Master Brewers Association of the Americas

Dedicated to the technology of brewing.

2014 MBAA Annual Conference

FLASH PASTEURIZATION

Advantages, weak points, remarkable points

2014 MBAA Annual Conference
June 5 - 7
Palmer House, Chicago, IL

Henri Fischer, Krones Inc., Franklin, WI

Submitter ID: 50
Abstract ID: 10413

Hygienic Filling - Introduction

- Maximum biological safety
- Maximum product quality and sensory purity
- Minimum installation costs
- Minimum energy costs
- Maximum product flexibility

Photo: Thanks to Krones AG

Flash Pasteurization – advantages, weak points, remarkable points

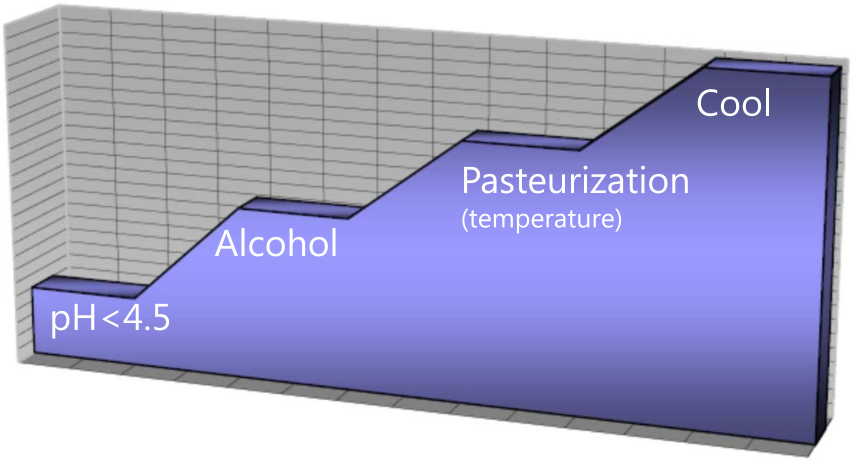
Why Pasteurization of Beer?

Pasteurization is the selective inactivating or killing of vegetative germs

- Prevents contamination of beverages → maximal biological safety
- ensures a safe (hygienic)product → maximal product quality

Pasteurization is part of the barrier concept of the preservation of beverages

Shelf live



➢ Extended shelf live → maximal transportation / storage stability

Flash Pasteurization – advantages, weak points, remarkable points

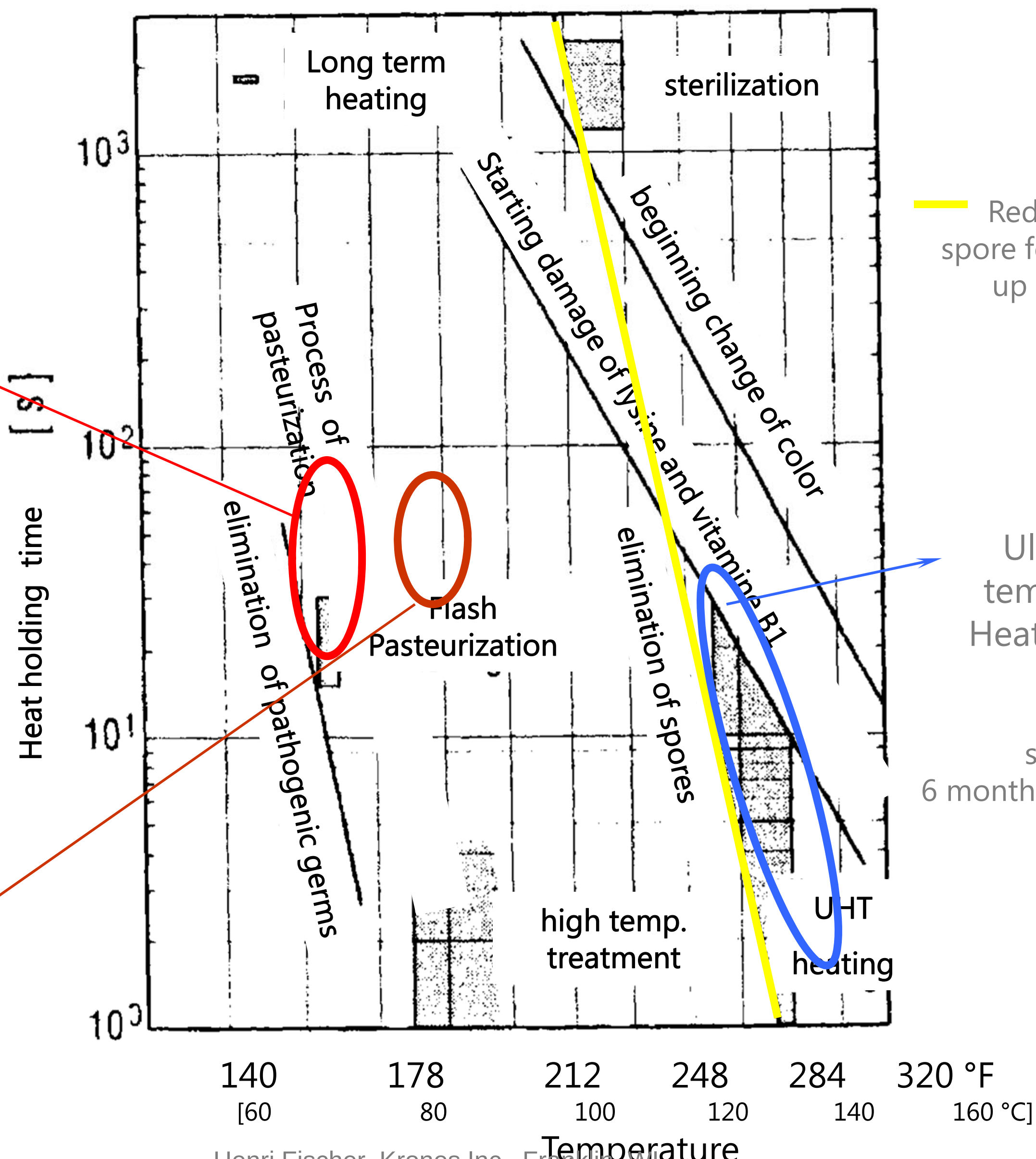
<u>Pasteurization</u>

Milk
shelf life 7 days
at 4-6°C

Beer
shelf life
> 6 months

<u>Pasteurization</u>

Juices / CSD
shelf life
12 months



Reduction of spore forming units up to LOG 9

Ultra high temperature Heating (UHT)

Milk
shelf life
6 months at 68°F [20°C]

Pasteurization Units (PU)

Pasteurization units (PU) are a function of D- and Z-value and a dimension for the effect realized through the heat impact:

- Elimination of beer spoiling MO's:

$$PU = t \cdot 1.393^{(Tp - 60\ °C)}$$

- Elimination of CSD spoiling MO's:
  $PU = t \cdot 1.393^{(Tp - 80\ °C)}$

- Elimination of juice spoiling MO's:
  $PU = t \cdot 1.2589^{(Tp - 80\ °C)}$

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

☞ Holding time is linear to the PU
double holding time results in double PU

☞ Temperature is power to PU
2 Kelvin more temperature results in double PU

The effect of thermal treatment alternatively is monitored just by the temperature at a certain holding time!

Flash Pasteurization – advantages, weak points, remarkable points

Reference PU Values

Bottom fermented beers (lagers)	15 – 30 PU
Top fermented beers	Up to 100 PU
Shandies / Alcohol free	> 100 PU

change of 1 or 2 PU

⇨

Change of 0.1 – 0.3 Kelvin!

Flash Pasteurization – advantages, weak points, remarkable points

Pasteurization of Beer: Comparison

- Tunnel / Chamber

  (Beer 143 – 158 F [62 – 70 °C],

  low/no alc. 154 – 167 F [68 – 75 °C])

  20 minutes to 143 F [62 °C]

  – hold for 20 min

  - 20 min cool down

- Flash Pasteurizer (plate)

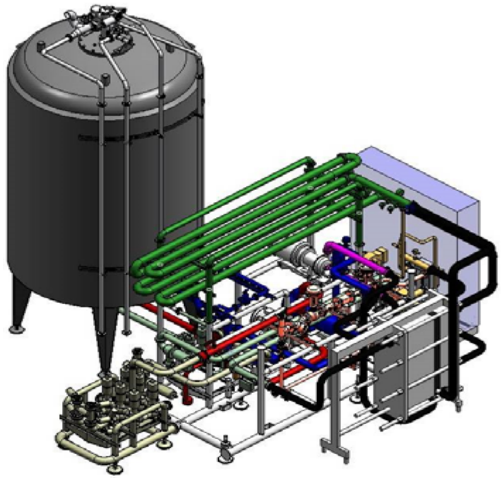
  (Beer 152 – 167 F [67 – 75 °C],

  low/no alc. 158 – 172 F [70 – 78 °C])

  heating up and cool down beer flow – less thermal load (O_2 reactions)

  holding time of about 30 seconds at 161.6 F [72 °C]

Comparing Tunnel Pasteurization with Flash Pasteurization



Flash Pasteurization

- Thermal product treatment before filling process
- Short thermal treatment
- Separate container & closure treatment ?, hygiene level ?
- Lower costs for installation, energy
- Smaller footprint
- Filling temperature - warmer needed? (condensation)

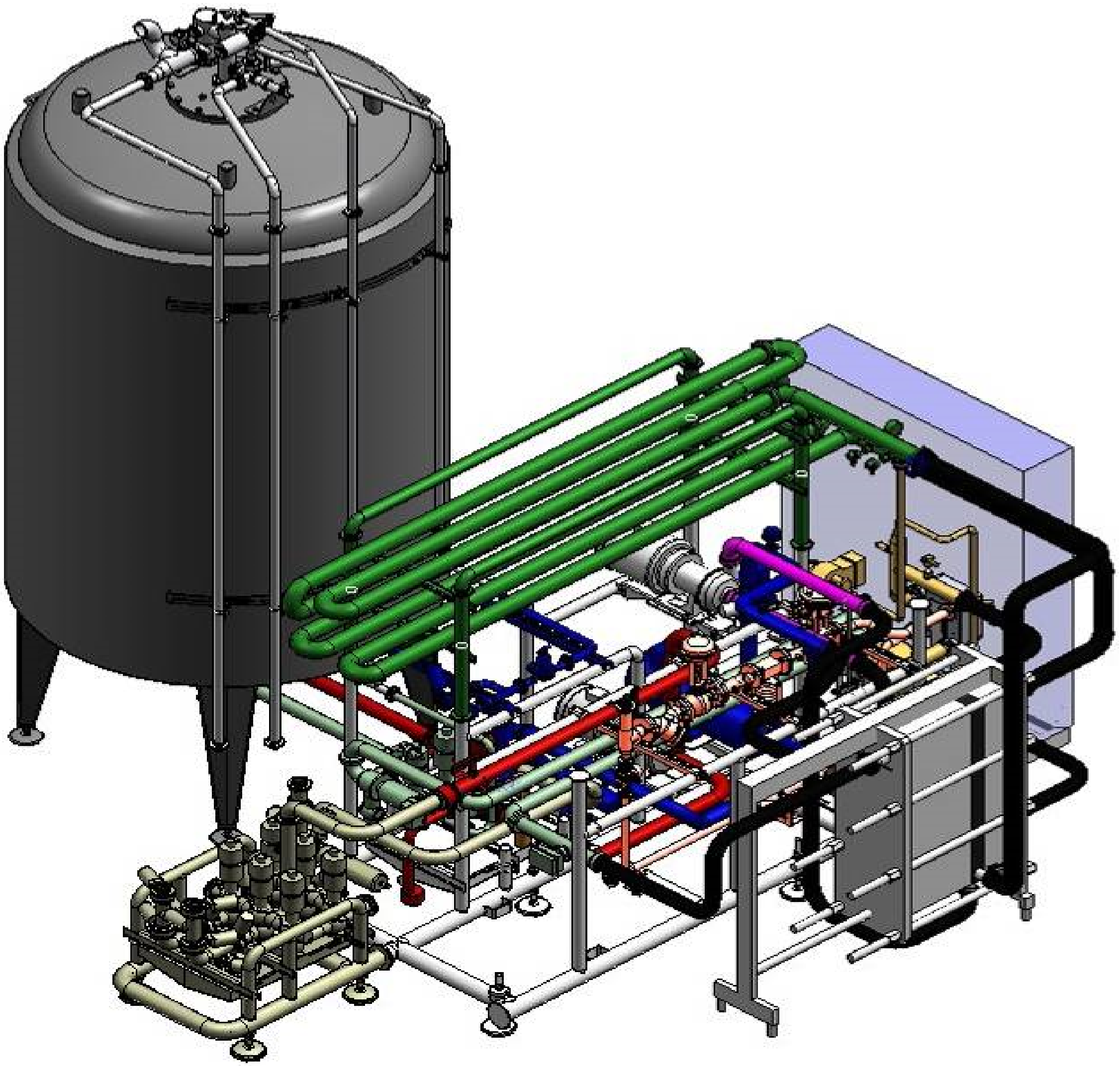
Graphics: Thanks to Krones AG

Tunnel Pasteurization

- Product, container and closure are thermally treated after filling process – very safe!
- Container internal pressure, glass break (delta T)
- Long thermal treatment, thermal load – cold spot
- Relatively higher costs for installation and energy
- Bigger footprint

Flash Pasteurization – advantages, weak points, remarkable points

Flash Pasteurizer



Graphics: Thanks to Krones AG

- Beer connection (BBT, filler)
- Water connection
- Inlet pump, booster pump, (pump to filler)
- Heat exchanger
  - with secondary water loop for heating (steam or superheated water connection, recirculation pump, controls
  - (cooling media circuit)
- Holding tube
- Buffer tank with CO_2, sterile air connection

Complete Concept with Flash pasteurization

Filler concept:

- Hygienic conditions at filler *(room, floor, air recirculation, conveyors…)*
- Hygienic filler design *(incl. flush system for valves and capper)*
- Automatic controls
- External cleaning / desinfection
- Optional: rinser, housing

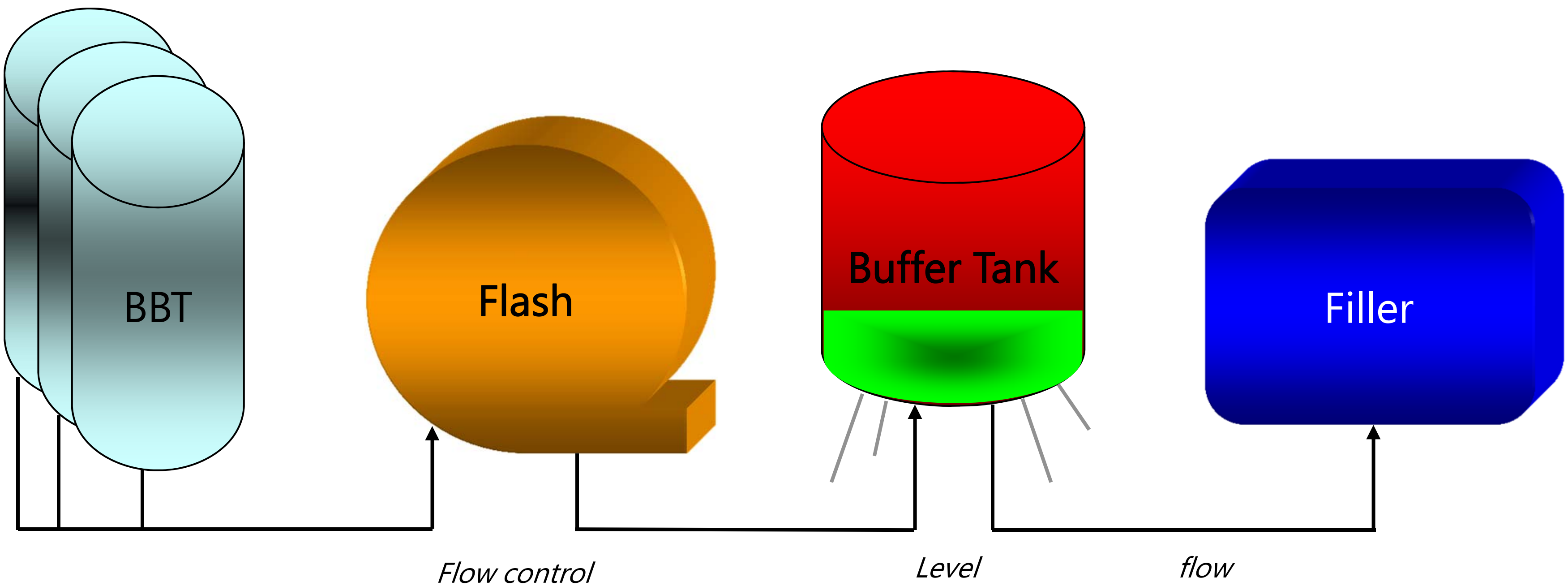
- Reliable CIP of all pipework and machines!

- Fresh / flush water treatment

Photo: Thanks to Krones AG

Flash Pasteurization – advantages, weak points, remarkable points

Buffer / Flow control



Filler consumption (flow)	↑	↓
Tank level	↓	↑
Flash Flow	↑	↓

- Heat exchanger minimum flow rate!
- Reliability of measurements and controls
- Adaption speed
- Buffer tank size
- Effective buffer time
- Push out frequency

Flash Pasteurization – advantages, weak points, remarkable points

Design and Control System MUST Ensure Product safety

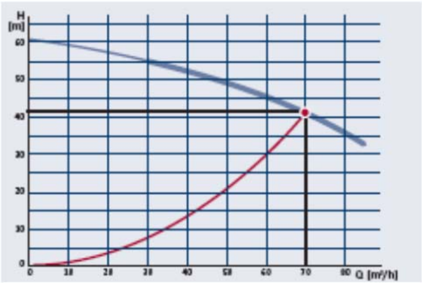
- Over pasteurization: thermal overload to the beer-> flavor change
- Under pasteurization: microbiological conditions are not safely guaranteed
- Under shooting saturation pressure : degassing in product --> undefined pasteurization with insulating gas bubbles
- Fault set points that are adapted to the product and overall conditions – flash internal purge to drain or rework tank
- Product recirculation: advantage of lowest product losses, disadvantage of high thermal effect (other risks?)
- Internal push out: no thermal overload to the sensible product
- Re-sterilization (with water) after undershooting – flash internal

Photo: Thanks to Krones AG

Effects on Functionality

- Constant feed pressures and temperatures of product, water, steam (or superheated water)
- Exact design of
  - control valves *(cv, control accuracy…)*
  - pumps *(pressure, control accuracy…)*
  - pipe size and geometry *(turbulences)*
  - heat exchanger *(delta T)*
  - holding *(length, bows..)*

- Exact adaption to local situation is basics for correct engineering



Graphics: Internet

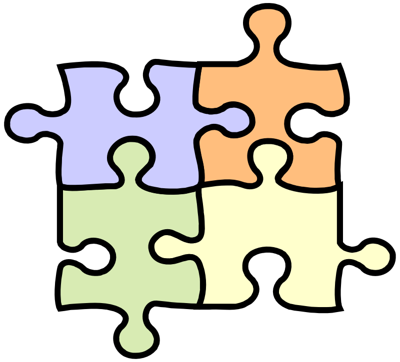
Water

- Fast / big pressure changes can not be balanced by flow and pressure control

  → flow change → PU change

  → pressure change → flow change → PU change

  → pressure change → deficient saturation pressure
- Water feed system design matters
  - Pressure control
    - Set point multiple pumps
    - Position of pressure sensor
    - Control speed and deviation
  - Dead end / ring pipe
  - Interaction with other big consumers



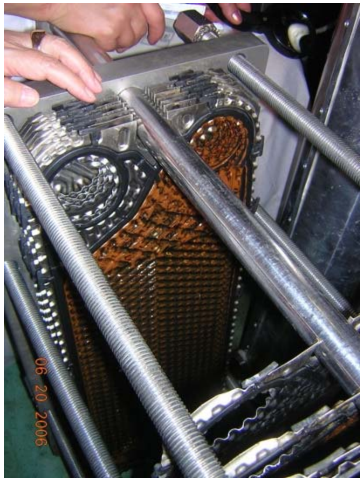
Corrosion

- Chloride content of water
- Salt content of special products

→ heat exchanger material with high temperatures

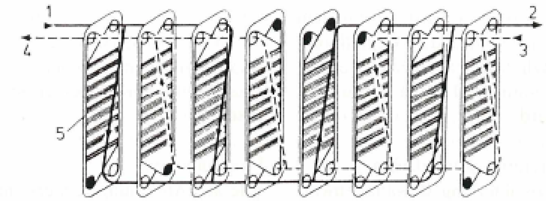
→ otherwise corrosion (at least by time)

- Material fatigue/ damage – micro cracks
- Worse functionality
- No product safety with mixture

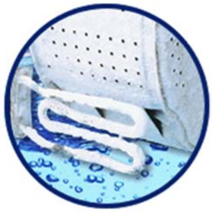


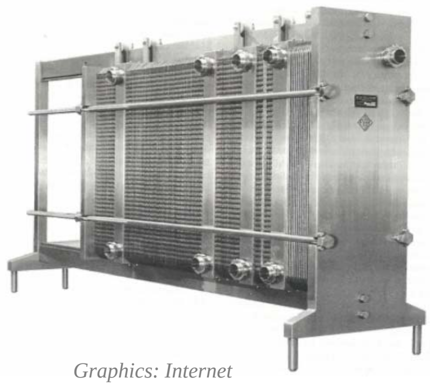
Flash Pasteurization – advantages, weak points, remarkable points

Heat Exchanger



- Positive pressure differential
- Secondary circuit de-aeration
- Correct installation of plates (maintenance) *(order, direction change end plates, amount, glue etc.)*
- Min. / max. wide! *(support points, flexible piping!)*
- Leaks
  - Visible – to outside
    - Seals after overpressure
    - Seal with wear
  - Not visible – inside
    - Corrosion
    - Breaks / micro cracks
  - Checks – recommended in maintenance intervals!
    - Pressurizing – even little leaks visible
    - Colored liquids
    - Gas
    - Gels
- Fouling
  - Biological → caustic CIP
  - Stone → Acid



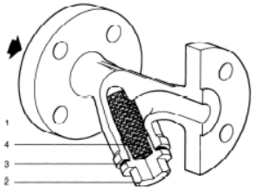


Graphics: Internet

Flash Pasteurization – advantages, weak points, remarkable points

Steam

- Fast / huge pressure deviations can not be balanced by control → PU deviation
- Balancing with (mechanical) pressure reducer / control valve
- Respect design / pipework
  - Interaction with other big consumers
  - Adequate dimensioning of pipework
- Condensate system
  - Counter pressure not too high
  - Respect pressure losses
  - Adequate dimensioning of pipework
  - Prevent „U-legs“



Picture: Spirax Sarco

Flash Pasteurization – advantages, weak points, remarkable points

Cleaning - CIP/SIP

A lot of different suppliers and brand products
Different active chemicals, basic effect similar

- Compatibility of chemicals with materials (Chlorine!)
- Temperature and recirculation time
- Wash off (residuals, flush amounts)
- CO_2 – NaOH reaction
- Effective NaOH concentration

Photo: Thanks to Krones AG

Flash Pasteurization – advantages, weak points, remarkable points

CIP

- Time
  - Check best by automatic system (CIP master)
  - Pulsing of valves
  - Tank spray
- Temperature
  - Production temperatures (heat exchanger)
  - Chemicals (cleaning optimum, corrosion)
- Flow rates
  - Flow rate / turbulences (Reynolds)
  - During pulsing of valves / sections / dead legs
  - Flow / pressure to filler
- Sample valves
- Vacuum valve of buffer tank (hard to clean, best: vacuum proof tank)
- Spray ball buffer tank
  - pressure
  - blocking

Flash Pasteurization – advantages, weak points, remarkable points

Saturation Pressure

- Low pressure: de-aeration of beer -> insulation at resulting bubbles – undefined heat transfer - undefined / low pasteurization effect!!
- Has to be respected in every spot in the flash, especially in the hot zone
  - Most critical after pre-warming before booster pump
  - Stay always above theoretical saturation pressure plus safety (+ 1 bar)
  - No foaming!

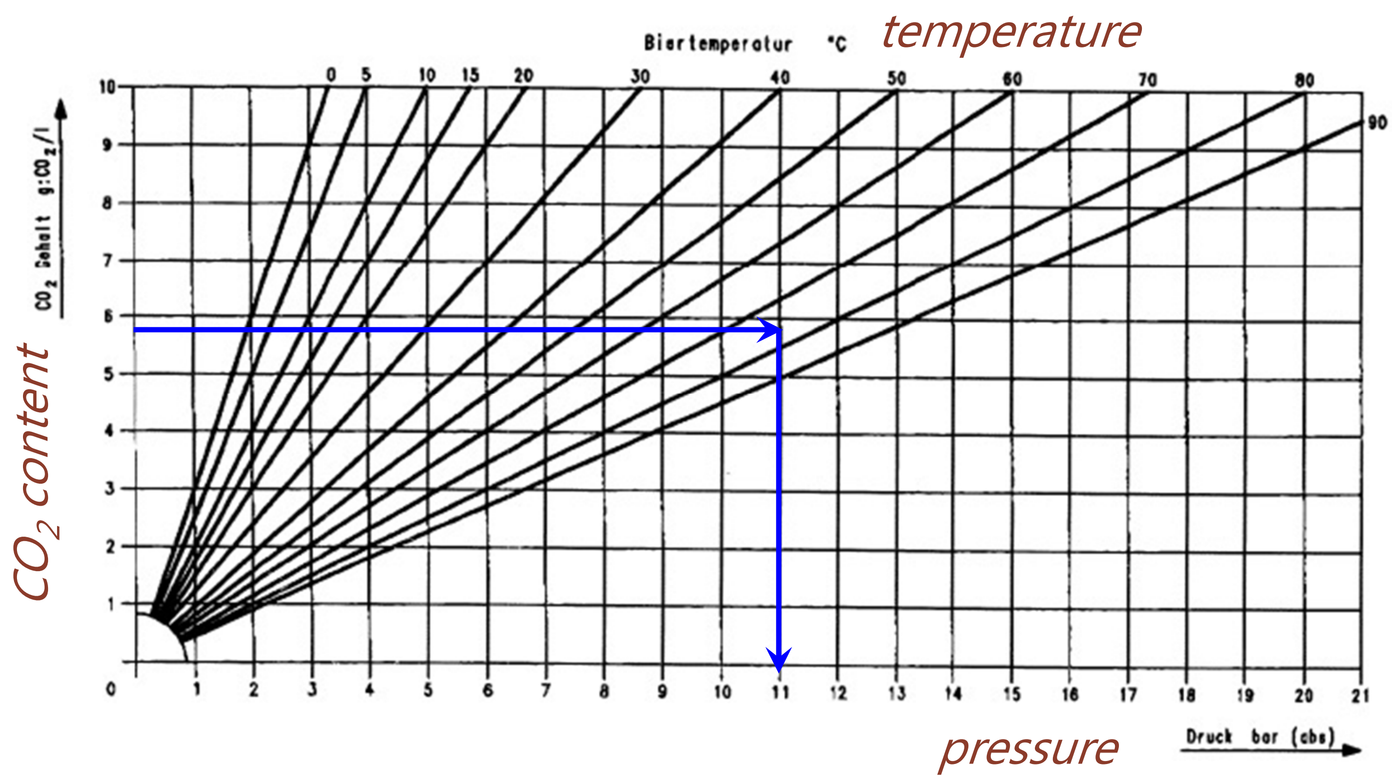
Backpressure valves at drains

Manually pressure maintaining valves – spring loaded

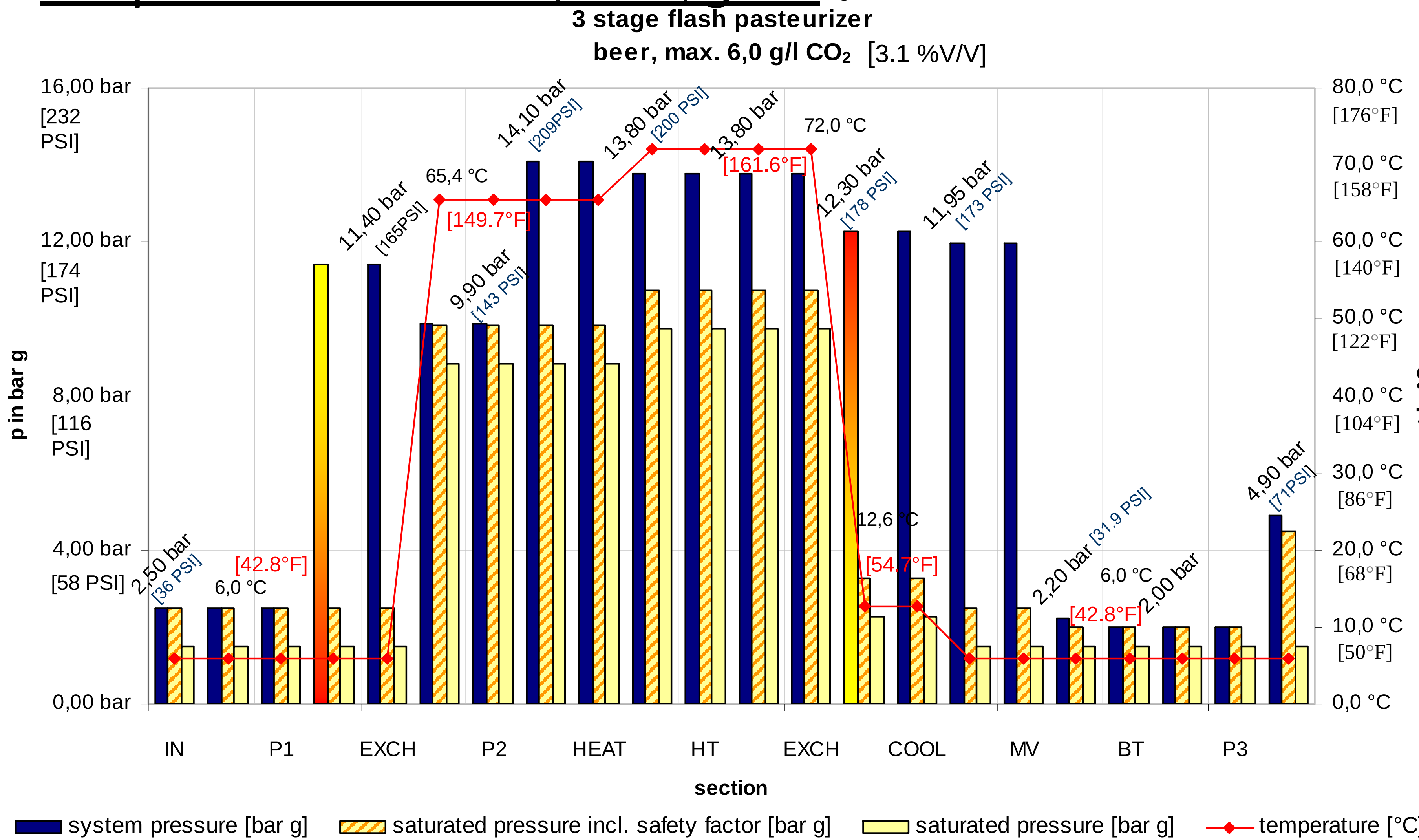
Set to respective pressure at about 43 PSI [3 barG]!

Saturation Isotherme (beer)

Relation:
A certain amount of CO_2 is bound in a certain liquid at a certain temperature at a certain pressure!



Temperature and Pressure Diagram



Flash Pasteurization – advantages, weak points, remarkable points

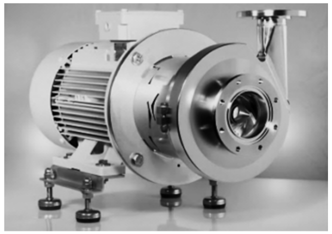
Pressure Situation During the Process

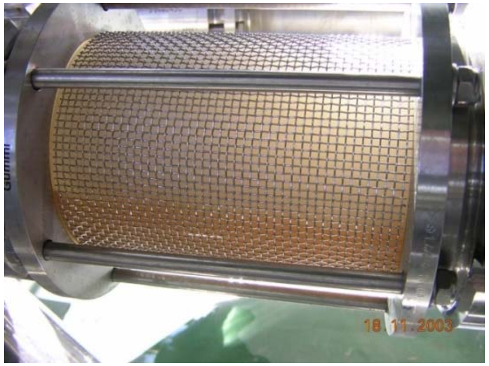
- Pressure in the whole system at every temperature

→ Min. saturation of the beer respecting the CO_2 content

Defined by:

- Design
  - Pump design
  - Feed pressure
  - Booster pressure
  - Pos. Pressure differential (heat exchanger)
  - Buffer tank pressure control
- Control
  - Measures
  - Alarm deviations





Beer Supply Problems – Mistakes in the BBC

- Admission
  - Keep saturation pressure → otherwise foam → results in issues (pressure, flow, sensors…)
  - Correct amount→ otherwise losses, dilution
  - Pipe end opposite to emptying flow filled too? → undefined amount for push out, dilution with tank
- Tank Changeover
  - Water plug between tanks? → Dilution
  - Swing bends de-aerated→ gas bubbles
  - Gas bubbles between tanks? → flow / pressure / sensor issues
  - Pressure fluctuation when switching tanks? → flow / pressure issues
  - Signal exchange
    - No short signal fall offs → flash control will react with push out / interruptions
  - No signal if no product available → flow / pressure issues, wrong reaction of flash

→ Mistakes in the cellar result in issues at the flash pasteurizer!

Flash Pasteurization – advantages, weak points, remarkable points

Oxygen Intake

- Cellar
- D/A-water
  - Water from cellar at beginning
  - Internal push outs with flash internal water supply
  - D/A-water for intermediate sterilization (saturation pressure!!)
- Filter
- Buffer tank
- Components
  - Seals
  - Pumps
  - Pipe connections (screw connections, clamps…)
- Admission to filler

Flash Pasteurization – advantages, weak points, remarkable points

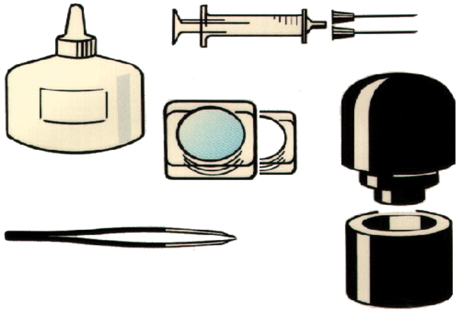
Beer Dilution

- Cellar
- Mix phases
- Leakage proof connections
- Counted / calculated amounts (espec. before flash)
- Sensor delay times

Calibration of Sensors

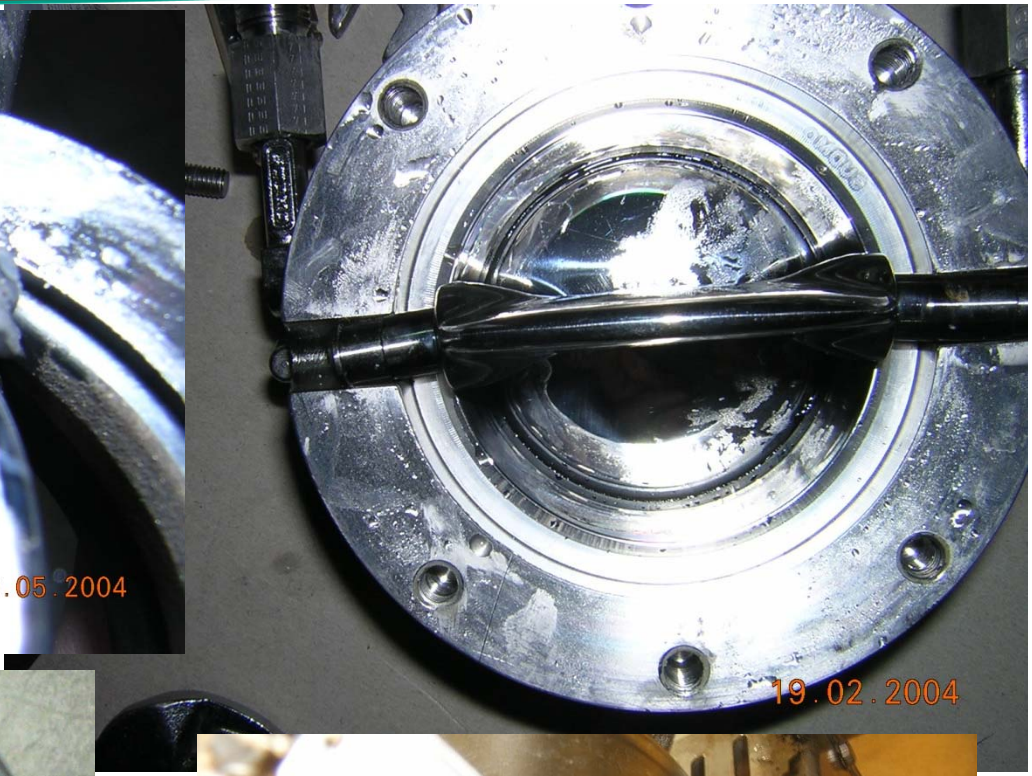
- More often:
  - O_2
  - Orig. gravity
  - Alcohol
  - Turbidity
  - Conductivity
  - Conductivity water and flow meter

- Rarely / (never):
  - Pressure sensors
  - Flow meter
  - Temperature sensors



Graphics: Orbishere Internet

Flash Pasteurization – advantages, weak points, remarkable points



MAINTENANCE!

- Maintenance interval
- Preventive action!

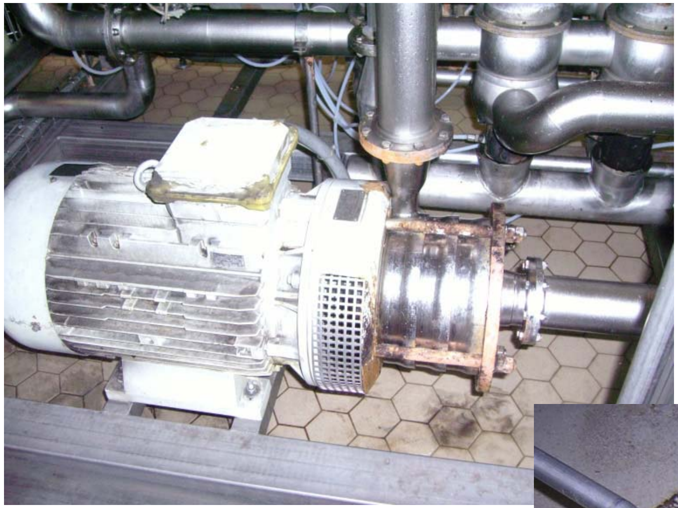
An ounce of prevention is worth a pound of cure. *[Benjamin Franklin]*

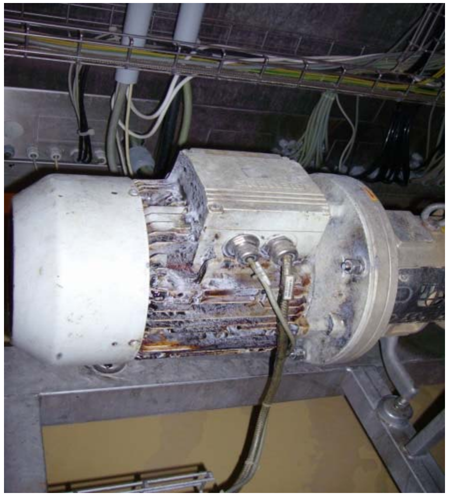
→ qualified personnel

→ external maintenance, vendor maintenance programs

Photos: Thanks to Krones AG

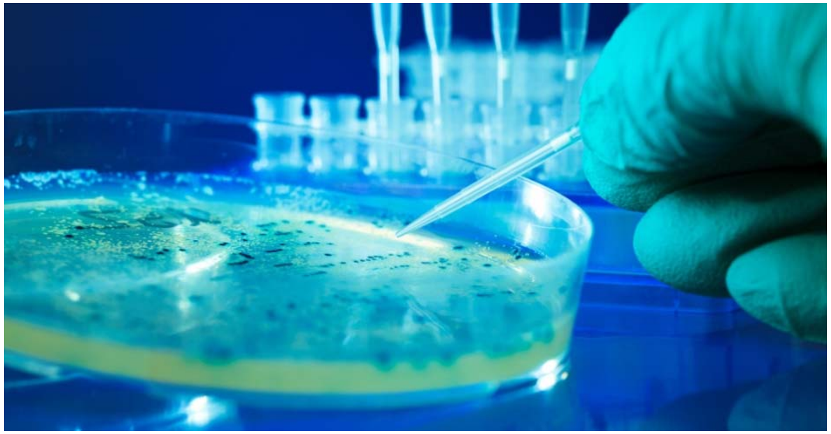
Flash Pasteurization – advantages, weak points, remarkable points





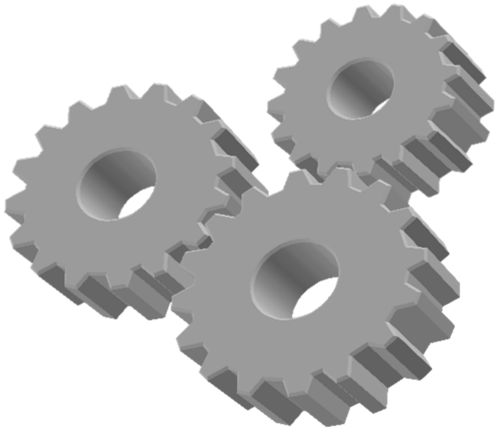
Microbiological checks - Step control

- Isolate / detect contamination spot
- Duration / time to respect
  - Sporadic results point more to periphery
- Layers in buffer tank



Fault diagnostics – Bug Fix

- „Keep calm, act carefully“
- Defined and factual fault detection and description
- When did the issue happen ?
  E.g. program step, exact situation



- Collect as much information as possible for the experts
- „Murphy´s Law“ is not always the reason for a fault !

  Very often it is the most obvious, most simpliest reasons which result in issues. (e.g. proxy loose)

- Use the advantage of diagnostic (IT-) tools if possible

Example: Trending Curves, Fault messages

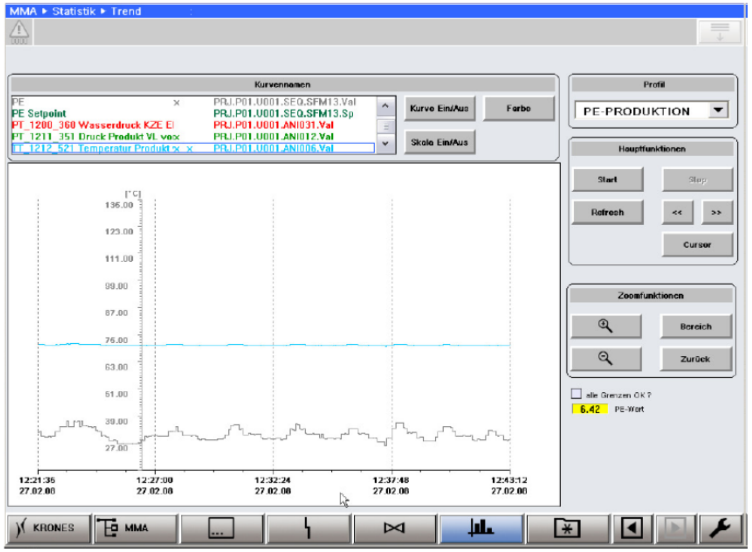


Photo: Thanks to Krones AG

Graphics: Thanks to Krones AG

Conclusion

Often external factors result in issues at the flash pasteurizer

Cellar

Media supply

Photo: Thanks to Krones AG

Operation

Signal exchange

Maintenance

QUESTIONS?

Henri Fischer
Educated Brewmaster
Product Manager Processing
KRONES Inc., Franklin, WI

☎ 414-409-4740
henri.fischer@kronesusa.com