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BREWERY OPERATIONS

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Introduction:

In the United States there are approximately 200 breweries. Six of these are national and are rated as large, with capacities on the order of ninety million barrels annual production. Eighteen others are regional, with capacities lower than six million barrels annual production. The remaining breweries, referred to as micro-breweries, have a capacity of approximately less than fifteen thousand barrels annually (one barrel equals 31 gallons). World production for 1991 is estimated at 1 billion barrels.

Breweries in the U. S., as a general rule, have no unique features that differentiate them from other facilities engaged in similar operations. Structurally, these buildings are not distinguishable from other production facilities involved in similar legitimate civil applications.

Brewing is carried out in a "batch process" in contrast to a "continuous process". However, several parallel batch processes could be in operation simultaneously, depending on the size of the brewery.

The brewery process consists of the following basic steps:

- o Wort Production
- o Fermentation
- o Finishing

Malt is the primary starting material used in brewing and determines the character and quality of the beer. It provides:

- o Basic flavoring to the beer
- o Major portion of fermentable extract
- o Protein necessary for foam formation
- o Entire enzymatic activity during mashing

Water comprises about 95 percent of the total volume of beer. Consequently, its purity and freedom from odor or contaminants are critical to production of quality beer.

Additionally, adjunct materials consisting principally of corn grits, brewers rice (a by-product of rice milling) and hops are used in the brewing process. Corn and rice supply starch, which is converted into fermentable sugars through enzymatic action.

Hops contribute significantly to beer quality by contributing to protein precipitation, foam formation and bittering; hops also contribute to stabilization and preservation of the beer.

Equipment used in a beer production facility:

The principal components used in the three steps of beer production are:

Wort Production

- o Malt Hopper
- o Malt Mill
- o Scales
- o Mash Tun
- o Cooker
- o Straining Tank/Lauter Tub
- o Pumps
- o Brew Kettle
- o Hop Jack

Fermentation

- o Hot Wort Receiver
- o Aerator & Cooler
- o Cellar Tank
- o Primary Fermentation Tank
- o Secondary Fermentation Tank

Finishing

- o Schoene & Decant Tank
- o Filter Operation Vessel
- o Filter Beer Tank

The Brewing Process

Malted barley, which consists of barley grains that have been softened by steeping in water, is crushed in the malt mill to break its kernel into coarse meal. Malt mills can range in size from mills that are equipped with one to six pairs of steel rolls. They are designed to crush rather than grind the malt.

Crushed malt is then fed to the mash tun. This is a large metal circular tank equipped with hot water and steam inlets, together with stirring devices of the rake, paddle or propeller type. Tuns are also equipped with a control panel which serves to monitor and control process parameters such as temperature, acidity (pH), etc. The mashing process achieves a wort of proper composition and acidity.

The next stage in the production cycle involves cooking of the mash to render the raw starch content of the adjunct material into a gelatinized state. The cooker is a steam heated vessel and is equipped with stirrers. Removal of the wort from the residuals is accomplished through a perforated false bottom in the cooker. In some instances special mash filters are used as alternative means of separating extractables from the spent grains. The wort is next fed to a brew kettle, which is a large domed vessel made either from copper or stainless steel. Vents from the dome permit the removal of carbon dioxide for collection and re-use. Kettle capacities can vary depending on the facility's production capacity and could exceed 600 barrels of wort.

After brewing, the boiled wort is passed through a hop jack. This consists of a large strainer equipped with basket shaped screens. The wort is then cooled to about 47 degrees F either in closed double-pipe or plate-type heat exchangers. The cooled wort is then clarified in centrifuges or by passing through diatomaceous filters.

Fermentation

Fermenters are tanks which are usually fabricated from stainless steel. They are either equipped with internal coils or external jackets which serve to cool the fermenting wort as fermentation progresses.

Fermenters can vary in size depending on the production capacity of the brewery. Micro-breweries which produce 5,000 barrels of beer annually use fermenters having a capacity of approximately 1,200 liters. In contrast large breweries with production capabilities of 500,000 to 5 million barrels of beer annually typically use fermenters with capacities of the order of 500,000 liters. Fermentation is carried out in several stages: the cooled wort is treated with yeast in fermentation tanks and allowed to ferment for 24 hours. It is then transferred to a second tank which receives fermenting wort which is essentially free of sedimented residuals generated in the first tank. Temperature controlling devices maintain the temperature of the wort between 55 to 60 degrees Fahrenheit.

After a period of approximately 10 days the resultant "green beer" is pumped into storage cellars at a temperature of 36 degrees Fahrenheit. A portion of the fermenting wort from the starter tank is also siphoned off into special closed fermenters. Accelerated fermentation occurs in this stage and results in generation of large volumes of carbon dioxide which is used later for carbonation.

Freshly fermented beer is then transferred to aging tanks, where it is clarified, stabilized and carbonated. Carbonation is achieved through various means such as absorption, injection, or diffusion. Packaging of the finished beer is a highly mechanized operation in modern breweries.

Summary

Much of the hardware used in brewery operations is identifiable as general purpose equipment that is common to a wide spectrum of civilian applications. For instance, hoppers, mills, scales, pumps, coolers and decanters are routine to basic functions in conventional industrial practice.

In contrast, although fermenters are not common to a wide range of industrial operations, they are an essential part of and critical to a major sector of civilian applications such as manufacture of pharmaceuticals and alcoholic beverages.