PALL

Food and Beverage

New Trends in Colloidal Beer Stabilization

Introduction

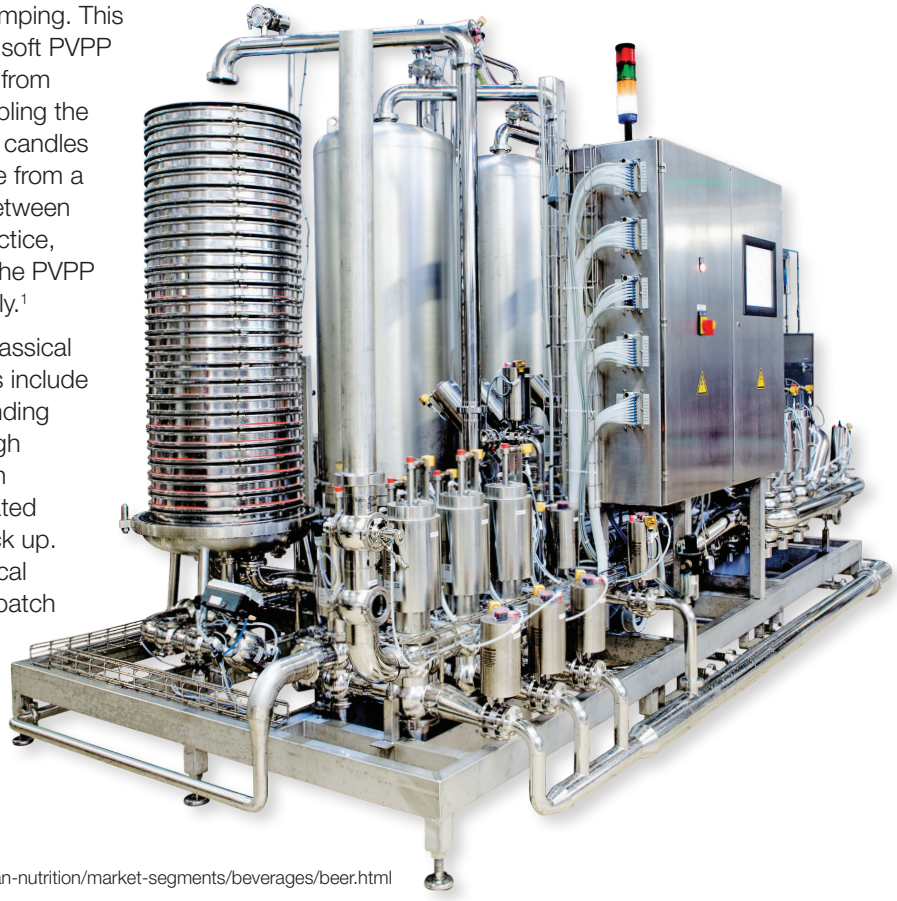
Today, consumers expect a beer with a long shelf life free of changes in clarity and appearance. Colloidal stability, in addition to microbial stability, is the main influencing quality criteria for a sufficient shelf life of packaged beer.

Polypeptides and polyphenols found in beer interact to impact colloidal stability, producing visible haze in the product that reduces its shelf life.

Polyphenols in beer play an important role acting as haze forming compounds in colloidal stabilization. To control the level of polyphenols, brewers are using polyvinylpolypyrrolidone (PVPP) as an adsorber for beer stabilization, implementing either a single use process or a multiple use process incorporating regeneration.

PVPP single use material is based on small particles (10-25 µm) and is typically commercially applied up to a dosage rate of 5 g/hl. For higher dosage rates, regenerable PVPP provides an overall lower total cost of ownership.

PVPP stabilization with the classic regeneration process is based on bigger PVPP particles (50-150 µm) and allows repeated use of the PVPP powder combined with candle or horizontal leaf filters. The PVPP is dosed into the beer stream and separated on the filter surface. After beer processing, the PVPP is regenerated on the filter screen or candle and then returned to a dosage tank, ready for the next usage. The main disadvantage with this process is the ongoing movement of the PVPP particles through dosing, stirring and pumping. This causes erosion of the relatively soft PVPP particles shrinking them in size from bigger to smaller particles, enabling the PVPP to pass through the filter candles or screens. The typical loss rate from a regenerable PVPP system is between 0.5 and 2%. This means in practice, that after 50 to 200 filtrations, the PVPP has been exchanged completely.[1]



Further disadvantages of the classical PVPP stabilization technologies include big system volumes, corresponding with high pre and after runs, high water and cleaner consumption and a high demand for de-aerated water to ensure low oxygen pick up. Additionally, the fact that classical systems can only operate in a batch mode makes it difficult to combine them with modern continuous operating crossflow clarification systems.

[1] https://nutrition.basf.com/global/en/human-nutrition/market-segments/beverages/beer.html

In recent years, several new approaches have been developed to overcome the aforementioned disadvantages of classical PVPP stabilization:

- **Implementation of PVPP regenerable system with multiple small vessels which operate as precoat system in an alternating mode:** This allows continuous operation, however, the problem with PVPP loss caused by erosion remains and in some cases is even magnified as particle movement is significantly increasing with shorter batch lengths per individual filter housing.
- **Usage of enzymes developed specifically from microorganisms for beer stabilization:** In this case, the reaction between polyphenols and proteins is blocked. The challenge is inactivation of the enzymes in beers, which are not pasteurized. Also, an additional stabilization with PVPP might be necessary for beer types with higher strength or with very long shelf life demands.
- **Stabilizers based on arabinose:** Here stabilizers linked with a PVP molecule as reactive group are also in use. The challenge is the stability of the chemical bond between the arabinose and the PVP molecule. Also, when compared to PVPP, the cost for the stabilizer materials are higher and more difficult to control as there is only one single source available worldwide.
- **CBS continuous beer stabilization system:** This system incorporates a well proven, regenerable PVPP in a newly developed process with a unique system design. The CBS technology is described in more detail below.

CBS Technology for Continuous Beer Stabilization

The target of the new system and process development was to capitalize on the positive attributes and characteristics of the classical PVPP regenerable process but eliminate the disadvantages like high PVPP losses and high water and cleaner consumption. A further development target was operation in batch and continuous mode at the same or a lower cost compared to classical technologies.

The CBS Concept

For the stabilizing material, well known standard PVPP from two main suppliers is the basis. For better control of the stabilization effect and to minimize material losses, the particle size range of the standard materials have been narrowed down. This results in higher raw material cost, however, this is offset by a significant reduction in material losses.

The PVPP with a defined particle range is then immobilized in stainless steel cassettes, where it remains without movement during its entire service life, which can be several years of operation without opening of the cassettes. Filling and emptying of the stainless steel cassettes takes place at the brewery. The cassettes are designed to be reused.

Between 20 and 30 cassettes are installed in a housing, representing one stabilization column. Three to six columns build a process unit, which is connected to a valve block and a Clean-In-Place (CIP) unit.

Three housings are combined in a system installed in parallel and connected to a valve block and a simple CIP unit.

The CBS Process

During processing, the columns are operated in an alternating sequence, with different columns switching between processing beer, regeneration and standby. The combination of alternating sequences combined with controlled flux variations per column results in a continuous process with highly precise stabilization effectiveness.

Typically, one column is in standby or regeneration, while the other two are in operation providing a constant output. Inside the system, the flow through each column is controlled with a flow meter and a regulation valve and varies during the stabilization process to utilize the PVPP adsorber capacity at maximum efficiency.

The system is easy to operate with a fully automated process providing 20 standard recipes for stabilizing all types of beer. Each recipe allows parameter adjustments by the brewery to ensure maximum flexibility.

The CBS System Design

The size of the housings is tailored to the CBS stainless steel cassette design resulting in minimal hold up volumes. The throughput/volume ratio of 15:1 results in fast brand changes combined with minimized beer and extract losses.

The regeneration process applies the same process steps as with classical PVPP systems by using standard caustic and acids. Due to the compact design, the required quantities are reduced which supports lower operation cost.

The overall footprint of the system is small compared to other technologies and allows flexible positioning.

Beer Quality

Oxygen pick up from the start is minimal due to the compact design and seamless switch between de-aerated water and beer at the process start, end and brand changes.

Foam, color, haze, bitterness and taste remain unaffected with the CBS technology. Stabilization degree is controlled by selecting the relevant recipe combined with the length of the specific stabilization run between regenerations. Stabilization effect is highly constant during the entire process.

Economics

The main economic advantage is the negligible loss rate of PVPP which is typically at < 0.3% over a total of 1000 regeneration cycles. This corresponds to a runtime of 2 to 3 years before the PVPP in the cassette requires a change out.

Change out takes place when a slight decrease in polyphenol reduction can be noticed. This happens slowly and over weeks, thus there is sufficient time to plan the PVPP change out.

Reloading of cassettes takes place at the brewery. The stainless steel cassettes can be used multiple times.

Water and cleaner consumption are low as system volumes are also low when compared to other technologies.

Experiences

The CBS technology operates in various breweries stabilizing all kind of beers. The cassettes have a performance warranty of 1000 regeneration cycles which is often exceeded. The ability to run the CBS continuously makes it the ideal solution in combination with continuous crossflow clarification systems. The CBS technology fits perfectly downstream in all clarification systems. The continuous design shows its strength combined with PROFi clarification systems, but also other crossflow technologies.

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