

PATENT SPECIFICATION

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(54) FERMENTATION PROCESS FOR BEER

(71) We, BRASSERIES KRONEN-BOURG, a Body Corporate organised and existing under the Laws of France, of 68, route d'Oberhausbergen 67/Strasbourg-Cronenbourg (B.Rhin) France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a fermentation process for beer.

For the production of beer, an alcoholic beverage which is obtained by the fermentation of a mash of malt and raw materials aromatized with hops, two types of process are chiefly distinguished: "high fermentation", if it is operated between 15 and 25 degrees Celsius and "low fermentation", if it is operated between 5 and 10 degrees Celsius.

The first operation of the beer production cycle is the conversion of barley into malt. The barley grains undergo soaking, then they are left to germinate for some time. The sprouting is arrested and the green malt is dried. The latter, roasted and with the reticule removed, is ground so that, during the wort preparation process, the water can more easily extract the soluble substances. The preparation of the wort can be carried out by the decoction process or by the infusion process. This operation is carried out at temperatures of 70 to 75 degrees Celsius. The wort is separated from the spent malt by decanting or by filtration. The decanted wort is boiled with hops, the boiling producing the aromatization of the wort and the separation by coagulation of protein substances which it contains. After cooling to 5 degrees Celsius, the wort passes into the fermentation vessels. Fermentation is an extremely delicate operation; the presence of micro-organisms foreign to those connected with the fermentation of the malt wort can be the cause of irreparable damage to the product. It is necessary to render the wort sterile so that the action of the yeast is not superimposed

by that of other micro-organisms. The choice of yeasts depends very much on the characteristics of the beer and the normal fermenting agent of beer is the yeast "*Saccharomyces cerevisiae*".

Once the main fermentation is completed, the beer has first to settle and is subjected to a warm storage, and then to a cold storage. The warm storage is hereinafter defined as keeping the beer at a temperature which decreases slowly from approximately 14.5° to substantially 6° Celsius, and the cold storage as keeping the beer at a substantially constant temperature of substantially —1° Celsius. During the warm and cold storages other fermentations occur which complete the organoleptic characteristics of the beer.

Before being recommended for consumption, the matured beer is filtered and then placed in bottles or in casks or vats.

The present invention concerns more especially the phases of fermentation, warm storage and cold storage.

Up to the present time a number of vats are used for the fermentation. The fermented beer is then transferred into a second series of vats for the warm storage, then transferred again into a third series of vats for the cold storage. This process method has several disadvantages. It is necessary to provide a very complex installation for transferring the beer. Moreover, the number of vats is very large. After each transfer of the beer, it is necessary to clean the transfer installation and the different vats, which necessitates the provision of a cleaning system.

The multiplicity of the vats, the transfer installation, and the cleaning system require very high investment costs, which create an increase in the cost price of the product. In fact, most of the pipes of the cleaning system and the transfer installation are in stainless steel. Furthermore, provision must be made for an adequate number of personnel for the normal development of the different phases of the known process.

An object of the invention is to remedy these disadvantages and provide a new

process in which the fermentation, the warm storage and the cold storage are carried out in the same assembly, which obviates a large number of vats, simplifies the transfer installation and the cleaning system and reduces the cost price and enables a large quantity of beer of identical taste and appearance to be produced.

According to the invention there is provided a method for the alcoholic fermentation at low pressure of beer in a tank having a substantially cylindrical side wall and a base of an inverted substantially conical shape, comprising placing an overall quantity of wort in the tank ready for fermentation by introducing into the base of the tank in succession a plurality of amounts of wort, the temperature of the first amount introduced being approximately 10° Celsius and that the last amount approximately 14° Celsius, the temperature being progressively increased from one amount to another successive amount in the aforesaid range of approximately 10° Celsius to approximately 14° Celsius, yeast being added to at least the first amount of wort introduced into the tank, fermentation being carried out in the tank with the overall quantity of wort reaching a temperature of substantially (but not more than) 15° Celsius and at a pressure which does not exceed 500g. per cm.² gauge, a warm storage (as hereinbefore defined) of the beer is then undertaken for approximately five days during which the temperature of the beer is progressively lowered from approximately 14.5° Celsius to approximately 6° Celsius, during the warm storage convection currents being produced in the beer in the tank by establishing a temperature difference in the beer between the top and bottom thereof wherein the beer at the bottom is at a higher temperature than the beer at the top, residue being discharged from the beer during said warm storage, suddenly cooling the beer after the warm storage to substantially minus 1° Celsius, and after said sudden cooling, subjecting the beer in the tank to a cold storage (as hereinbefore defined) for approximately five days during which the temperature is maintained at substantially minus 1° Celsius, and finally the beer is racked and filtered.

The invention will now be further described by way of example with reference to the accompanying drawing which is an operating diagram of the process according to the invention.

The wort is taken *via* a pipe 1 into a tank 2, which has a substantially cylindrical side wall and a base 7 of inverted substantially conical shape. The filling of the tank 2 with wort is carried out by introducing the wort into the tank in successive amounts from respective mash tubs, yeast being added to

the first four amounts of wort. The first three amounts of wort are introduced at a temperature of 10 to 11 degrees Celsius, the next four at a temperature of 12 degrees Celsius and finally the last three at a temperature of 14 to 14.5 degrees Celsius.

To obtain a substantially uniform distribution of the wort and yeast and a uniform temperature in the tank 2, a convection current is produced in the tank 2. This current is achieved as a result of introducing different successive horizontal regions of wort, in the tank, at different temperatures which increase from the top region to the bottom, and by subjecting the different successive horizontal regions of wort, in the tank, to different temperatures which increase from the top region to the bottom. These regions are represented in the drawing by the cross-hatched portions. Thus the bottom region 3 is the warmest and has a tendency to rise, whilst colder upper regions such as indicated at 4, 5 tend to fall towards the bottom 6 of the tank 2.

Fermentation proceeds in the tank filled with wort and for this it is necessary that the overall quantity of wort reaches a temperature of substantially (but not more than) 15 degrees Celsius, whilst the pressure must not exceed 500g per cm.² gauge pressure.

This fermentation stage can be carried on until the fermentation ends naturally, which fermentation can conveniently be called fermentation to the limit, and then the warm storage stage proceeds. Or the fermentation stage may be a limited fermentation in the sense that the following warm storage stage is commenced before fermentation to the limit has been reached. If the fermentation stage is a limited fermentation, the duration of the limited fermentation can be substantially 93% of the time required to carry out fermentation to the limit.

During fermentation, yeast is deposited in cone 7. Prior to the warm storage this yeast, other sediments discharged from the beer, and beer are extracted from the tank 2 through the pipe 8 and fed through a centrifuge 9 whereby the yeast is recovered. The centrifuged beer is reinjected into tank 2 *via* pipes 10 and 11.

After fermentation, the warm storage proceeds. The duration of the warm storage is approximately five days. During this period a slow decrease of the temperature of the beer is created and the initial temperature of approximately 14.5 degrees Celsius is brought to substantially 6 degrees Celsius. The pressure is retained and does not exceed 500g. per cm.² gauge. During the warm storage convection currents are generated in the beer in tank 2 with a view to obtaining a substantially uniform liquid. The convection currents are derived by establishing a temperature gradient in the

beer from top to bottom, this being achieved by subjecting successive horizontal regions of beer to different temperatures so that the lowest region is the warmest and the upper regions colder. During the warm storage, the sediments are again discharged from the beer, that is to say the wastes consisting chiefly of nitrogenous matter and yeast which is deposited in the cone 7. To remove this yeast and the sediments, the beer is again supplied *via* the pipe 8 to the centrifuge 9 but this time the centrifuged beer is fed *via* a pipe 14 to a vat 15 provided with an agitator 16. From the vat 15, the beer is re-introduced into the top of the tank 2 *via* a pipe 17 and the pipe 11.

After the warm storage the beer is cooled to substantially minus 1° Celsius. This is effected by drawing off beer from the top of the tank 2 *via* the pipe 11, passing the beer through a cooler 12, and re-introducing the cooled beer into the base 7 of the tank *via* a pipe 13 from the cooler; consequently this cooling is sudden compared with that during the warm storage. Diastatic treatment of the beer is maintained continuously.

A probe 18 in the tank 2 is provided with several sampling tubes (some of which are indicated at 19, 20 and 21) at different heights, for the analyses of the carbon dioxide gas content of the beer. Carbon dioxide gas can be added to the beer during the cooling stage to increase the carbon dioxide content to a desired value.

The cold storage then proceeds with the beer at a temperature of substantially minus 1 degree Celsius. Pressure is maintained at 500g per cm² gauge and the duration of the cold storage is approximately five days. In the course of the cold storage sediments and yeast are discharged by the beer.

After the cold storage, a current can be established in the beer primarily from top to bottom or primarily from the bottom upwards to circulate the beer with a view to achieving a substantially uniform beer.

The beer is then raked by centrifuging in the centrifuge 9 and filtered by a filter 22 in readiness for filling bottles and casks with the beer.

In the case of limited fermentation yeast is recovered by centrifuging to obtain a desired predetermined amount of dry matter from the beer. Recovered yeast can be re-injected during recycling of the beer. The process is then continued in accordance with the different stages described above.

WHAT WE CLAIM IS:—

1. A method for the alcoholic fer-

mentation at low pressure of beer in a tank having a substantially cylindrical side wall and a base of an inverted substantially conical shape, comprising placing an overall quantity of wort in the tank ready for fermentation by introducing into the base of the tank in succession a plurality of amounts of wort, the temperature of the first amount introduced being approximately 10° Celsius and that of the last amount approximately 14° Celsius, the temperature being progressively increased from one amount to another successive amount in the aforesaid range of approximately 10° Celsius to approximately 14° Celsius, yeast being added to at least the first amount of wort introduced into the tank, fermentation being carried out in the tank with the overall quantity of wort reaching a temperature of substantially (but not more than) 15° Celsius and at a pressure which does not exceed 500g per cm² gauge, a warm storage (as hereinbefore defined) of the beer is then undertaken for approximately five days during which the temperature of the beer is progressively lowered from approximately 14.5° Celsius to approximately 6° Celsius, during the warm storage convection currents being produced in the beer in the tank by establishing a temperature difference in the beer between the top and bottom thereof wherein the beer at the bottom is at a higher temperature than the beer at the top, residue being discharged from the beer during said warm storage, suddenly cooling the beer after the warm storage to substantially minus 1° Celsius, and after said sudden cooling, subjecting the beer in the tank to a cold storage (as hereinbefore defined) for approximately five days during which the temperature is maintained at substantially minus 1° Celsius, and finally the beer is raked and filtered.

2. A method as claimed in claim 1, in which during the fermentation, sediment is deposited in the inverted cone shaped base of the tank, yeast is recovered from the sediment by centrifuging the beer, and the centrifuged beer is re-injected into the tank.

3. A method for the alcoholic fermentation of beer in a tank having a substantially cylindrical side wall and a base of an inverted substantially conical shape, substantially as hereinbefore described with reference to the accompanying drawing.

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beer from top to bottom, this being achieved by subjecting successive horizontal regions of beer to different temperatures so that the lowest region is the warmest and the upper regions colder. During the warm storage, the sediments are again discharged from the beer, that is to say the wastes consisting chiefly of nitrogenous matter and yeast which is deposited in the cone 7. To remove this yeast and the sediments, the beer is again supplied via the pipe 8 to the centrifuge 9 but this time the centrifuged beer is fed via a pipe 14 to a vat 15 provided with an agitator 16. From the vat 15, the beer is re-introduced into the top of the tank 2 via a pipe 17 and the pipe 11.

After the warm storage the beer is cooled to substantially minus 1° Celsius. This is effected by drawing off beer from the top of the tank 2 via the pipe 11, passing the beer through a cooler 12, and re-introducing the cooled beer into the base 7 of the tank via a pipe 13 from the cooler; consequently this cooling is sudden compared with that during the warm storage. Diastatic treatment of the beer is maintained continuously.

A probe 18 in the tank 2 is provided with several sampling tubes (some of which are indicated at 19, 20 and 21) at different heights, for the analyses of the carbon dioxide gas content of the beer. Carbon dioxide gas can be added to the beer during the cooling stage to increase the carbon dioxide content to a desired value.

The cold storage then proceeds with the beer at a temperature of substantially minus 1 degree Celsius. Pressure is maintained at 500g per cm² gauge and the duration of the cold storage is approximately five days. In the course of the cold storage sediments and yeast are discharged by the beer.

After the cold storage, a current can be established in the beer primarily from top to bottom or primarily from the bottom upwards to circulate the beer with a view to achieving a substantially uniform beer.

The beer is then racked by centrifuging in the centrifuge 9 and filtered by a filter 22 in readiness for filling bottles and casks with the beer.

In the case of limited fermentation yeast is recovered by centrifuging to obtain a desired predetermined amount of dry matter from the beer. Recovered yeast can be reinjected during recycling of the beer. The process is then continued in accordance with the different stages described above.

WHAT WE CLAIM IS:—

1. A method for the alcoholic fer-

mentation at low pressure of beer in a tank having a substantially cylindrical side wall and a base of an inverted substantially conical shape, comprising placing an overall quantity of wort in the tank ready for fermentation by introducing into the base of the tank in succession a plurality of amounts of wort, the temperature of the first amount introduced being approximately 10° Celsius and that of the last amount approximately 14° Celsius, the temperature being progressively increased from one amount to another successive amount in the aforesaid range of approximately 10° Celsius to approximately 14° Celsius, yeast being added to at least the first amount of wort introduced into the tank, fermentation being carried out in the tank with the overall quantity of wort reaching a temperature of substantially (but not more than) 15° Celsius and at a pressure which does not exceed 500g per cm² gauge, a warm storage (as hereinbefore defined) of the beer is then undertaken for approximately five days during which the temperature of the beer is progressively lowered from approximately 14.5° Celsius to approximately 6° Celsius, during the warm storage convection currents being produced in the beer in the tank by establishing a temperature difference in the beer between the top and bottom thereof wherein the beer at the bottom is at a higher temperature than the beer at the top, residue being discharged from the beer during said warm storage, suddenly cooling the beer after the warm storage to substantially minus 1° Celsius, and after said sudden cooling, subjecting the beer in the tank to a cold storage (as hereinbefore defined) for approximately five days during which the temperature is maintained at substantially minus 1° Celsius, and finally the beer is racked and filtered.

2. A method as claimed in claim 1, in which during the fermentation, sediment is deposited in the inverted cone shaped base of the tank, yeast is recovered from the sediment by centrifuging the beer, and the centrifuged beer is re-injected into the tank.

3. A method for the alcoholic fermentation of beer in a tank having a substantially cylindrical side wall and a base of an inverted substantially conical shape, substantially as hereinbefore described with reference to the accompanying drawing.

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