Notes on Production of Beer

Beer is a low alcohol content beverage produced by fermenting sugars extracted from various types of cereals. A large number of different beer types exist that vary in the use of raw material, and the strength, taste profile, and packing of the final product. Each brewery generally has its own specific product and container mix.

Production methods differ by brewery, as well as according to beer types, equipment, and national legislation. Historically beer was produced from malted barley. However, there is a trend toward a more diverse group of cereals, with modern large breweries increasingly using maize and rice. The sugar is extracted from the cereal into the water, hops are added, and the mixture boiled. After cooling, the mix is fermented with yeast to produce alcohol. This raw beer is then matured and packed. Some beers are filtered and pasteurized.

1.1.1. Raw Material Handling and Storage

The raw materials for beer production generally include cereal (barley malt, rice or maize), hops, water, and yeast. The malting process converts the starch in the cereal into fermentable sugar which is extracted from the malt during mashing. Extracts from the hop are used as a preservative and to add bitterness to the sugar solution. Yeast converts the sugars into alcohol during fermentation. Brewery operations require heating and cooling, cleaning agents, and packaging materials.

6. BEER PRODUCTION PROCESS: (Flow diagram enclosed as Annexure- 3 )

a) Malt Storage Room
   Malt & Barley receiving and storage.
   Malt & Barley dumped in hopper at the start of milling

b) Malt Milling
   From hopper malt & barley comes into screener with the help of conveyor. Dust particles are separated there then by means of chain conveyer it comes into De-stoner for stone and dust separation. After that the bucket elevator takes it to the Magnetic
separator to separate iron particles and then it comes into the 6 roller malt mill from where they obtain coarse and finely ground malt and barley, keeping husk intact as much as possible, after grinding it is known as grist. With the help of another chain conveyer and bucket elevator, the grist is stored into Grist Bin.

c) **Mash Kettle**
From Grist Bin the grist comes in to Mash kettle by means of a chain conveyer it is mixed with water, enzymes and calcium salt are added at this stage, and cooked at different temperature to convert the starch of the grains into fermentable sugars. The mixture of grist & water is called Mash at this stage.

d) **Lauter Tun**
In this vessel solid and liquid separation takes place i.e. the wort water with fermentable sugars is separated from husk. Wort collected to the next vessel called Wort Kettle by means of filtration on a porous surface (False bottom of Lauter tun). After separation of water & fermentable sugar, solution (Wort), the leftover separated husk material is then removed and transferred to Spent grain Bin beneath Lauter Tun. Spent grain are transferred to spent grain silo for where its loaded to vehicles and used as cattle feed.

e) **Wort Kettle**
In this vessel, the wort is boiled at 100 °C for 40 – 60 Minutes to destroy the entire microorganism, trace enzymatic activities and colloidal stabilization takes place during boiling process in this vessel. They obtain a sterilized and stabilized hopped wort from this stage.

f) **Whirlpool**
In this vessel the wort gets in at a very high velocity from Wort Kettle. With the help of tangential entry of wort to this vessel, whirling action created which intern helps hot tub to settle in the center of vessel due to centrifugal force, clean & clarified wort is then subjected to wort cooling. The clear wort passes through a Plate Heat Exchanger to achieve final wort temperature 12 -17°C and collected in the fermentation vessels. During wort cooling, air injected for aeration of wort and yeast addition (pitching) done for fermentation.

g) **UNI Tanks**
The wort pitched with yeast collected to the fermentation vessels called UNI tanks where fermentation of the wort carried for 5-6 days at controlled temperature of 16°C with the help of glycol.
After completion of fermentation, the yeasts is cropped for re-use into subsequent batches and surplus yeast is dumped, now the tanks are rapidly cooled from 16°C to -2°C with the help of glycol within 72 hrs. After cooling, the beer stored at least for 4 days at -2°C for maturation. This process also known as beer treatment and chill proofing at this stage. Now the beer at this stage is called as Green Beer.

h) Filtration
Horizontal Plate Filter is used for this filtration process. The plates are coated with Kieselguhr powder through which the green beer is passed and gets polished (free from yeast and protein coagulants).

i) Bright Beer
After Filtration process the clear beer is stored in Bright Beer Tank at <-1°C for <24 hrs from here it is sent to the pack line for bottling / canning.

1.6. Beer Processing

1.6.1. Filtration
Following maturation, most beer is filtered to remove remaining yeast to obtain “bright beer” which has the specified level of clarity and prolonged shelf life. The filtration takes place in a kieselguhr (diatomaceous earth) filter using frame, candle, or mesh filters. Spent kieselguhr can be used in farming, reprocessed, or as building material. Following filtration beer is stored in “bright beer tanks” and is ready for packaging in the bottling Section.

1.6.2. Carbonation
The beer may be carbonated before being sent to the bright beer tanks. Nitrogen gas may also be used in small quantities to enhance foam performance.

1.6.3. Dilution
High alcohol content beer resulting from high-gravity brewing is diluted to final product strength with de-aerated brewing-quality water before packaging.

2. Cleaning-in-Place (CIP)
It is important that all process equipment and pipes are kept clean and disinfected. Cleaning is carried out by means of CIP systems, where cleaning agents are circulated through the equipment or sprinkled over the surface of the tanks. Caustic soda or acid are often used as cleaning agents. The cleaning and disinfection of the brewery equipment may use a substantial amount of energy, water, cleaning agents, and disinfectants. The design of CIP systems can vary greatly, ranging from simple systems in which a batch of cleaning solutions is prepared and pumped through the system and drained, to fully automatic
systems consisting of tanks for water and cleaning solutions that make it possible to reuse some water and cleaning solutions.

3. Packaging Operations

Beer is pumped from the bright beer tanks and after dilution to sales strength is bottled, canned, or kegged in the packaging area. During these operations, it is important that the beer is protected from oxygen contact and carbonation loss. Packaging lines may have different packaging materials and levels of automation, and typically produce high noise levels.

3.1. Bottle Washing and Control

Returned bottles are sorted electronically. Foreign bottles are returned to their respective manufacturers or crushed and sent to recycling. After sorting, bottles are sent to a bottle washer where all internal and external impurities are removed. Bottle washer operations typically include soaking and washing, high – temperature sterilization, and rinsing. The bottle washer consumes large quantities of energy, water, and caustic soda. Substantial quantities of wastewater are discharged and the effluent may have a high organic load. When a bottle has been cleaned, it is inspected for damage and residual dirt.

3.2. Bottle Filling

The bottles are transported by conveyor belts from the bottle washer to the filling machine. They are filled under pressure according to the quantity of dissolved carbon dioxide in the beer. An important function of the filling machine is to prevent oxygen from coming into contact with the beer. The bottles are sealed immediately after filling (usually with crown corks) and the filling volume is checked. The sealed bottles are then conveyed to the tunnel pasteurizer.

3.2.1. Can Filling

Can filling is based on the same principles as bottle filling. Because of their low weight, it is necessary to convey the cans gently to ensure constant spacing. Furthermore, special attention should be paid to the thin wall thickness and resulting low stability of the cans. Filling lines consume large quantities of electricity. Beer loss can occur on the filling line, contributing to the organic load of the effluent.

3.3. Pasteurization

Beer is usually pasteurized to kill any remaining live yeasts or other microorganisms and so prolong the shelf life. Two alternative methods are used for pasteurization:

Tunnel pasteurization, during which the beer is pasteurized in bottles or cans (i.e. the beer and container are pasteurized as a closed, assembled unit);
Flash pasteurization, which employs a heat exchanger in which the beer is pasteurized before it is filled into kegs.

3.4. Labeling

Following tunnel pasteurization, the bottles are conveyed to the labeler. Starch- or protein-based glues are used as adhesives to ensure labels come off easily when the returnable bottles are cleaned. Labelling lines consume large quantities of electricity. High noise levels can arise from the labelling line.

3.5. Packing

Bottles and cans are packed in crates, cartons, or other forms of transport packaging and palletized. Kegs are transported on pallets.

4. Utilities

Brewery processes have a high energy demand for heating and cooling purposes, in addition to high water consumption. Utility installations are therefore a key factor in this sector. Brewery processes are typically supplied with heat from a steam boiler plant. Process cooling is usually provided by central ammonia based refrigeration systems, which circulate ammonia or a secondary fluid (e.g. chilled water, brines or glycols) to the points where cooling is required. Compressed air is mainly used for instruments, actuators, pressurizing of tanks, and sometimes the transport of spent brewers grain.

4.1. Water Treatment Plant

Breweries typically draw water from wells or from surface intake at a lake or river, and use several different qualities of water, for example, brewing quality water for mashing, deaerated brewing water for dilution, softened water for utility systems and tunnel pasteurizers, wash down water etc. For this reason, breweries often have several sophisticated water treatment facilities.

4.2. CO₂ Recovery Plant

The CO₂ generated during the fermentation process can be collected, cleaned and stored before being used in the process. CO₂ is necessary for carbonation and to provide inert atmospheres as required by the process.

4.3. Electricity Supply

Most breweries purchase electricity from the national grid, although some use cogeneration/combined heat and power (CHP) plants that produce both electricity and heat/steam.
WATER BALANCE - WDBL

BOREWELL WATER

UTILITIES 1.02 HL/HL

BREWING 2.0 HL/HL

PACKING 2.0 HL / HL

OTHERS 0.48 HL/HL

5.5 HL / HL TOTAL
The defects of Beer

- **Band-Aid (chlorophenol):** You just know something is out of whack when your beer smells of adhesive bandages. This aroma also may remind you of disinfectant or diaper aromas. It’s the artificial quality that really stands out in this defect, which usually is caused by a problem with sanitizers or yeast.

- **Butter or butterscotch (diacetyl):** Think of that artificial butter aroma and flavor from movie-theater popcorn, and you’ve got the diacetyl character in some beers. At low levels, this can be an enjoyable flavor component. But just like popcorn that’s swimming in butter, too much can make for an unpleasant experience. Beers with too much diacetyl often are called “butter bombs,” and the cause is often a problem with the yeast and amino acids.

- **Cardboard (oxidized):** The aroma usually will remind you of wet cardboard or wet paper, like if you left a box out in the rain and then took a whiff of it. Sometimes, it may seem leathery. It can be a sign of boiling too long, but more often it’s simply stale beer that’s too old or been stored improperly.

- **Cheesy (isovaleric acid):** If you get a whiff of bad cheese or stinky feet, use your own to run away. It’s a doozy. It can have a benign origin, such as the poor storage of hops, or it could be a bacteriological infection.

- **Cooked corn or cabbage (dimethylsulfide):** Often called DMS, if this is in your beer’s nose, it’s probably a sign of something gone awry, especially in ales. It also may have an asparagus or vegetal smell. In dark beer, the aroma may remind you of tomato soup. Its cause is commonly a grain infection or brewhouse problem, which usually occurs in the boil.

- **Green apples (acetaldehyde):** If you smell green apples or green leaves, it’s most likely a sign that the beer was released too soon, or that there was a yeast metabolic problem. Like its aroma, the beer is a little green. While usually evidence of a defect, it’s not as unpleasant a problem as many others.

- **Lightstruck (methyl mercaptan or isopentyl mercaptan):** A beer can become light struck, causing it to smell like a skunk; it happens almost instantaneously when it encounters light, especially UV rays. Fluorescent lights and bright sunlight are common culprits. Since both clear and green glass offer much less protection, many popular brands of beer are very susceptible to this problem. Brown glass, while not perfect, offers the most protection of any common glass color, which is why most brewers use this for their bottles.

- **Metallic (lacquer like, metallic):** It’s important to note that this would hardly ever come from canned beer. The metal turbidity that once caused metallic flavors to leach into canned beer has been virtually eliminated. Today, can manufacturers spray an organic polymer inside the can so that the beer literally never touches the aluminum. Metal flavors in beer are usually bitter, and they’re always bad, caused primarily by iron, copper or other metals in the water.

- **Plastic (phenolic):** The aromas in your beer should never seem artificial, and that’s what phenolics smell like. They have an artificial aroma that can take the form of something medicinal, mouthwash or plastic, and they’re cause is often a problem with the water, yeast or sparging.
• Rotten eggs (sulfitic): Rotten eggs can be a sign of a serious problem of contamination, especially when the smell is overwhelming. By contrast, it can be highly desirable when it’s just a very faint or subtle whiff, more like a burned match. Many ales that were originally brewed in Burton-on-Trent in the United Kingdom famously had this character. If it’s overpowering, it most likely signals a yeast problem, or sometimes it’s a sign that a beer is too green.

Dr Seema Paroha
NSI, Kanpur.