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Production processes in Brewery Plant

Er. Bikash Poudel

Abstract— **The paper presents the detail production process, activities involved for the production of quality beer, findings and analysis of those steps involved along with lab test of beer in one of the renowned brewery plant in Nepal. All those process and steps need to meet the specific criteria for the quality beer. The data are collected from direct observation, interviews with brew masters and detail study and observation of the processes involved in one of the top brewery plant in Nepal. Brewing, and pasteurization are the main steps involved in the production of brewery. Brewing involves milling, mashing, lautering, boiling, cooling, fermentation and conditioning Cleaning-In-Process (CIP) and bottle washing involve before brewing. The work resulted in finding of the following:**

- **The main cause of less production of beer bottles is frequent malfunctioning of leveling machine since it is not in good working condition. Whole bottling process is disturbed due to poor working of leveling machine.**
- **The percentage of caustic in bottle washing water is 2.77% measuring at the end of bottling process.(at the end of the day) but the requirement if 3.3%.**
- **Effectiveness of the filler machine is 99.9%.**
- **The specific gravity of beer is 1.015**

Index Terms— **Beer, Brewing, Fermentation , Production Process**

I. Introduction

Beer is the mostly consumed alcoholic drinks whose color is determined by malt and the ingredients are water, starch, malted barley, able to be saccharified (converted to sugars) then fermented (converted into ethanol and carbon dioxide); a brewer's yeast to produce the fermentation; and a flavoring such as hops. There are many steps and process involved for the production of quality beer.

II. Production Process

The major production process of beer are given below:

A. *Brewing*

Brewing occurs in brewing section.
First of all, milling of oat is done by two rollers. Mashing is done by mixing acids (phosphoric and sulphuric acids , biogluconase in 400gm i.e. gypsum) and water. Mixture is heated at 47.5°C for about 15 min then again heated to 62.5°C for 10 min. Mixture is kept at 62.5°C for 90 min then again heated to 72°C and kept at this temperature for 30 min. Sacharification process occurs which is the process of checking the amount of starch. If this process does not occur, then acid is added or temperature is increased. Then again heated up to 76°C for 5 min and then heated mixture is transferred to Lauter Tun (tank). Filtration also occurs in Lauter Tun then the mixture is pumped to Lauter Tun which takes 9 min. Circulation occurs in Lauter Tun for 15 min and then transferred to wort Pre-run Tank at 76 degree centigrade and stored here for 1 h. For another beer, first wort is of 23 hl. Sparing occurs in Lauter Tun for 6 times. Then 8 hl water is added to the mixture at wort Pre-run tank. Mixture is transferred to wort kettle where hoops pallet is added which is imported from India, America. Sugar is added for yeast survival. Wort kettle has 78.5 hl of mixture but if demand is high then volume can be made up to 90 hl. After sugar is added, mixture is boiled for 85 minutes. After evaporation, volume of mixture comes down to 72 hl and whirlfloc i.e. addition of gypsum 400-500 gm is done. Mixture is transferred to whirlpool tank and rest for 25 min and then cooled at 8.5 to 9 °C. (drop down from 100°C) Wort goes to the cellar where fermentation occurs at -12 to -15°C. Beer is kept for about 14-25 days for proper fermentation, yeast toad (powder) is added for their survival. Mixture at 15°C cooled down to -3 °C in BBT water is added for treatment and mixture of chemicals in powder form is added. After 14 – 25 days the mixture goes to filtration section where beer is filtered to make beer clear and bright different chemicals are added.
After filtration and necessary lab test, beer is ready for bottling.

The Brewing Process

Milling
↓
Mashing
↓
Lautering
↓
Boiling
↓
Cooling
↓
Fermentation
↓
Conditioning

B. *Fermentation*

Yeast is added once the wort has reached the desired temperature for fermentation. Brewers call the addition of yeast pitching. Once the yeast has been pitched the wort can properly be called beer. Fermentation last for 12 to 24 days depending on the strain of yeast and the strength of the beer. During the process the yeast reproduce and then metabolize the sugars, making CO2, alcohol, and a host of most flavorful and aromatic compounds that add complexity to the beer. During the height of fermentation the beer is capped by a creamy foam called krevsen. Once the available sugars have been consumed the yeast cells clumps together or floc and fall to the bottom of the fermenter.

Er. Bikash Poudel, Bachelor's Degree in Industrial Engineering, Head of Mechanical Engineering Department at Sandwich Home Solution Pvt. Ltd. Mechanical Engineer at Lama Construction Company Pvt. Ltd. Teacher at Namuna Institute of Technology & Construction Pvt. Ltd.

C. Conditioning

With fermentation complete, the beer is removed from the yeast and pumped to a conditioning or bright tank where it is stored at near freezing temperature that cause most of the remaining yeast to drop out of suspension. Hops can be added at this point as well, a step known as dry hopping that lends the beer additional hop flavor and aroma. Once the beer is clear it is ready to filter and package.

D. Pasteurization

Pasteurization is the process of gentle heating and rapid cooling of fresh packaged beer to prevent bacterial contamination.
The filled and closed packages of beer are conveyed through different sections of a "tunnel" pasteurizer and sprayed with mild hot water.

E. Findings

First heating of beer up to 32°C is done which takes 8 –10 min. Second heating of beer is done up to 45°C which takes 10 –15 min. Heating up to pasteurizing temperature of 63 °C for 10 min and holding the beer at 60°C for 10 min is done.
First cooling of beer up to 45 °C is done. Second cooling of beer up to 32°C is done. The time of pasteurizing phenomenon should be proper otherwise too little time may result in poor flavor stability of the beer because of the remaining live microorganisms. Too much time may have a cooking effect, causing the accelerated staling of the beer. The balanced, tightly controlled and gentle treatment results in stable and fresh tasting beer.
Length of pasteurization machine = 53 feet 6 inches.
Before the production process starts, the following steps need to be followed and taken.

III. Cleaning In Process

There are two types of CIP:
A. Half CIP
B. Full CIP

In this plant, mainly full CIP is done. CIP is done by caustic soda. Hot caustic is used for cleaning wort kettle, lauter tun and cold caustic is used for cleaning rubber pipe. Acid is also added to kill the microbes. First, the tank is resined with water and caustic is added and then bright acid is added. Anciently, trimeta was used.
Risen time for BBT = 10 min
Resin time for CCT = 10 min
Percentage of caustic in solution = 2.5 %
Full caustic is run for 30 min and again resin with water.

IV. Bottle Washing

Caustic is added to the hot water at 80 degree centigrade, which is used to wash the old bottles.
According to the international standards, maximum number of times that the bottle can be reused is 7. But this standard is not being followed.
About 3200 pieces of bottles can be washed at a time in washing tank. 16 bottles can enter the tank at a time. After 50 minutes of washing the bottle is ready for filling. Bad and cemented bottle bottles are thrown away. Some of them are rewashed. Volume of washing tank is 12000lt
A bottle takes 12 – 14 lt of water to be properly washed.

3.1 Observation and Findings:
Number of washed bottles damaged = 52 bottles/h.
Total number of unnecessary and unused bottles that have small neck, that are small in height, that are rejected from washing = 500000
Cost/bottle = Rs.8
Total unnecessary expenditure in buying old bottles = 8 * 50000 = Rs. 4000000

V. Lab Test and Findings

A. Measuring the percentage of Caustic in bottle washing water.

Procedures:
•Take 5 ml sample of caustic solution.
•Add 2-3 drops of phenolphthalein solution.
•Add solution of H2SO4 and make it colorless.
•Record the volume.
Findings:
22.7 ml of H2SO4 is consumed to make caustic solution colorless.
Factor of solution= 0.1
So,
0.1*22.7
= 2.77 %
But, requirement is 3.3 %. The percentage calculated is less since it is measure at the end of bottling process.(at the end of the day).

B. Measuring standard specific gravity and portion of CO2.

Measure the temperature and pressure of beer in bottle using instrument Zham and Nagel CO. INC. By using chart,
Standard specific gravity of beer= 1.015
For eg. if 32°F and % psi then CO2 is 2.15 % by volume.

C. Measuring temperature of liquid CO2.

Temperature of liquid CO2 in refrigeration system is -15.7°C.

D. Calculating effectiveness of filler machine.

Production rate of filler machine= 167 bottle/min
Volume of beer bottled per minute= 167 *650 ml
= 108550 ml
= 108.5 lt
Breakage of bottle in filler machine= 5 bottles/hr
=0.08 bottle/min
=0.054 lt/min
Wastage due to leakage in filler machine= 0.05 lt/min (from direct observation).
Total wastage due to filler machine=0.054+0.05
=0.104 lt/min
Total beer incoming= 108.5+0.104
= 108.604 lt/min
Utilized beer percentage =108.5/108.604
Effectiveness of filler machine= 99.9 %.
Hence 0.1 % beer is lost due to leakage and breakage in filler machine.

Reference:

[1] Energy Audit Catalogue of Mount Everest Brewery Pvt. Ltd.