Masterfilter Europe-Unitec

Microbial Stabilisation of non-alcoholic beer

7 March 2024

Stabilisation of NAB/LAB

Background

- 'Low alcohol beers' are projected grow exponentially next 10 years (fashionable, sociable, cultural for no alcohol countries, healthy, etc.)
- NAB/LAB will be differentiated and marketed by their flavors, aroma and colour. This means there are greater challenges with NAB/LAB to control the organoleptic & shelf-life stability issues to maintain the characterization of the beer.

The characterization of the beer can be influenced by the type of stabilization method. Breweries are therefore, <u>challenged by choosing the correct Pasteurization or Sterilisation techniques, that allow cost-effective OPEX variables and maximum cost/liter profit of the beer.</u>

Ref [4] see appendix

Cold Beer Stabilisation (CBS) V Flash & Tunnel Pasteurisation (FP/TP)

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Definitions

Brewers use the term ‘sterilisation’ that implies a microbiologically stable product, in which the aim of sterilisation is to remove spoilage organisms, which could impact the product quality.

Microbiological stabilisation can be achieved by **heat**, chemicals, irradiation or **filtration**.

In the process of beer manufacturing, the **multi-step filtration** of beer is termed as **Cold Beer Stabilisation (CBS).**

Pasteurisation **requires specific temperatures** to pasteurize the beers. In this process the NAB/LAB is **exposed to a temperature for a time** (PU units) that will stabilize the beer. **Flash pasteurization** is using HTST (high temperature/short time) and then rapidly cooled before filling. Tunnel pasteurization is using LTLT (low temperature/long time) and is microbiological stabilizing the product+ packaging. Pasteurization is used to achieve a reduction in concentration of spoilage microbes, which is particularly critical in the production of NAB/LAB. These beers are more at risk to microbial growth due to their reduced ethanol in the beer.

$$PU = t \cdot 1.393\ (T_p - 60\ °C)$$

T = heat holding time (min)
T_P = pasteurization temperature (°C)
60°C / 140°F
80°C / 176°F

Cold Beer Stabilisation (CBS) V Flash & Tunnel Pasteurisation (FP/TP)

The benefits and considerations of CBS & FP/TP

The method of stabilisation used must consider the type of beer being processed. The organoleptic, shelf-life stability, haze, aromatic, and colour properties must be maintained for the respective type of beer.

Variables (Beer)	Cold Beer Stabilisation	Flash (HTST) / Tunnel Pasteurisation
Flavour	Seen has gentler impact on flavors and maintains the stability of organoleptic properties by eliminating undesirable spoilage microbes, polyphenols and excess yeast.	Seen as having more impact on flavors so requires better temperature control
Colour & Brightness	Using the right filter membranes like PES, PVDF or Cellulose will prevent stripping out of the color and maintain the brightness	FP seen as more favorable than TP in maintaining the colours (HTST)
Shelf-life	Beer is less oxidized and remains fresh for longer – shelf life.	In some instances, the oxidation of beer is susceptible to increase by thermal shock of the beer. Shelf life can still be maintained by accurate control of oxygen pick-up
Microorganisms	Delivers better control of removal beer spoilage micro-organisms . (multiple step filtration). Removal of CB !	Inactivates yeast and prevents spoilage in beer – FP preferred over TP. (HTST)

Cold Beer Stabilisation (CBS) V Flash & Tunnel Pasteurisation (FP/TP)

The benefits and considerations of CBS & FP/TP **Key:** $ = Low cost, $$ = Moderate Cost, $$$ = High Cost

OPEX /CAPEX	Cold Beer Stabilisation	Flash Pasteurisation	Tunnel Pasteurisation
Consumable spend (OPEX)	$$	$	$$$
Maintenance/service (OPEX)	$ - CIP/filter changes less downtime than FP	$$ - (CIP/Corrosion/Fouling – heat XC)	$$$
Auxiliary Equipment (OPEX & CAPEX)	$ - Filter vessels / pumps	$$ - Heat exchangers / Pumps / buffer tanks /CO_2 and sterile air(acid cleaning) tanks /	$$$
Electrical Energy consumption (OPEX)	$	$$ - (Heat Regeneration)	$$$
Water consumption (OPEX)	$ low (CIP mainly / low frequency)	$$ Moderate (Water Beer Mix -) (Heat recouperation +)	$$$
Beer loss (OPEX)	$	$$	$ (broken bottles)
Equipment investment (CAPEX)	$	$$	$$$
Quality Control and testing (OPEX CAPEX)	$$(integrity test)or sampling tests	$ - (as part of the FP control)	$$ (sensor recorder)

Cold Beer Stabilisation (CBS) V Flash & Tunnel Pasteurisation (FP)

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Filtration R&D / New Product Development

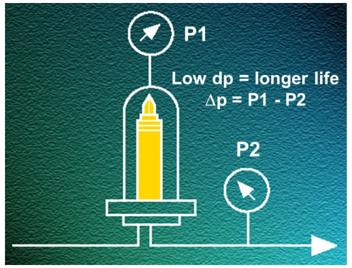
D'Arcy's Law $\Delta_P = \frac{Qt}{kA}$ $\qquad \Delta_P \propto \frac{Q}{A}$

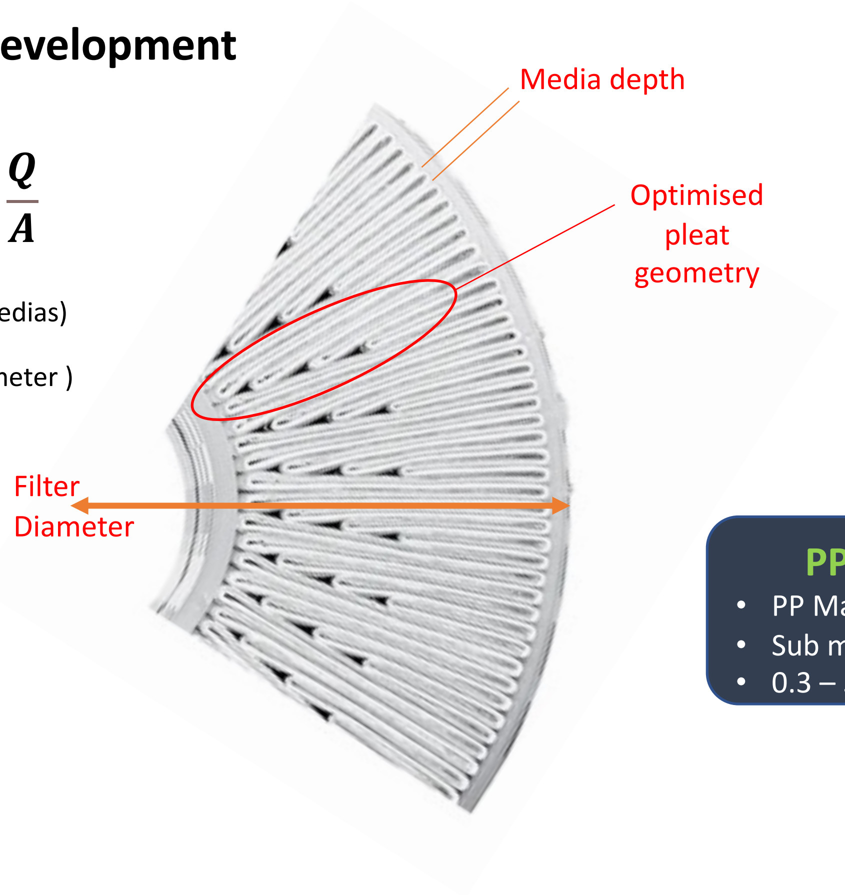
k = permeability constant (different filter medias)

A = Area (pleats and pleat geometry & filter diameter)

Δ_P = Delta p (pressure drop)

t = Thickness (depth of media)





Wide format

- PP graded depth & Pleated , Resin Bonded GF, & Polyaramid, PES pleated
- 0.3 – 70um PP media
- 0.8 – 25um GF media
- ≤ 99.98% efficiency (absolute)
- FDA & EU 1935/2004

PP/PVDF nanofibre

- PP Matric & PVDF Nano-fibre
- Sub micron layer combinations
- 0.3 – 3.0um range

- Optimised for backwashing
- Pre-stabilisation / Bio-burden filter
- Absolute rated – yeast removal 99.98%
- Wine / Beer / Pharma

- Traditional filtration steps following Kieselguhr (Free) / PVPP/ Sheet Filter → 10um Trap → BBT → 0.65um PPP → PES 0.45 PP/Nano/ PVDF 0.45

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Filtration R&D / New Product Development

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PP/PVDF nanofibre

- PP Matric & PVDF Nano-fibre
- Sub micron layer combinations
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Nr/naam	Startlading bacteriën	Medium	Datum staal	Cartridge/ capsule	Debiet	Voorfilter	Steriele filter	CFU/plaat	Volume plaat	CFU/ml
	(CFU/ml)				(l/min)				(ml)	
1	LB 10^4	Bier	20/apr	Cartridge	9	APKV 65 µm	APKV 0,45 µm	8	32	<1
2	LB 10^5	Bier	20/apr	Cartridge	7	APKV 65 µm	APKV 0,45 µm	0		n.d.
3	Lb 10^6	Bier	21/apr	Cartridge	6	APKV 65 µm	APKV 0,45 µm	0		n.d.
4	Lb 10^4	Water	29/apr	Cartridge	6	APKV 65 µm	APKV 0,45 µm	0		n.d.
5	Lb 10^4	Water	29/apr	Cartridge	6	APKV 65 µm	APKV 0,45 µm	0		n.d.
6	Lb 10^5	Water	29/apr	Cartridge	3	APKV 65 µm	APKV 0,45 µm	0		n.d.
7	Lb 10^5	Water	29/apr	Cartridge	3	APKV 65 µm	APKV 0,45 µm	0		n.d.
8	Lb 10^5	Water	3/mei	Capsule	1	APKV 0,65 µm	APKV 0,30 µm	0		n.d.
9	Lb 10^5	Water	4/mei	Capsule	1	APKV 0,65 µm	APKV 0,30 µm	0		n.d.
10	Lb 10^5	Water	5/mei	Capsule	1	APKV 0,65 µm	PES 0,45 µm	0		n.d.
11	Lb 10^5	Water	11/mei	Capsule	3	APKV 1,2 µm	APKV 0,45 µm	0		n.d.
12	Lb 10^5	Water	11/mei	Capsule	8	APKV 1,2 µm	APKV 0,45 µm	0		n.d.
13	Lb 10^5	Bier	16/mei	Cartridge	3	APKV 1,0 µm	APKV 0,2 µm	0		n.d.
14	Lb 10^5	Bier	16/mei	Cartridge	8	APKV 1,0 µm	APKV 0,2 µm	10	40	<1
15	Lb 10^5	Bier	16/mei	Cartridge	3	APKV 0,65 µm	PES 0,45 µm	0		n.d.
16	Lb 10^5	Bier	17/mei	Cartridge	8	APKV 0,65 µm	PES 0,45 µm	0		n.d.

n.d.= not detected

Cold Beer Stabilisation (CBS) V Flash & Tunnel Pasteurisation (FP)

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Conclusion

- [1] The reduction of ethanol can influence the stability of beers, so FP/TP or CBS ensures trace microbes are deactivated and maintain shelf life & organoleptic characteristics unique to the beer.
- TP is 100% fully pasteurised final package consumer product.
- Since NAB/LAB are crafted with diversity of flavours and colours, CBS and FP (High Temp/Short Time -HTST) maintains the beers organoleptic properties. TP is more sensible because of risk of over pasteurizing , which can influence organoleptic properties.
- FP inactivates fermenting yeast and spoilage microorganisms, so ensuring shelf life of beer at room temperature
- [2,3] Filtration removes yeast, haze, bioburden (*Clostridium botulinum)* found in NAB/LAB content , bacteria ,without stripping out colour and flavours.
- The right CAPEX can reduce or maintain a steady OPEX in the long term (Total cost of ownership)

[1,2,3] see appendix

Appendix – references

1. https://www.frontiersin.org/articles/10.3389/frfst.2021.798676/full - Pasteurization of Beer by Non-Thermal Technologies by Eham A Milani & Filipa VM Silva

2. https://core.ac.uk/download/pdf/14916388.pdf - PROCESS HYGIENE CONTROL IN BEER PRODUCTION AND DISPENSING by Erna Strogards VTT Biotechnology

3. https://cdn.brewersassociation.org/wp-content/uploads/2022/08/19105124/BAtech22-Non-Alcohol-Beer-A-Review-and-Key-Considerations-201.pdf - Non-Alcohol Beer: A review and Key Considerations, BREWERS ASSOCIATION publication. USA

4. https://www.gminsights.com/industry-analysis/non-alcoholic-beer-market **Non-Alcoholic Beer Market - By Product (Alcohol Free {By Material [Malted Grains, Hops, Yeast and Enzymes], By Technology [Restricted Fermentation and Dealcoholization {Reverse Osmosis}], By Sales Channel (Liquor Stores, Convenience Stores]}, Low Alcohol) & Forecast, 2023-2032**


Dziękuję
Mauruuru
Спасибо
Dankie
D'Akujem
хвала
Obrigado
Gracias
Merci
Sagolun
Danke
Arigatô
Kiitos
Köszönöm
Rahmat
Kiitos
Multumesc
Misaotra
Mercé
Thank You
Tak
Grazie
Thank You
Gracias
Merci
Arigatô
Xièxie
Matondo
Obrigado
Chokrane
Mahalo
Sagolun
Chokrane
Grazie
Efharisto
Спасибо
Takk
хвала
Toda
Hvala
Tak
Danke
Dank Je
Takk
Faleminderit
Terima Kasih