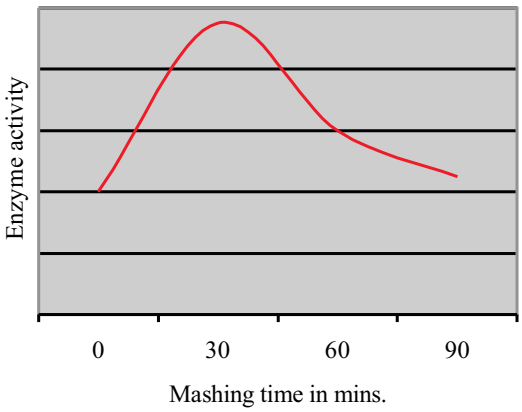
2. Mash times

Each enzyme reaches its maximum activity after 10 to 20 minutes, after 40 to 60 minutes enzyme activity at first decreases rapidly, but the reduction in activity continuously decreases (fig. 2).

So in general:

With increasing mashing time the concentration of the extract solution increases, but the rate of increase becomes slower and slower.
With increased mashing time (especially when mashing at 62 to 63°C) the maltose level increases and with it the attenuation limit. These worts should produce a vigorous main fermentation.

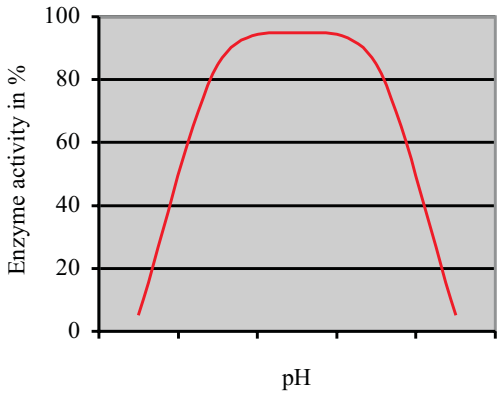
Fig. 2



3. Mash pH

Each enzyme reaches a maximum activity at different pH values, and decreases at higher or lower pH values (fig. 3). The effect of pH on the mashing process is in general not as large as the effect of temperature. The optimum pH for mashing can be regarded as 5.5 to 5.6.

Fig. 3



4. Mash concentration

In thin mashes more extract goes into solution but thicker mashes protect the enzymes from the effects of temperature. In thicker mashes the amount of fermentable materials and the attenuation limit is increased.

Methods of Wort Production

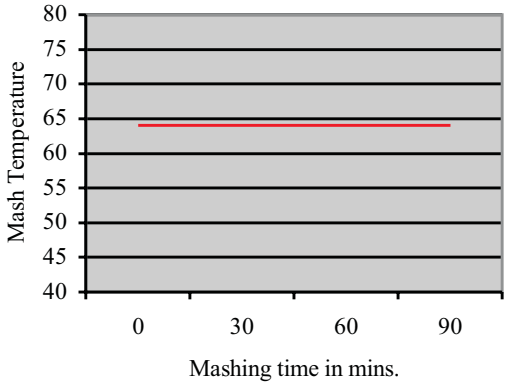
There are three mashing methods used for the production of wort.

- Single-stage Infusion Mash.
- Multi-stage Infusion Mash.
- Decoction Mash.

1. Single-stage Infusion mash

Here the ground malt and hot liquor is mixed to achieve a temperature between 62 to 66°C (fig.4). The mash is left to stand for 60 to 90 minutes allowing the enzymes to breakdown the starch in a range of fermentable and non-fermentable sugars. For this

Fig. 4



method of mashing to produce a good extract the malt must be highly modified. This is the normal method used in British breweries to produce ales and stout.

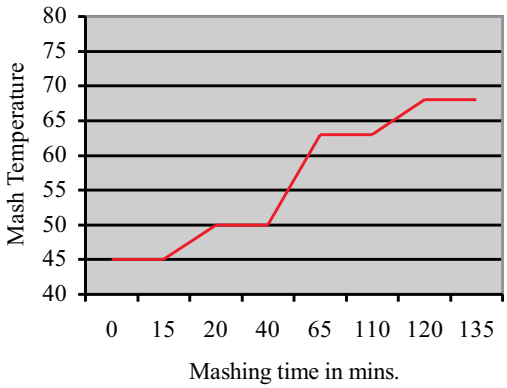
2. Multi-stage Infusion mash

Here the initial mash-in temperature is lower and is raised during the mashing process either by the addition of hot liquor to the mash or heating the mash with steam. The mash is normally thinner than with the single-stage infusion process to allow the mash to be mixed while it is heated. The malts used in this process can be less well modified as they will undergo a protein rest, but the time of the mashing will be longer as there are a number of temperatures to be reached. The main advantages of the infusion process over the decoction process are:

- they can be easily automated
- they require 20 to 50% less energy than the decoction method
- they are easier to monitor

An example is given (fig. 5):

Fig. 5



3. Decoction mash

In the decoction process part of the mash is removed and boiled. When it is pumped back the temperature of the total mash is higher. There can be one, two or three stages in the decoction process depending on the number of boiled mashes. Again the malts can be less well modified and still achieve a good level of extract. When boiling the thick portion of the mash is removed to help breakdown the starch in the grain but not effect

the enzymes in solution. Fig. 6 shows an example of a two mash process. As can be seen the process is often longer than the multi-stage infusion mash.

Fig. 6