Continuous Beer Stabilization – For improved Process Economics and Environmental Protection

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Summary

Continuous beer stabilization streamlines production and improves operating efficiencies for breweries. The Pall Continuous Beer Stabilization System (CBS) is designed for this application and provides a seamless link in the brewing process between (continuous) clarification and final filtration. A new fixed bed technologies combined with approved materials for beer stabilization (PVPP) enables the CBS to provide continuous stabilization of all styles of beer. This process also enhances product consistency, maximizes throughput at customizable volumes ranging from 100 to 600 hL/h and reduces production time, cost, labor and waste. The CBS system was validated at the Carlsberg brewery Frederica, Denmark and was recently shown during the last Brau Beviale in Nuremberg.

Objectives of the development

New product and process developments are often driven by process economics and environmental protection. At this time most of the conventional beer stabilization systems are designed for batch mode operation only in opposition to more modern continuously operating membrane filtration systems. Thus, a major target of this development was the ability of the CBS system to operate continuously with a very high automation level and the lowest possible maintenance. Additional development targets included a compact design, low investment cost and improved operational cost over standard batch mode operation systems currently in use.

Technical approach

By combining three stabilization columns, it is possible to generate continuous operation. Due to increased system utilization and 24/7 operation smaller sizing of complete production lines is also possible. In addition, this continuous production line offers an enormous flexibility in terms of brand changes, which is also becoming more important with concentration of brewery plants and increasing numbers of brands.

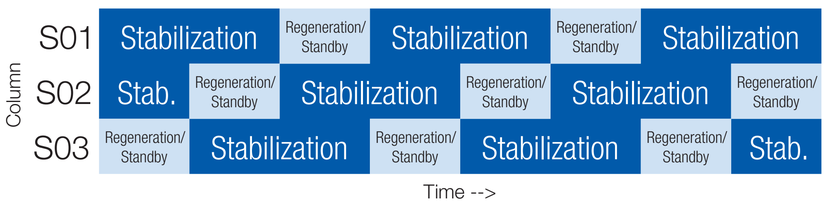


Table 1: Columns working mode

Columns packed with a fixed bed of PVPP avoid extensive PVPP handling and costly PVPP losses. A compact system design reduces the consumption of chemical, water and energy. A CBS-System (Picture1) consists of 3 or 6 stabilization columns, each equipped with 20 up to 30 cassettes filled with 1.6 kg PVPP each. The stabilization columns are skid mounted, completely wired and piped, to support rapid installation and commissioning. From the automation point of view the integrated Siemens S7 control system can easily be connected to the brewery overall main control.

CBS System		CBS - 3/26	CBS - 6/26	Unit
Capacity		100-300	300-600	hl/h
Volume per column		450	450	Liter
Hold-up volume		215	215	Liter
Column diameter		610	610	mm
Footprint	Length	3700	5000	mm
	Width	1800	2600	mm
	Height	2800	2800	mm

Table 2: Technical details CBS System

Process Description

Filtered but non-stabilized beer is routed to the stabilization columns across a valve knot and through a pressure regulated pump. During operation 2/4 out of 3/6 columns are in parallel but time delayed in stabilization mode when at the same time columns 3/5,6 are in cleaning or standby mode. After reaching the cycle time, the used columns will be replaced by the columns which were in standby. This method allows a continuous flow. We recommend a bypass flow at the beginning of operation or when switching to fresh regenerated columns to avoid over-stabilization. In general, performance is controlled by: cycle time; flow rate distribution over the columns; and, if necessary with bypass operation mode.

When the maximum cycle time is reached, the PVPP inside the cassettes must be regenerated with a combination of caustic, acid and water flushing steps. The duration of the whole cleaning procedure takes just 90 minutes. Polyphenols and Anthocyanogens content of the beer is currently utilized to calculate the correct dosage of single use PVPP required to maintain the expected shelf life. Using this system these same measures are used to determine cycle time duration.

Picture 1: CBS-3/26 with one open housing

Test Results

In the period of July 2009 and February 2010 the CBS 3-26 System has been tested in the Frederica Brewery, Denmark. The installed system had a capacity of 250 hL/h and within the test period around 151,000 hL were stabilized.

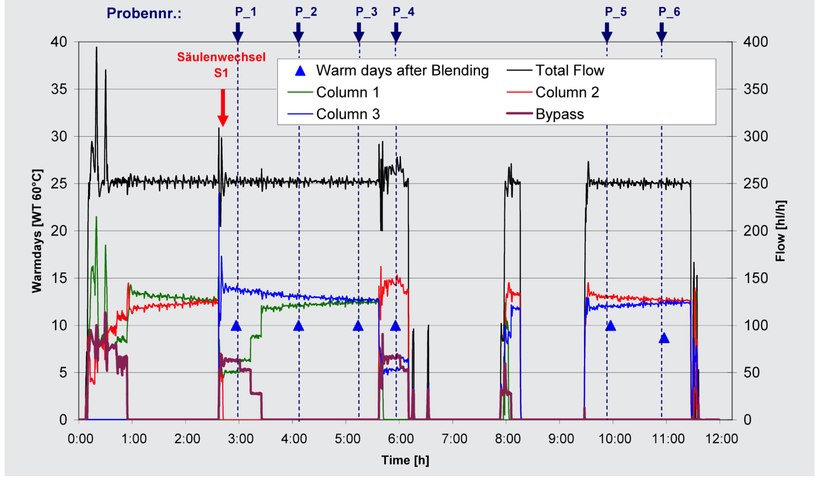
Beside all stabilization criteria like reduction of Total Polyphenols and Anthocyanogens, the complete range of beer quality parameters and a sensory panel have been conducted. All analytical tests were either performed by the brewery's QA department or by the VLB Institute in Berlin.

stabilization criteria								
time	sample number	Forclertest WT	total polyphenols	polyphenols 12% wort	total polyphenols reduction	Anthocyanogens	Anthocyanogens 12% wort	reduction Anthocyanogens
		60 °C	ppm	ppm	%	ppm	mg	%
stabilization lost dosing PVPP (9 g/hl) and BK75 (70 g/hl)								
10:45	HGA		258	208	21	66	53	20
10:58	A	3,8	171	195	26	43	49	25
12:53	HGB		260	207	22	65	52	22
13:06	B	3,4	159	197	25	42	52	22
Continuous Beer Stabilization System (CBS)								
16:57	HG1		168	133	50	44	35	47
17:08	1	10,0	108	125	53	29	34	49
17:43	US_start		281	326		72		
17:55	HG2		164	130	51	46	36	45
18:07	2	10,0	107	123	53	30	34	48
19:03	HG3_1		177	141	47	47	37	43
19:14	3	10,0	112	133	50	30	35	47
20:08	HG4		166	133	49	42	34	49
19:56	4	10,0	102	119	55	26	30	34
23:48	HG5		172	136	48	44	35	47
23:58	5	10,0	116	133	49	29	33	49
00:12	US_end		278	221		68		
00:48	HG6		187	149	44	50	39	40
00:58	6	8,7	124	143	46	32	37	44

Table 3: Analytical results

Table 3 shows some results from the validation and stabilization criteria. The light blue marked part reflects the results from the current stabilization regime in the brewery, the dark blue marked part indicates the results obtained from the CBS system. Total Polyphenols could be reduced between 44 to 53 %, the Anthocyanogens by around 33 up to 37%. With this reduction an average of 10 warm days corresponding to one year shelf life may be realized. In terms of all beer quality criteria, including the taste panel, none of the results indicates any unacceptable values.

Graph 1 shows a 12 hours stabilization run, displaying the alternating columns between cleaning and stabilization mode. Keeping a constant high level of warm days at the same time.



Graph 1: Stabilization cycle showing flow rates, alternating columns and warm days achieved

Consumption data:

Because of the very low hold-up volume of just 215 liters per column the amount of cleaning chemicals, water and energy are reduced compared to other PVPP regenerating technologies. The volumes are so low that there is no need for a CIP.

Cold Water	1.2 m^3
Dearated Water	0.9 m^3
Hot Water	1.4 m^3
1% Caustic	1.3 m^3
0,5% Acid	0.5 m^3
Sum:	**5.3 m^3**

Table 4: Media consumption volumes per column

By considering the media consumption volumes mentioned in table 4 the resulting media costs are in the range of 0.07 Euro/hl filtered beer.

Features and Customer Benefits

3/6 Column design
- Reduced stabilization costs
- Enables continuous operation
- Small footprint of the system
- Excellent fit to continuous filtration

PVPP as stabilizing agent
- Well known material no user restriction
- Highly specific to polyphenols
- Food contact compliance
- Excellent availability of raw material

Low system hold-up volume
- Small footprint
- Very low beer and beer extract losses
- Less media consumption
- Less water consumption
- No need for CIP tanks

Fixed bed technology
- No powder handling
- Lower consumption of media
- Stop and Go – operation independent processing
- No mechanical stress to adsorber material
- Less moving parts thus lower maintenance costs

Fully automated process
- Easy to operate
- Reliable stabilization and regeneration process
- Low need for operator engagement
- Dynamic adjustment to stabilization beer needs
- Up to 20 standard programs for the stabilization
- Very quick switch (brand change)

Modem on board
- Enabling remote consultancy
- Enabling online service
- Quick trouble shooting