Yeast propagation

An introduction






Yeast propagation

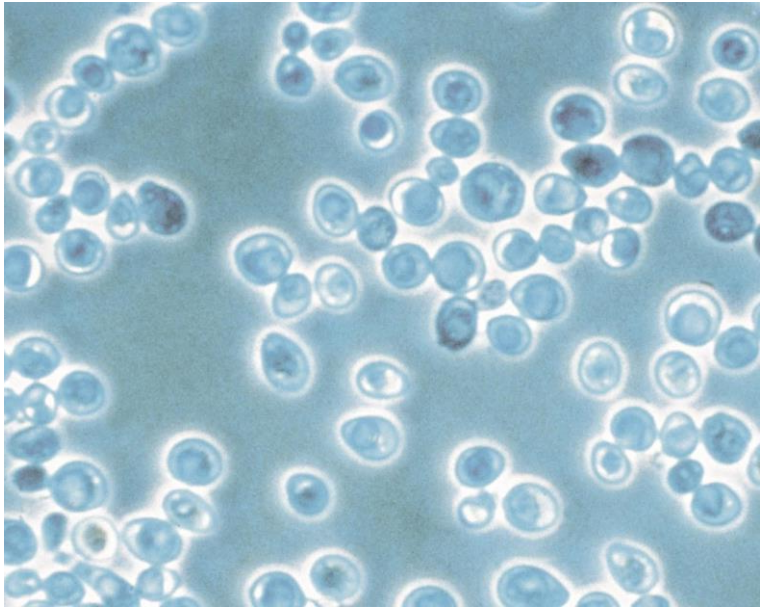
What is yeast?

- It is a single-celled organism that belongs to the fungus kingdom
- It multiplies through cell division or ‘budding’
- It is aerobic and anaerobic, so it is able to live with and without oxygen
- It undergoes anaerobic reactions when deprived of oxygen and produces alcohol

Yeast in the brewery

Yeast is the most important microorganism in the production of beer

- Yeast metabolizes sugar from wort, producing alcohol and carbon dioxide thereby turning wort into beer.
- It ferments beer and influences its character and flavor; however, there must be no oxygen present.
- In the presence of oxygen, yeast multiplies which is important for propagation and the baking industry. This can spoil the long-term stability of beer flavour and clarity.



Yeast propagation and storage

What is propagation and what is storage?

Yeast propagation

New yeast is required from time to time, as old yeast becomes unable to produce good beer with age. Growing new yeast is called yeast propagation.

Yeast storage

After the yeast has been used to produce beer it should be stored in comfortable surroundings in order not to loose its ability to produce good beer next time. This is yeast storage.

Yeast management

- **Yeast propagation**
- Yeast cropping
- Yeast storage
- Yeast pitching
- Beer recovery from cropped yeast
- Waste yeast handling
- Cleaning-in-Place plant

Yeast plant
Propagation

Carlsberg
Flask

Yeast screen
Storage

Dynapitch
Yeast pitching

Lobe pumps
Cropping

HSS
Beer separation and recovery

Rotary jet heads
Cleaning

Top tank systems
Yeast and fermentation management

CIP station
Cleaning-in-place

Yeast systems
Propagation and storage

Thermolyzer
Yeast autolyzation

Coolers
Yeast and beer cooling

Five breweries produce 50% of the world's beer today

Designed for the future

- Bottom-fermented lager strains
- Top-fermented ale strains
- Rehydration of dried yeast
- Yeast inoculation from Carlsberg Flask
- Yeast inoculation from re-hydrator
- Craft brewers combine propagation and storage

Respiration in the yeast cell

$C_6H_{12}O_6$ (glucose) + $6O_2 \geq 6CO_2 + 6H_2O$

- Energy gain: 28 moles of ATP per mole of monosaccharide
- Energy conservation: 29%
- Heat loss: 71%
- Yield factor: 0.54 g dry solids yeast per g carbohydrate = 54%

Fermentation in the yeast cell

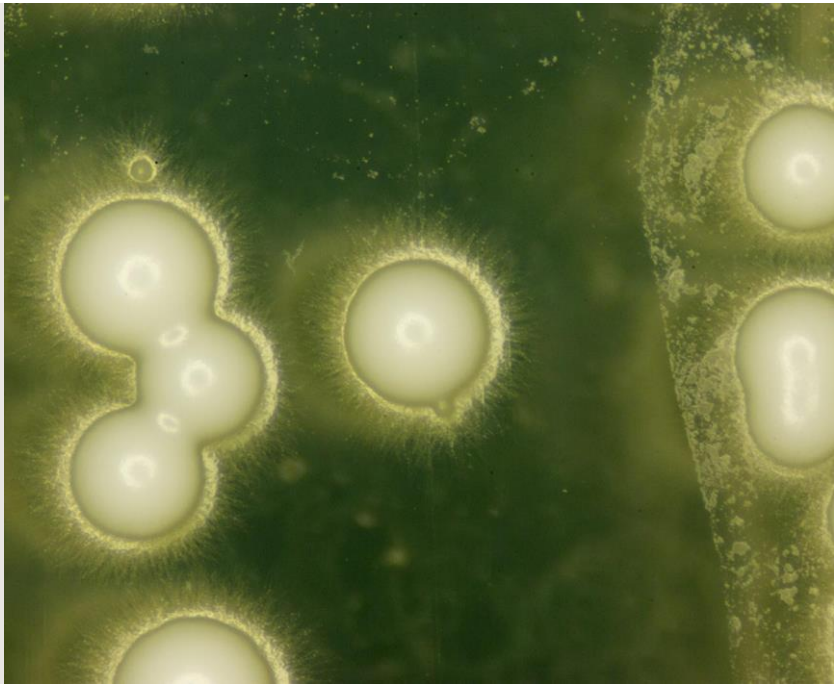
$C_6H_{12}O_6$ (glucose) ≥ $2CO_2$ + $2C_2H_5OH$ (ethanol)

- Energy gain: 2 mole of ATP per mole of monosaccharide
- Energy conservation: 26%
- Heat loss: 74%
- Yield factor: 0.075 g dry solids yeast per g carbohydrate = 7.5%

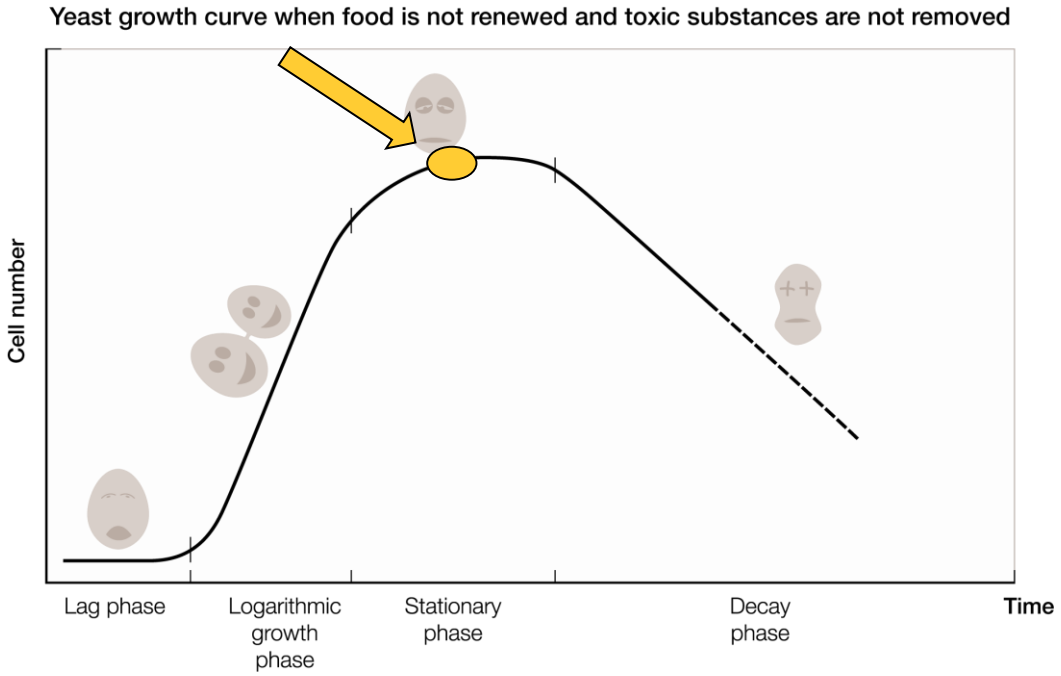
Crabtree effect versus Pasteur effect

- **Crabtree effect**
  The inhibiting effect of respiration, or the use of oxygen, caused by the presence of certain carbohydrates in concentrations above certain levels. The yeast will not use oxygen when there is an abundant supply of food.

- **Pasteur effect**
  The inhibiting effect of oxygen on the process of fermentation. Yeast will use oxygen, when available, to better utilize the food available.



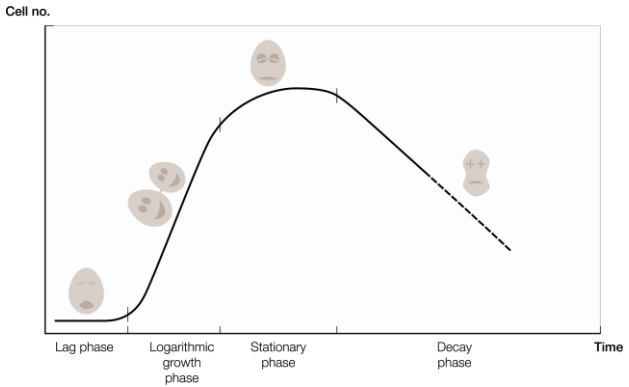
Yeast propagation to increase cell numbers



How much will yeast grow in a propagator?

Typical cell numbers at the end of logarithmic growth:

- Lager strains: 80–120 million cells/ml
- Ale strains: 150–200 million cells/ml
- Aerobic growth: Max. 40 million cells/ml per degree Plato consumed



Definition of “end of logarithmic growth”: Less than 20 million cells/ml per degree Plato consumed

Anaerobic growth (Balling’s formula): About 14 million cells/ml per degree Plato consumed
(at 40 million cells/ml = 1 g dry matter/litre)

What will stress the yeast ?

Stress factors affecting yeast vitality, reproductivity and fermentation capability

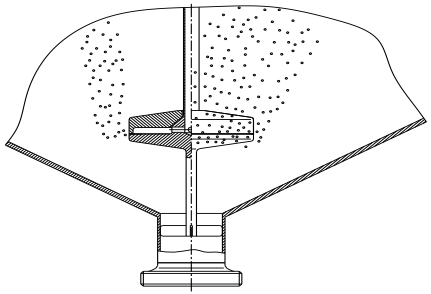
- Shear and turbulent forces
- Oxidative stress
- Carbon dioxide toxicity
- Alcohol toxicity


Aeration
equipment

Yeast mixing and aeration

Yeast agitator and Cleaning-in-Place (CIP) system

- For propagation and storage plants
- With aeration or acid washing facility

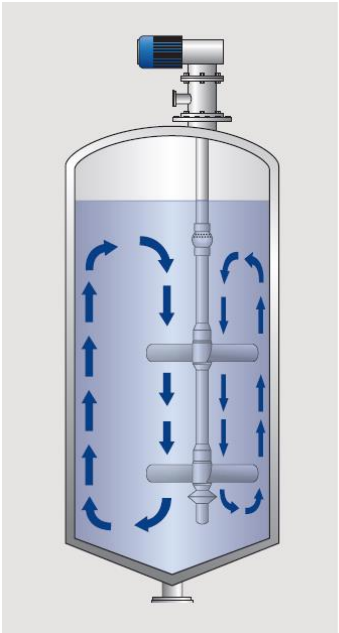


Scandi Brew® agitator

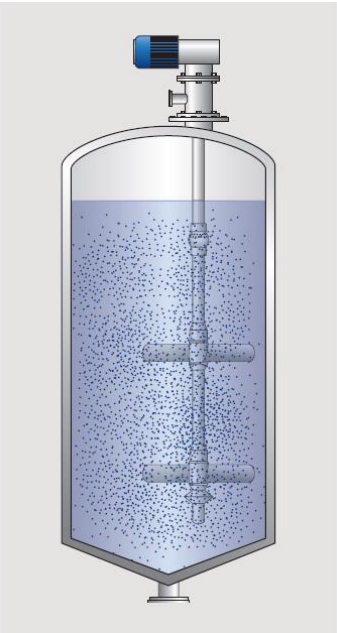
Agitator

Off centre

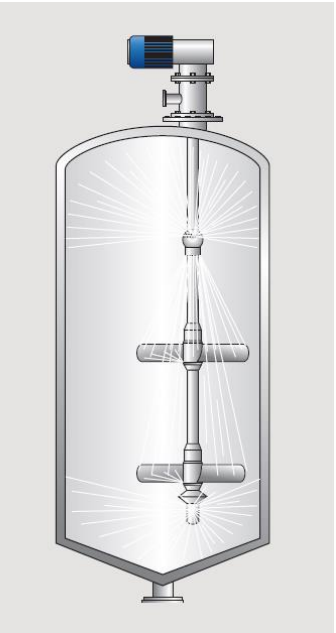
- Mixing
- Aeration/acid wash
- CIP



Mixing



Aeration/acid washing



Cleaning

Agitator or pump circulation loop?

Agitation mixing more effectively

- Our agitator homogenizes the tank (100 hl) within 60–120 seconds with a 2.2 kW motor whilst a repumping loop with an 11 kW motor circulates at a flow rate of 700 hl/h
- This test clearly shows how little effect a repumping loop has on tank mixing
- We can conclude that our agitator provides more effective tank mixing than the repumping loop

Aeration


Alfa Laval ALT SB 15 Yeast Agitator Aeration Test 1...
Se senere
Del

CIP test with cold water at 3 bar

3-in-1 agitator

- Gentle agitation
- No stratification
- In-tank process
- Homogeneous after one minute of agitation
- 100% hygienic
- Steam sterilized

=

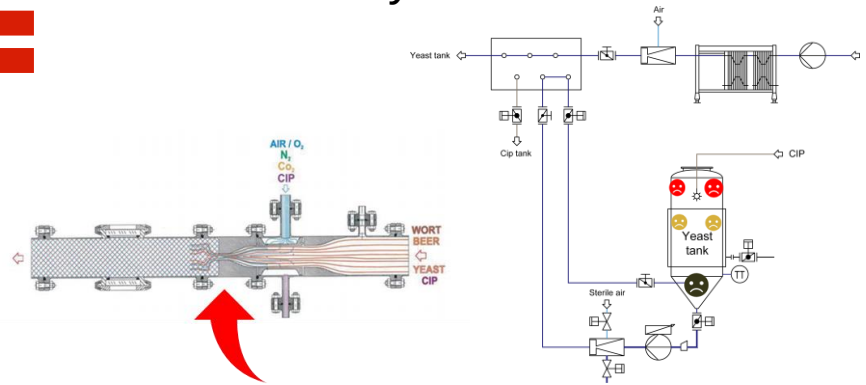
- ✓ High vitality
- ✓ ≥ 99% viability
- ✓ 100% sterile conditions

Pump circulation loop

- High shear stress
- Stratification
- Cleanability
- Venturi pipe
- High power consumption

=

- Low viability (≥ 95 %)
- Stressed yeast
- Low vitality

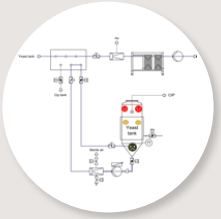


Comparison

3-in-1 agitator

- Gentle agitation
- No stratification
- In-tank process
- Homogeneous after one minute
- 100% hygienic
- Steam sterilized
- Low power consumption

Pump circulation loop



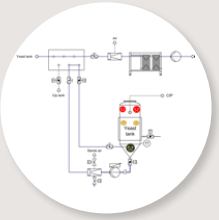
- High shear stress
- Stratification
- Cleanability
- Venturi pipe
- High power consumption

Why a 3-in-1 agitator versus a pump circulation loop?

3-in-1 agitator

- ✓ ≥ 99% viability
- ✓ High vitality
- ✓ 100% sterile conditions

Pump circulation loop

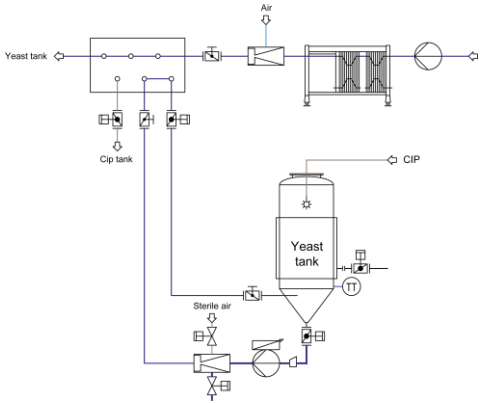


- ✓ Low viability (≥ 95 %)
- ✓ Stressed yeast
- ✓ Low vitality

Total cost of ownership: Agitators versus repumping

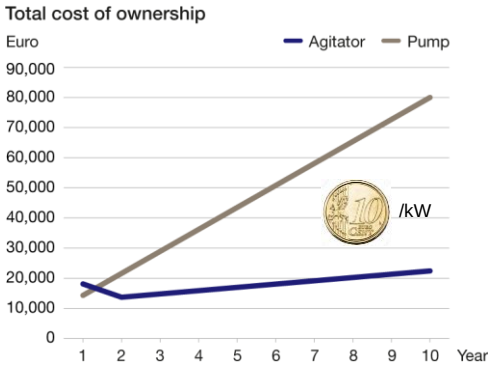
2.2 kW

99% homogenized
in 1–2 minutes



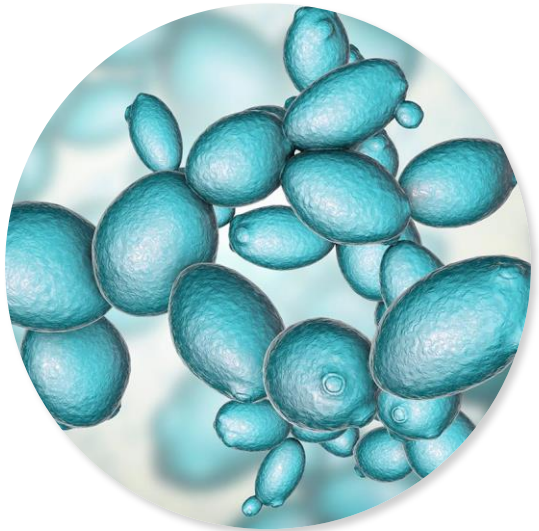
11 kW

99% homogenized
in 1–2 hours



Stress factors:
agitator test for propagation plant

- **Viability methylene blue and acridine orange:**
  Dead cells < 1%
- **Proteinase activity:**
  No detectable proteinase activity
- **Concentration of medium-chain fatty acids:**
  No correlation with agitator speed
- **Carbon dioxide concentration:**
  Less than 1 g/l



Yeast vitality / viability

Yeast vitality
Define the health of your yeast

Measuring yeast vitality is very difficult (intracellular pH measurement). Only very few labs in the world can do so.

Yeast vitality can be evaluated in the fermentative capacity. Stressed yeast with low vitality leads to:

- Longer lag phase
- Slow extract utilization and slow fermentation

Yeast viability
Define the number of living cells

Measuring if cells are dead or alive, or if cells have the ability to divide or grow.

Method of measuring methylene blue or acridine orange:

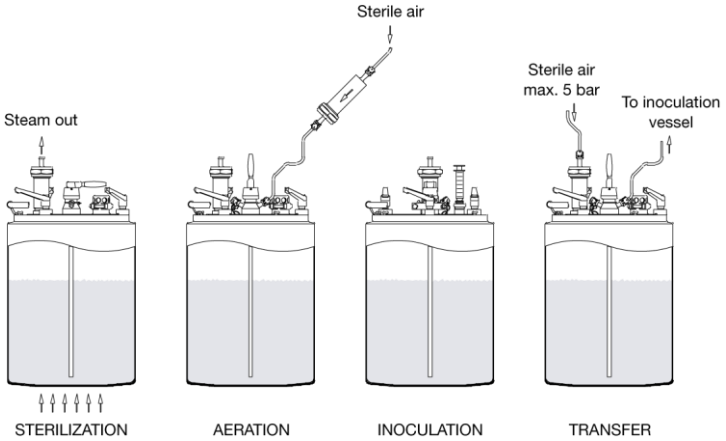
- Viability of fresh propagated yeast ≥ 99%
- Cropped yeast ≥ 97%

Propagation equipment

Carlsberg Flask

- Since the first single yeast cell was isolated at Carlsberg Laboratories, propagation has begun in the laboratory
- The last step before the propagation plant is the Carlsberg Flask
- In the Carlsberg Flask, wort can be sterilized, inoculated and transferred out again under sterile conditions

Function of the Carlsberg Flask

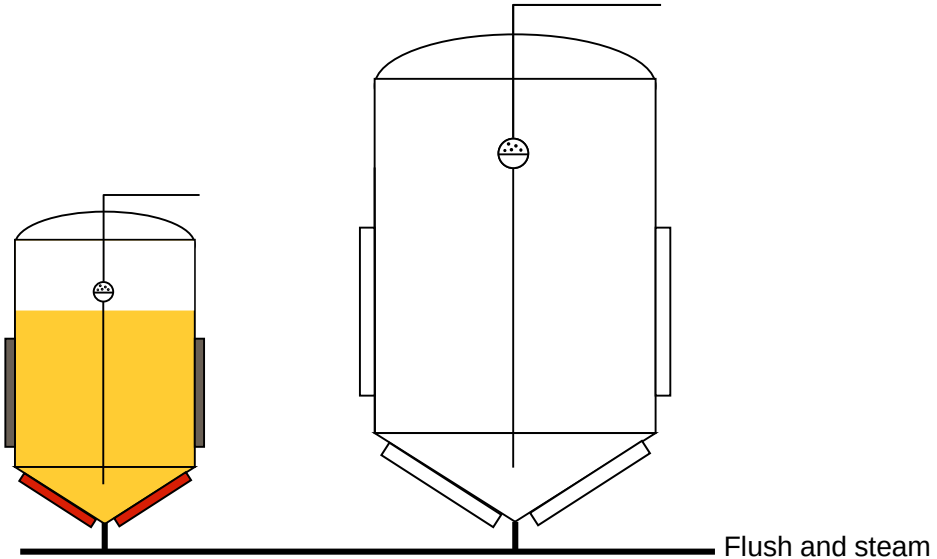


Operation range	
Net volume	25 l (6.6 gal)
Total volume	33 l (8.7 gal)
Recommended transfer pressure	2–3 bar (29–44 psi)
Allowable pressure PS	6 bar (87 psi)

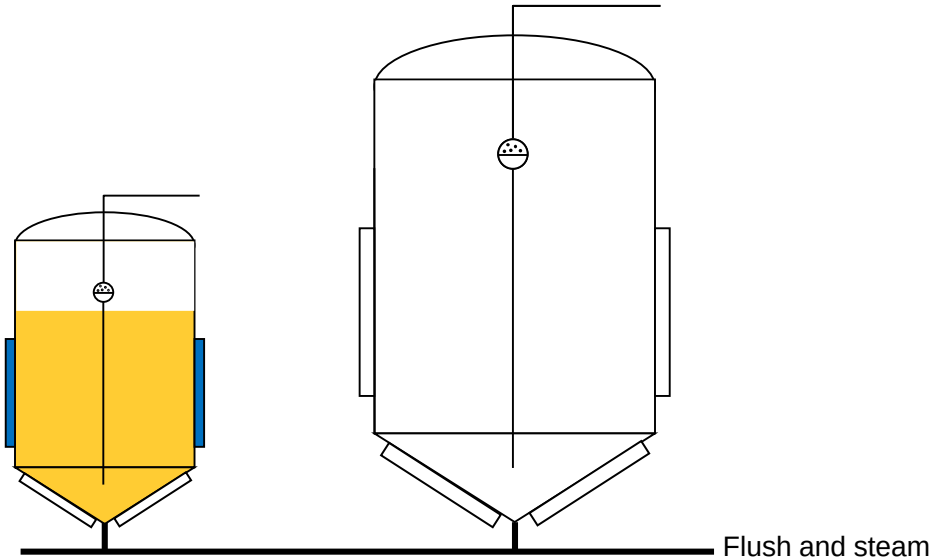
Single or multiple vessel plants

- Batch production in a single vessel in a yeast propagation plant
- Continuous production in a multiple vessel in yeast propagation plant
- Choice depends on propagation philosophy, frequency and investment
- Cell counts are typically about 100 million/ml (sometimes higher for ale strains)
- Difference in laboratory work

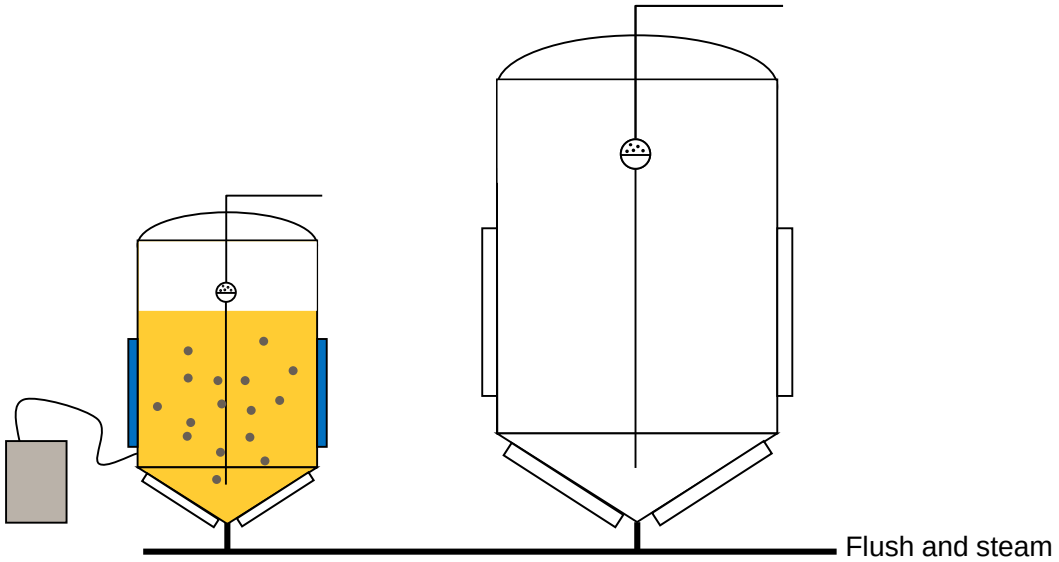
Wort sterilization



Wort cooling

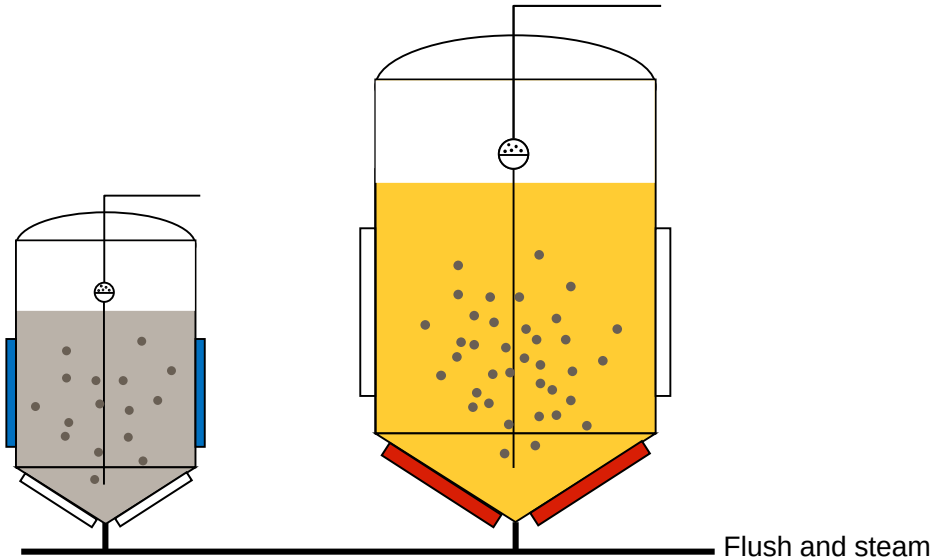


Aeration and inoculation



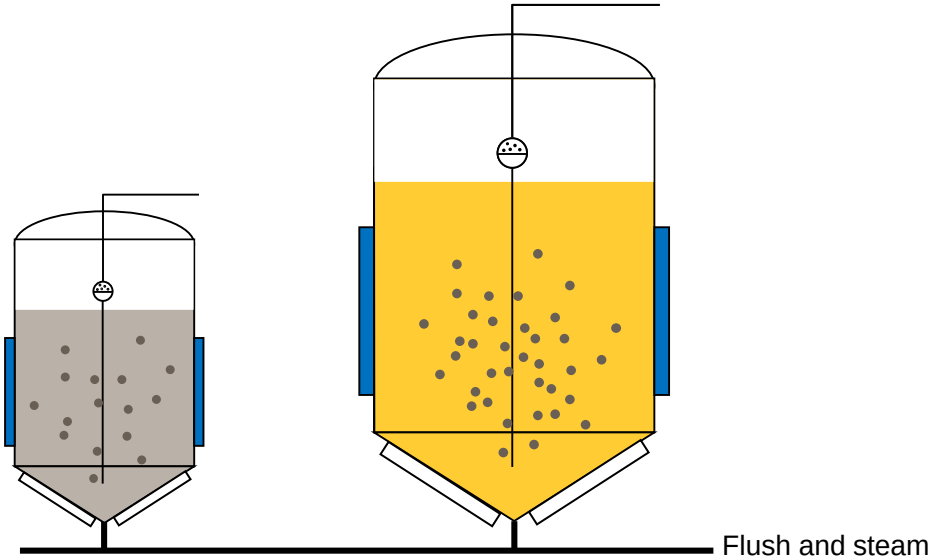
Propagation and sterilization

Propagation in yeast propagation vessel 1
Sterilization of yeast propagation vessel 2



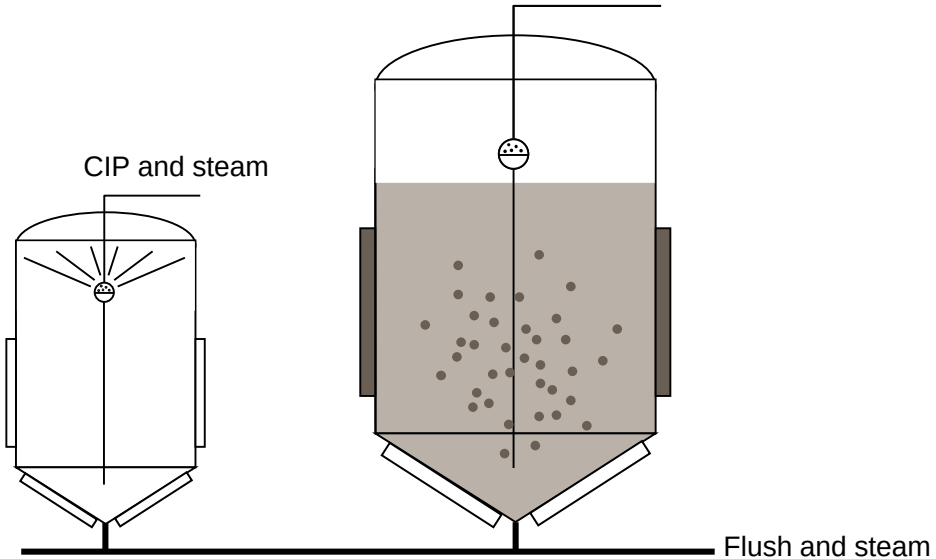
Propagation and cooling

Propagation in yeast propagation vessel 1
Cooling of yeast propagation vessel 2



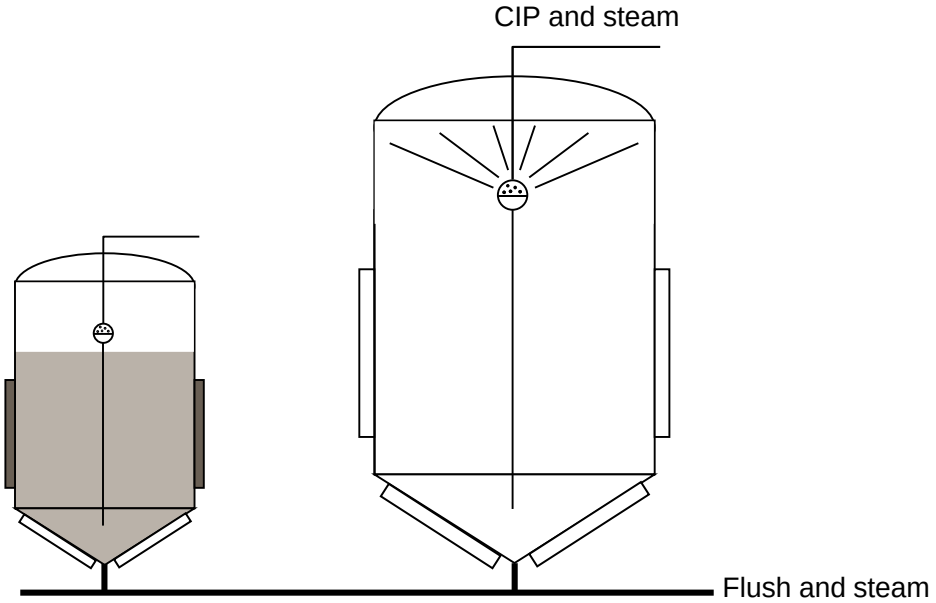
Transfer of yeast 1

Transfer of yeast propagation vessel 1 to yeast propagation vessel 2
CIP of yeast propagation vessel 1 – Propagation in yeast propagation vessel 2



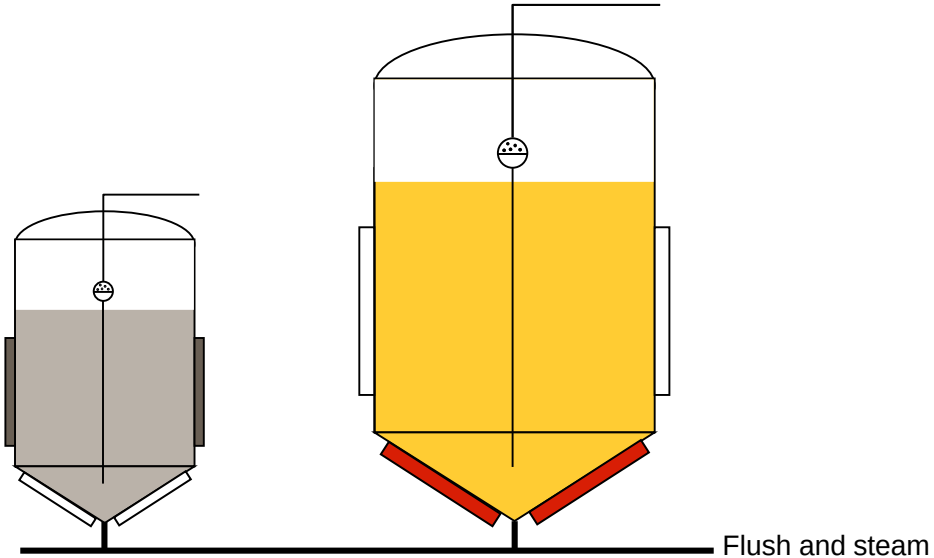
Transfer of yeast 2

Transfer of yeast from yeast propagation vessel 2 to yeast propagation vessel 1
The rest of yeast propagation vessel to fermenter



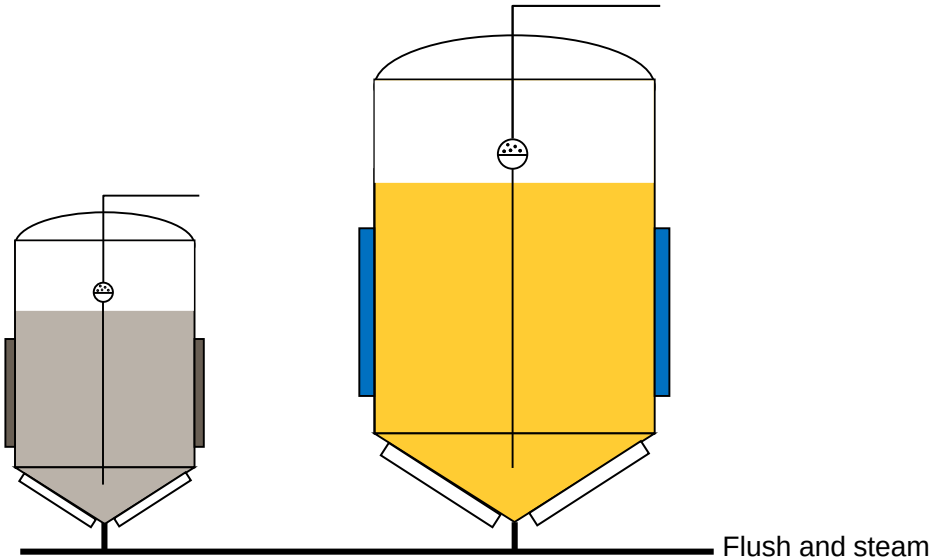
Wort sterilization

Yeast propagation vessel 2



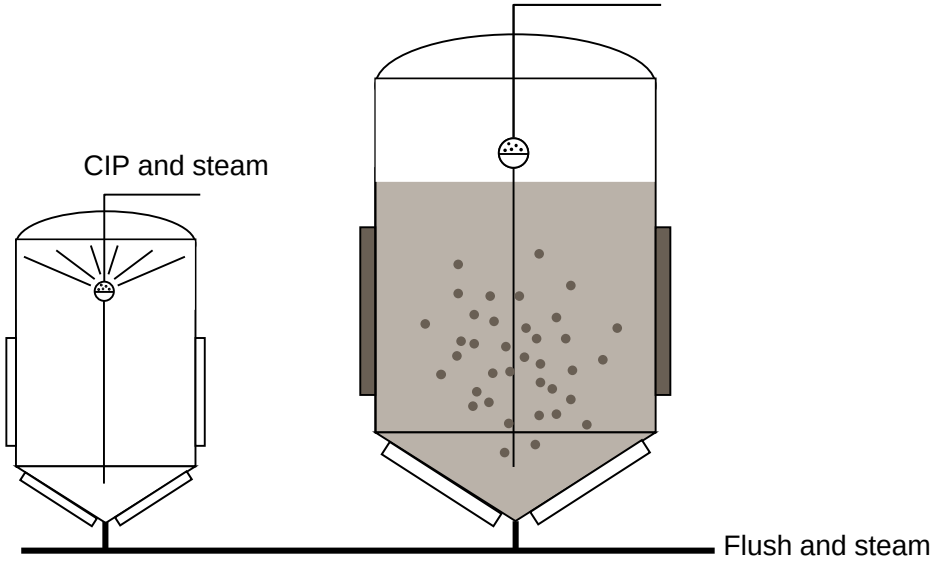
Wort cooling

Yeast propagation vessel 2



Inoculation

Inoculation from yeast propagation vessel 1 to yeast propagation vessel 2
Propagation in yeast propagation vessel 2



Yeast propagation plant

Special features of Alfa Laval Scandi Brew® plant

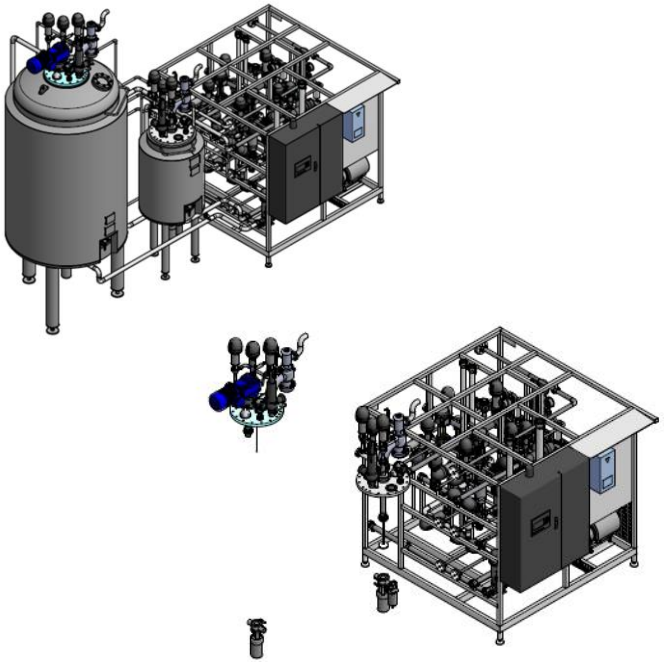
- Separate heating and cooling jackets on all vessels
- Possibility for in-vessel sterilization of wort
- All process and sterile air pipes and valves must be easily cleanable and designed for steam sterilization
- Aeration facility must be fully integrated in the CIP and sterilization system

Yeast propagation plant

Special design features of Alfa Laval Scandi Brew®

- Special outlet valve with no dead space
- Automatic controlled pressure regulation
- Unique aeration control
- Unique top plate design – 100% CIP-able
- Sterilizable aeration aggregate/CIP system for improved plant efficiency, depending on the tank volume

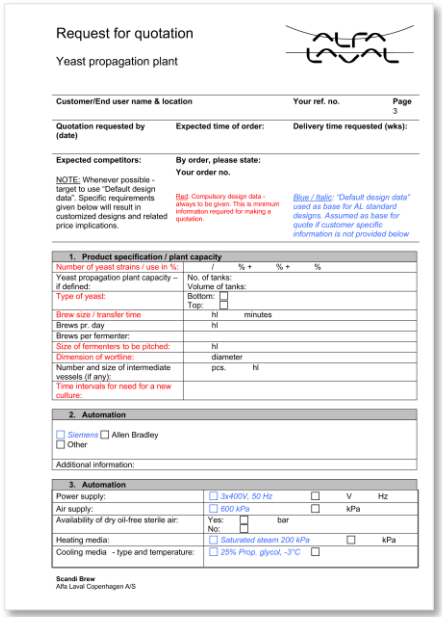
Modular design



- Easy installation
- Short commissioning
- Well-proven technology
- Optimized tanks
- Comprehensive documentation
  - User manual
  - Commissioning reports
  - Drawings
  - Recommended list of spare parts
  - Maintenance manual

Yeast propagation

Request for quotation



Request for quotation

Yeast propagation plant

Customer/End user name & location		Your ref. no.	Page 3
Quotation requested by (date)	**Expected time of order:**	**Delivery time requested (wks):**	
Expected competitors:	**By order, please state:** **Your order no.**		

NOTE: Whenever possible - target to use "Default design data". Specific requirements given below will result in customized designs and related price implications.

Red: Compulsory design data - always to be given. This is minimum information required for making a quotation.

Blue / Italic: "Default design data" used as base for AL standard designs. Assumed as base for quote if customer specific information is not provided below

1. Product specification / plant capacity

Number of yeast strains / use in %:	/ % + % + %
Yeast propagation plant capacity – if defined:	No. of tanks: Volume of tanks:
Type of yeast:	Bottom: ☐ Top: ☐
Brew size / transfer time	hl minutes
Brews pr. day	hl
Brews per fermenter:	
Size of fermenters to be pitched:	hl
Dimension of wortline:	diameter
Number and size of intermediate vessels (if any):	pcs. hl
Time intervals for need for a new culture:	

2. Automation

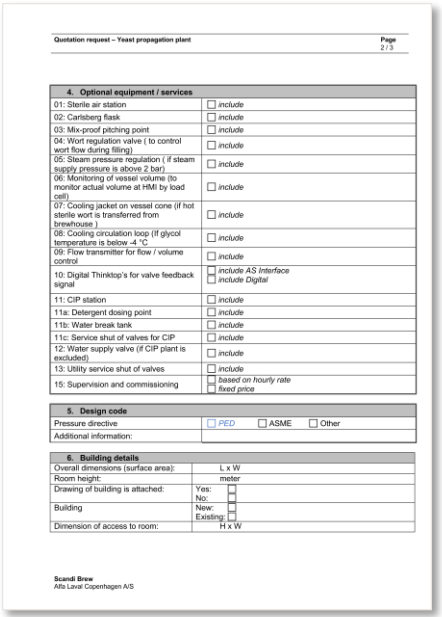
☐ *Siemens* ☐ Allen Bradley ☐ Other

Additional information:

3. Automation

Power supply:	☐ *3x400V, 50 Hz* ☐	V	Hz
Air supply:	☐ *600 kPa* ☐	kPa	
Availability of dry oil-free sterile air:	Yes: ☐ No: ☐	bar	
Heating media:	☐ *Saturated steam 200 kPa* ☐	kPa	
Cooling media - type and temperature:	☐ *25% Prop. glycol, -3°C* ☐		

Scandi Brew
Alfa Laval Copenhagen A/S



Quotation request – Yeast propagation plant — Page 2 / 3

4. Optional equipment / services

01: Sterile air station	☐ *include*
02: Carlsberg flask	☐ *include*
03: Mix-proof pitching point	☐ *include*
04: Wort regulation valve (to control wort flow during filling)	☐ *include*
05: Steam pressure regulation (if steam supply pressure is above 2 bar)	☐ *include*
06: Monitoring of vessel volume (to monitor actual volume at HMI by load cell)	☐ *include*
07: Cooling jacket on vessel cone (if hot sterile wort is transferred from brewhouse)	☐ *include*
08: Cooling circulation loop (if glycol temperature is below -4 °C	☐ *include*
09: Flow transmitter for flow / volume control	☐ *include*
10: Digital Thinktop's for valve feedback signal	☐ *include AS Interface* ☐ *include Digital*
11: CIP station	☐ *include*
11a: Detergent dosing point	☐ *include*
11b: Water break tank	☐ *include*
11c: Service shut of valves for CIP	☐ *include*
12: Water supply valve (if CIP plant is excluded)	☐ *include*
13: Utility service shut of valves	☐ *include*
15: Supervision and commissioning	☐ *based on hourly rate* ☐ *fixed price*

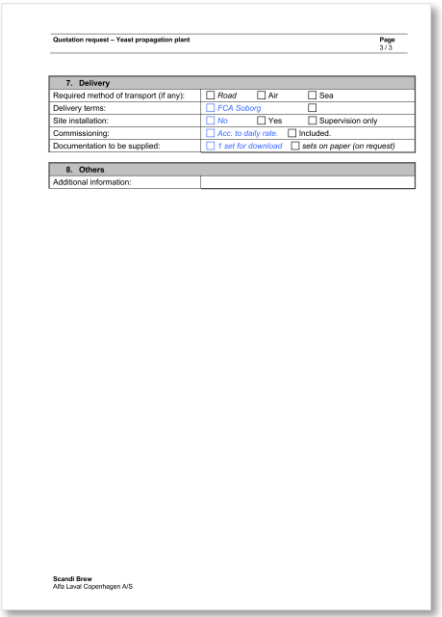
5. Design code

Pressure directive	☐ *PED* ☐ ASME ☐ Other
Additional information:	

6. Building details

Overall dimensions (surface area):	L x W
Room height:	meter
Drawing of building is attached:	Yes: ☐ No: ☐
Building	New: ☐ Existing: ☐
Dimension of access to room:	H x W

Scandi Brew
Alfa Laval Copenhagen A/S



Quotation request – Yeast propagation plant — Page 3 / 3

7. Delivery

Required method of transport (if any):	☐ *Road* ☐ Air ☐ Sea
Delivery terms:	☐ *FCA Soborg* ☐
Site installation:	☐ *No* ☐ Yes ☐ Supervision only
Commissioning:	☐ *Acc. to daily rate.* ☐ Included.
Documentation to be supplied:	☐ *1 set for download* ☐ *sets on paper (on request)*

8. Others

Additional information:	

Scandi Brew
Alfa Laval Copenhagen A/S

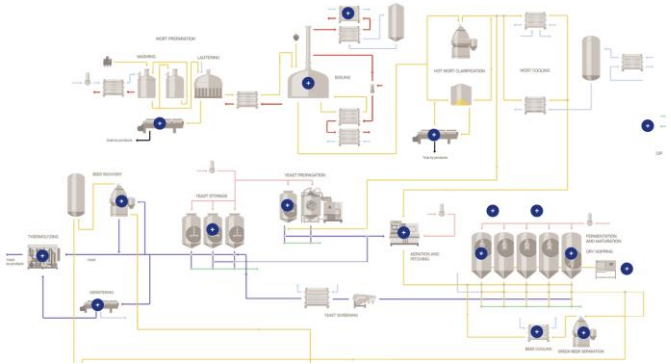
Contact us

Henning and our global sales team are delighted to help you with your yeast management needs.

Let us help you by contacting us here.

More information

- Yeast management systems
- Yeast cooler
- Yeast propagation plant
- Aeropitch
- Dynapitch
- Beer production
- Commercial brewing
- Craft brewing

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