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, protiens, 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

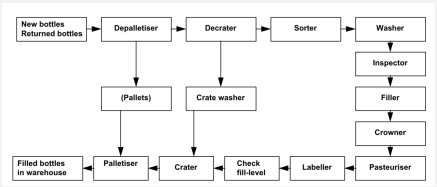
Milling

Objectives	crush husks to expose endosperm
	completely disentegrate 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 aeration ->	yeast pitching
	Pitching: yeast is mixed with wort
Ale or top fermenting yeast	vs Lager or bottom fermenting yeast
	The yeast converts fermentable carbohydrates in the wort into alcohol and carbon dioxide

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

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

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	Embro
	Leaf
	Endosperm
	beta glucan walls
aleurone	production of enzymes 71% arabinoxylan 26% ß-glucan
Endosperm	Storage of starch 75% ß-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, xantohumol
	isomeresation of alpha acids increases solubility and bitterness. also makes the light struck flavour
Water	At least same quality as drinking water
	Opimization of minerals (disolved ions) -> Hardness
	ptimization 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

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
Gelati-nisation	Some adjucts gelatinise at higher temps than malt, so it has to be boiled seperately