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118

Flash Pasteurization: how long is the optimal heat-holding time for achieving the best beer quality?

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Abstract

Flash pasteurization of beer is an important tool for dependable shelf-life extension. In conjunction with a correspondingly hygiene-enhanced filler, flash pasteurization is a product-friendly alternative to tunnel and chamber pasteurizers.
A flash pasteurizer's efficacy in stabilizing turbidity and taste, for example in wheat beer, is also gaining steadily in perceived importance.
Established figures for pasteurization units (PUs) are used to determine the dimensions for the heat-holding sections (30 seconds) and the heat-holding temperatures (66°C – 72°C / 147 – 162 F).
The question then arises: Do these traditional parameters (utilizing the analytical and technological options now available) actually represent the optimum?
Flash pasteurization is essentially focused on killing beverage-specific micro-organisms. In the case of cloudy beers, the main consideration is stabilizing turbidity by means of rigorously targeted protein denaturation. With filtered beers, it is precisely this turbidity formation that must be prevented. In every case, pasteurization must only lead to a minimized effect on sensory perceptions and ageing stability.

This new procedure, using a constant heat-holding section of a defined length, enables both: 1) cloudy beers to be produced with improved ageing & turbidity stability and 2) filtered beers without the risk of pasteurization-related turbidity. For the equally important task of microbiological stabilization, it is immaterial in this context what the individual time and temperature parameters are. The crucial factor for the kill-off kinetics is only the time/temperature pairing involved.
The result of the work is a "hot-short process" that enables the heat-holding sections currently measuring about 50 meters (164 ft) to be shortened to as little as 10 % of the traditional length. When this is done, then – depending on the type of beer and focus (turbidity stabilization) – the temperature must be increased to 78°C to 83°C (172 – 181 F) in order to achieve identical PU values. The most important task was to find the maximum temperature for eliminating pasteurization-related turbidity in filtered beers and to be able to assure turbidity stabilization by reaching a denaturation temperature when producing cloudy beers still with the same flash pasteurizer.
Filtered and cloudy beers were compared in both processes in regards to the effect on turbidity stability, foaming characteristics, microbiology, thermal stress and ageing stability.
The "hot-short" process exhibited shows significant technological and commercial advantages. A difference in the thermal stress induced by the higher temperatures could not be found by quantifying free radicals by means of electron spin resonance measurements (T-500 value).
Besides the technological advantages covered in this presentation regarding beer quality, a shorter heat-holding section also offers commercial advantages. Reduced capital investment, downsized footprint, fewer mixing phases and product losses, plus enhanced microbiological safety are some of the commercially quantifiable benefits that can be achieved.

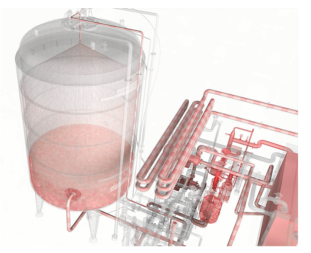
Target of the work

Finding optimal process parameters (time & temperature) in the flash pasteurizer to achieve:
- higher beer quality
- haze & aging stability to unfiltered beers
- compact units with low mixing phases -> pressure drops -> product losses

Possibility?
Reduction of the heat-holding time from 30 sec to e.g. 4-6 sec.

PE $_{Beer}$ = t x 1,393 $^{PT - 60°C}$

The PE-value, his calculation and the reaction kinetics for microorganism (D-values) shows that the traditional heat holding time of 30 sec. is not necessary for the microbiological stabilisation!



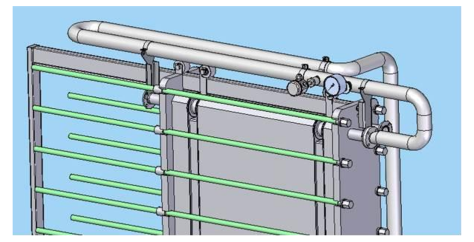
$$D = -\frac{1}{t}\log\left(\frac{N}{N_0}\right)$$

Result:
The basic for the PE-value is the D-value (time who is necessary to reduce the microorganism load about one power of ten). So the amount of reduction is only proportional to the relationship temperature and time.

$$D_{60} = D_T \cdot 1{,}393^{\left(\frac{T}{°C}-60\right)}$$

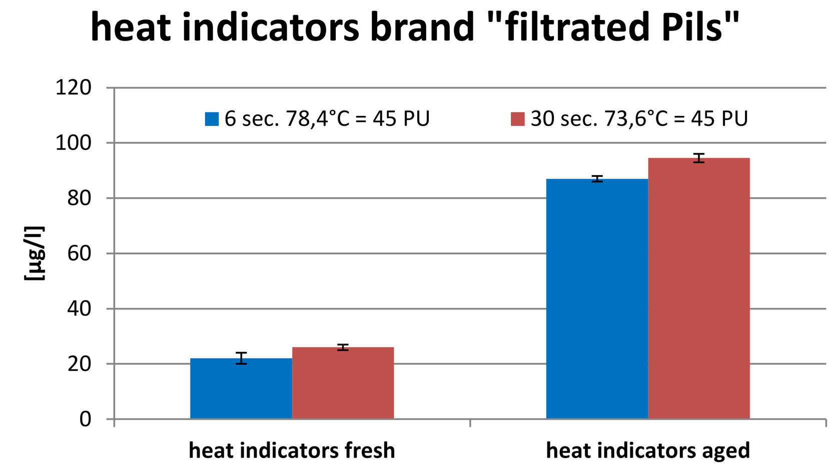
PE $_{Beer}$ = t x 1,393 $^{PT - 60°C}$

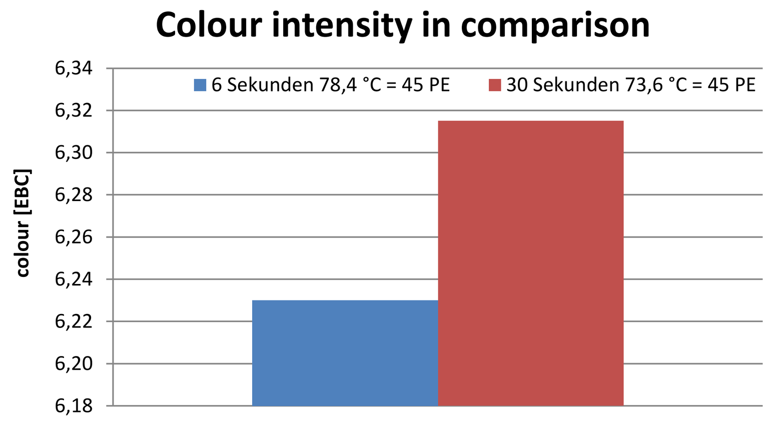
6 sec. x 1,393 $^{77,2°C - 60°C}$ = 30 sec. x 1,393 $^{72°C - 60°C}$
28 PU = 28 PU



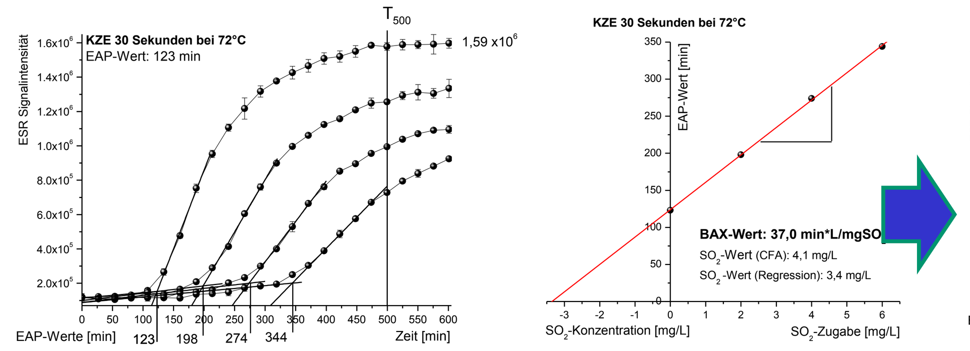
Results thermal impact

Aim:
-> less thermal impact through shorter heat-holding time

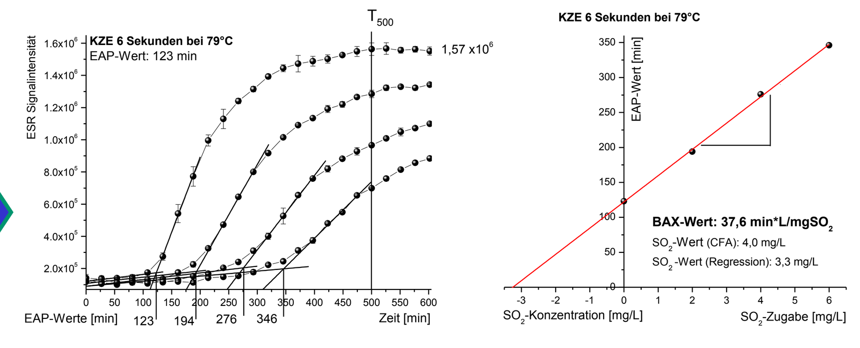




30 seconds



6 seconds



Result:
-> less heat indicators and higher antioxidative stability through shorter heat holding time!

Results haze stability

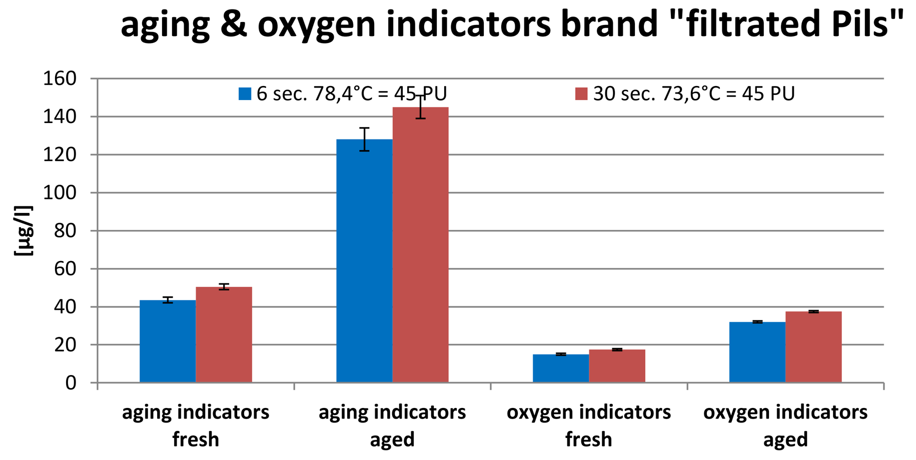
Aim:
-> no haze formation through high temperatures in filtrated beers
-> define a maximum temperature and less heat-holding time

Table 1: haze indicators in comparison	6 sec. at 78.4°C (173.1F)	30 sec. at 72°C (161.6F)
haze (760 nm / 700 nm) [extinction]	0.065 / 0.007	0.065 / 0.006
haze 90° / 25° [EBC] 0°C	0.28 / 0.10	0.26 / 0.10
haze g 90° / 25° [EBC] 20°C	0.21 / 0.06	0.20 / 0.07

Result:
-> no haze formation through temperatures < 78.5°C (173.3F) at 6 sec

Results aging stability

Aim:
-> better product quality



Result:
-> less aging and oxygen indicators in comparison long/warm vs. short/hot

Results wheat beer

Aim:
-> wheat beer must heat up to 80°C (176F) to guarantee a well haze stabilization
-> for microbiological safety 150 – 220 PUs are necessary
-> with a standard heat-holding tube, an over-pasteurization is always the result

Table 2:

	Time	Temp-erature	beer-PU
	[sec]	[°C]	[PU]
100 % Flow	30.0	80.0	378
50 % Flow	60.0	80.0	757

Table 3:

	Time	Temp-erature	beer-PU
	[sec]	[°C]	[PU]
100 % Flow	6	83,2	220
50 % Flow	12	81,1	220

Result:
-> exact PU values AND colloidal stabilization can be realized WITHOUT too much thermal impact

Summary

-> 30 seconds heat-holding time is no longer state of the art (flash pasteurizer).
-> 6 seconds at higher temperature shows better product quality with same microbiological safety.
-> the biggest advantage is for cloudy beers because a good colloidal stability is achieved as well as a reduction of the thermal impact is realized

Mechanical benefits:
-> less material, less welding, less space, less components etc.

Process benefits:
-> less mixing phases, less product losses, less pressure drop, lower microbiological risk because of less differences between fastest and slowest particle

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