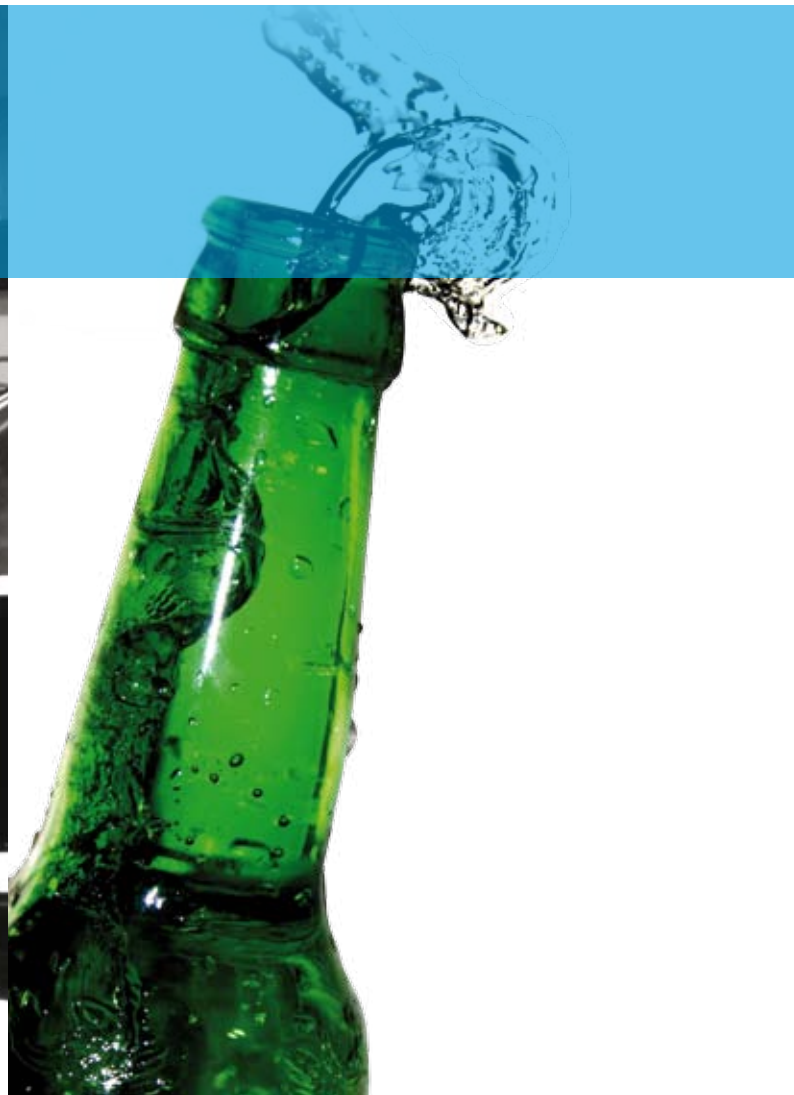


GEA Refrigeration in Breweries



GEA Refrigeration

The image shows a large industrial brewery. In the foreground, there are several large, cylindrical stainless steel tanks. In the background, more tanks and a person can be seen near a large window. The scene is lit with bright, cool-toned lights. A semi-transparent blue banner is overlaid on the top left of the image, containing the text 'GEA Refrigeration'.

The History of beer

Beer brewing is a very old profession with an interesting history. Before we go into detail about the brewing process and the refrigeration used in a modern brewery, it's nice to know a little more about its history.

As long as people have existed they have used skill not only to feed and to clothe themselves, but also to obtain luxuries to make life more enjoyable. The consumption of intoxicating drinks has always been one of the luxuries most valued.

From all the evidence available to us we can reconstruct the story of roughly 6000 years of beer brewing, and here we learn that the Sumerians already had a flourishing beer trade. Their brewers used barley and other cereals to produce several types of beer.

In more recent times beer became popular in those parts of Western Europe where the Anglo-Saxons and Teutons lived (where the British, Germans, Dutch and the Belgians live now).

A major step forward was made when the brewers accepted the advice of the well-known French scientist Pasteur, who urged them to use pure yeast for the fermentation of their beer.

All beer, ales and lagers are produced with barley, hops, water and yeast. Some have other additions such as wheat and rye or rice, but primarily, they contain these four substances.



Cooling is essential in the brewing process

GEA Refrigeration

GEA Refrigeration, is the worldwide market leader in industrial refrigeration. We offer our customers high-quality refrigeration systems and components to help facilitate their industrial operations.

The services offered by GEA Refrigeration cover the entire spectrum of refrigeration engineering:

- system design
- component manufacturing
- installation
- commissioning
- service & maintenance

All services are the result of a thorough understanding of the customer's needs and are based on continuous innovation in refrigeration engineering solutions. All this is made possible by a company with a history of 150 years and based on a worldwide network of 45 companies and around 3,800 employees.

Refrigeration in Breweries

The cooling processes in breweries are present in the following processes:

- hop store cooling, germination conditioning (malting)
- wort cooling
- fermentation, deep cooling, lagering
- filtration cooling, dilution water cooling, beer and yeast cooling
- cooling after pasteurizing, bottle line cooling

For calculation of cooling loads and heat transfer characteristics, knowledge about the thermal properties of the product at the different production stages is important.

Improving time and time again.

The brewing process



Raw Material, Handling and Storage

All beer, ales and lagers are produced with barley, hops, water and yeast. Malt is barley that has been germinated. The germination process is, however, terminated before a new plant has been developed. The purpose of the malting process is to prepare the raw grain for the first step of the wort production. This process is divided into the following three steps: Steeping, Germination and Kilning. In the context of refrigeration the control of the germination process is the most important.

Germination generates a great amount of CO₂ and heat. The germination boxes - either rectangular or circular - are equipped with a perforated false bottom so that air can be circulated through the grain bed. The temperature and relative humidity of the circulated air needs to be controlled.



Wort Production

The process begins with the milling of the grains. The malted barley is put to a grain mill to crack open the husks. This milled product is then mixed with hot water to produce liquor. During this process, called mashing, the enzymes in the malted barley convert the starches to sugar. The result produces a sweet liquid called wort.

The sweet wort is drawn off the bottom of the mash tun and transferred to the kettle for boiling of the mash to rinse out all the converted sugars from the mash tun.

The wort that has been collected in the kettle is then boiled for 1 to 1½ hours. In order to flavour the beer, hops are added once the wort is boiling.

The required refrigeration capacity (either via direct ammonia or a coolant) is produced in a central machine room using our components:

Our Components

Air coolers, Compressors (piston & screw), Condensers, Plate heat exchangers, Valves and Controls

Cooling points

Hopstore cooling

The hops should be stored at a temperature between 0 and +1°C. The relative humidity should be rather low, somewhere between 55 and 75%. The room aircooling is done by means of fan cooling.

Germination conditioning

For germination both temperature and relative humidity have to be controlled. This is generally done by aircooling.

Wort cooling

The wort must be cooled from boiling point to a temperature of 7°C to 12°C to prepare it for fermentation. To avoid contamination with foreign organisms this cooling must be done as quickly as possible. As long as the number of "brews" is less than 16 or 20 there is a large fluctuating load on the refrigeration system. This makes it necessary to store refrigeration (or "cold").

From the point of cost of chilling there are several alternatives depending on the size of the brewery. Normally wort cooling is considered as a separate part of the refrigeration installation aiming to operate at the highest possible temperature to minimise energy costs.





Fermentation and Maturation

The next stage is the fermentation. After boiling, the wort is transferred to the fermentation vessel. Once the wort is in the fermentation vessel, the yeast is added. Yeast is a single cell organism that metabolises sugar and oxygen for its reproduction. This process called fermentation needs to be controlled by setting the right temperature.

During fermentation CO₂, alcohol and heat are produced. When the fermentation of all the sugars is almost finished, the head brewer will often chill the beer to force the yeast to go dormant and halt any further fermentation (Deep cooling). Once the fermentation has ceased, the beer begins to mature.



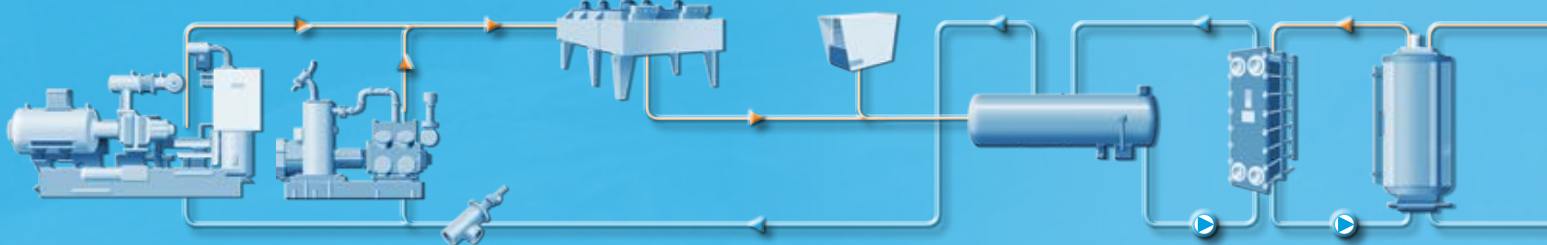
Beer processing and yeast storage

The first step of the maturation process is conditioning: the beer is filtered by using centrifuges, cooling, kieselguhr filters or sheet filters.

New yeast is formed during fermentation. After primary fermentation the new yeast is removed from the tank (cropped). This is then stored in insulated tanks equipped with cooling jackets.

Theoretically it would be possible to use the yeast over and over again in the brewery. There are examples of yeast in breweries that originate from the 18th century. Normally however, a yeast is reused 15 to 20 times. After that the brewery starts with a new yeast culture which has been produced in a laboratory under controlled conditions.

Machine room



Compressors

Grasso

Valves

AWP
Revalco

Air cooled condensers

Goedhart, Küba
Raffel, Searle

Air Purger

Grasso

Separator

Pump

Buffer tank

Deep cooling, fermenting, lagering

Refrigeration is very important because it maintains a necessary fermentation temperature varying from 7°C to 15°C.

Deep cooling of the young beer to lager temperature can be done in the same tank as the fermenting process. This deep cooling is normally done within 24 to 36 hours.

The challenge is to have the right amount of refrigeration capacity to quickly reduce the beer temperature.



Cooling in beer processes

Filtration

During the filtration the young beer increases in temperature and has to be cooled down to its initial temperature.

Yeast cooling

In the yeast culture room, yeast is propagated to be used in reseeded and replacing yeast that has lost its viability. Subsequently it is stored in insulated tanks equipped with cooling jackets. Reused yeast is carefully handled to avoid contamination with bacteria and is stored in the yeast room as a liquid slurry (yeast balm) in suitable vats, kept at an appropriate temperature.

Dilution water

To boost the output of a brewery a double strength brew can be produced by means of high gravity brewing. In order to achieve the desired final alcohol content chilled deaerated and carbonated water is added.



Packaging

Filling is the last process stage in the brewery before intermediate storage and distribution. The finished beer is distributed in bottles, cans, kegs and tanks.

The CO₂ content, crucial for the beer quality, must be within specific limits.

Stages in the filling process with connection to refrigeration are:

- Pasteurisation
- Beer Cooling
- Rest Beer Cooling

In all filling systems energy is supplied to the beer. To compensate for that, and mainly to avoid CO₂-losses, the beer is cooled before the filling procedure begins.



Warehouse and Dispatch

The finished beer must be distributed to the different outlets as quickly as possible. Due to the fact that consumption is not evenly spread over the year, some breweries build up stocks, to be used during high seasons.

The breweries usually store and distribute their products without refrigerating them. Shelf life is normally 6 months during ambient conditions, provided that the beer is protected against excessive heat and sunlight.



Process



With our components we design and install a complete refrigerating system in which energy and cost awareness are key design criteria.

Heat Exchangers

GEA Ecoflex

Coolers

Goedhart, Küba
Raffel, Searle

It is all about getting the right amount of refrigeration capacity, at the right temperature at the right time at the right place in the brewery.

Cooling after pasteurising

In the pasteurisation process the beer is heated up to a temperature between 62 and 70°C, maintaining the beer at that temperature for a certain period of time, and then cooled to a temperature appropriate for the subsequent stages.

Bottle line cooling

Most filling systems require a low temperature, normally around 0°C.

Cold beer

The breweries usually store and distribute their products without refrigerating them, shelf life is normally 6 months during ambient conditions, provided that the beer is protected against excessive heat and sunlight.

Should the brewery wish warehouse and dispatch cooling, the air-cooling is accomplished in familiar ways by means of fan coolers, and the system design does not differ from other applications. It is important to have refrigeration capacity at the right time, at the right place.

The last phase is "the drinking phase" most people like their beer to be cool.

Cheers!



GEA Refrigeration

Parallelweg 27, 5223 AL 's-Hertogenbosch
The Netherlands
Phone: +31 (0)73 6203 911
www.gearefrigeration.com
info@gearefrigeration.com