

Brewing operations

Milling of malt - > Mashing (converting the starch)->

Wort separation (filtering the mash) -> Wort boiling (boiling, adding hops) ->

Trub separation (whirlpool) -> finished wort (cooling to fermentation)

Mashing (important step, time and temp) Infusion mashing: one vessel

Decoction mashing: two vessels, better if you can't control temps

Grist load 20% spent grains

out of the rest, 65% are fermentable sugars, rest are not

maltose, maltotriose, fructose, glucose, sucrose

unfermentable are dextrins, proteins, gums, pentose, minerals

Lautering

Lauter tun or mash filter

First wort - sparging - last runnings - spent grain removal

boil wort 4-10% evaporation, boiling about 60 mins, hop added

Milling

Objectives crush husks to expose endosperm

completely disintegrate endosperm to make all constituent available for enzymes

keep fine powder at minimum

Prevent extraction of unwanted substances during mashing

Milling types Hammer mill: fine pieces. used for mash filters

Roller mill: husk not damaged, must be used for filtering

From wort to final beer

Whirlpool -> cooling wort ->

wort yeast pitching

aeration - >

Pitching: yeast is mixed with wort

Ale or top fermenting vs Lager or bottom fermenting yeast

The yeast converts fermentable carbohydrates in the wort into alcohol and carbon dioxide

Objectives of mashing (cont)

Purpose To dissolve immediately soluble substances. This fraction constitutes approximately 15% of the total ingredients.

To convert substances that are initially insoluble in the mash into soluble substances, through enzymatic action.

To convert the extracted substances into fermentable extract, through enzymatic action.

alfa amylase cuts big pieces

beta amylase cuts in parts of two

iodine test shows positive test for starch

Heating jacket Limpet coil

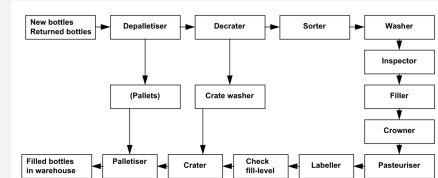
Dimple jacket

Lauter tun Principle: filtration through a bed of grains

Compared to mash filter: • more flexible – variation in brew types and sizes • less expensive • lower yield

Mash filter Principle: • filtration takes place through a filter cloth

Bottling line



Objectives of mashing

Aim to form an extract with a desired profile of sugars and a desired level of proteins, amino acids and other minor chemical constituents

Not published yet.

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Objectives of mashing (cont)	
	Compared to lauter tun: • less flexible – variation in brew types and sizes • more expensive • higher yield
Purpose of Wort Boiling and Hopping	Conversion of bitter components in hops from insoluble form to water soluble form – isomerisation of hop α -acids • Extraction of hop aroma • Sterilization of the wort • Adjustment of strength (% Plato) by evaporation • Removal of unwanted aroma components – DMS • Precipitation of proteins and polyphenols – trub, break • Inactivation of any remaining enzymatic activity
Hopping	Bitter hops: Hops added in beginning of boiling Aroma hops: Hops added at end of boiling
Wort cooling	
Coolship	big shallow trough
Plate heat exchanger	Hot wort runs next to cold water. hot water is recycled, fx in CIP

Malt, hops, Water and Adjuncts	
Barley -> Malt	Two-row barley and Six- row barley (two-row better)
Barley composition	Embryo
	Leaf
	Endosperm
	beta glucan walls
aleurone	production of enzymes 71% arabinoxylan 26% β -glucan
Endosperm	Storage of starch 75% β -glucan 20% arabinoxylan
Steeping	grain take up water
Germination	enzymes activated and synthesised, cells walls and protein broken down
Kilning	heating to stop enzymatic activity, production of colours and flavours
Barley Handling	Pre-cleaning, De-stoning, Removal of half grains and weed seeds, Screening
Hops (only female hops)	Bitterness, aroma, taste stability antioxidants, antibacterial foam, cling, lacing
Growth	Upwards, harvested bottom to top
Hop products	
Pellets	Pellets (90 and 45)
Isomerised	Iso-pellets IKE Isomerised Kettle Extract

Malt, hops, Water and Adjuncts (cont)	
	PIKE Potassium Isomerised Kettle Extract
Downstream	ISO extract
	RHO, Tetra, Hexa Hop Oils and Fractions
Special products	
Lupulin glands	Alpha and beta acids, xanthohumol isomerisation of alpha acids increases solubility and bitterness. also makes the light struck flavour
Water	At least same quality as drinking water Optimization of minerals (dissolved ions) -> Hardness optimization of pH -> Alkalinity bottom fermented beers (lagers) are brewed with soft water top fermented beers (ales, stouts, etc.) on hard and mineral rich water.
Ground water	very clean, stable low temperature, often very hard but depends on ground composition
Surface water	more particles and microorganisms, varies in temperature, often very soft
Town water	Really well balanced
Hardness	Temporary end permanent depending on mineral salts



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Malt, hops, Water and Adjuncts (cont)

Adjuncts

Types Peas, Rice, Corn flakes, rye, soya

“ANY CARBOHYDRATE SOURCE OTHER THAN MALTED BARLEY WHICH CONTRIBUTES SUGARS TO THE WORT”

Quality Taste and Flavour Stability • Head Retention • Colour • Degree of Fermentation • High Gravity Wort

Economy Price of the adjunct versus malt • Influence on brewing capacity • Energy savings • Taxation

Gelatinisation Some adjuncts gelatinise at higher temps than malt, so it has to be boiled separately

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