

Oxygen in Breweries

Enemy or Friend? – Both!



Overview



1 **The Role of Oxygen**

2 Enemy & Friend

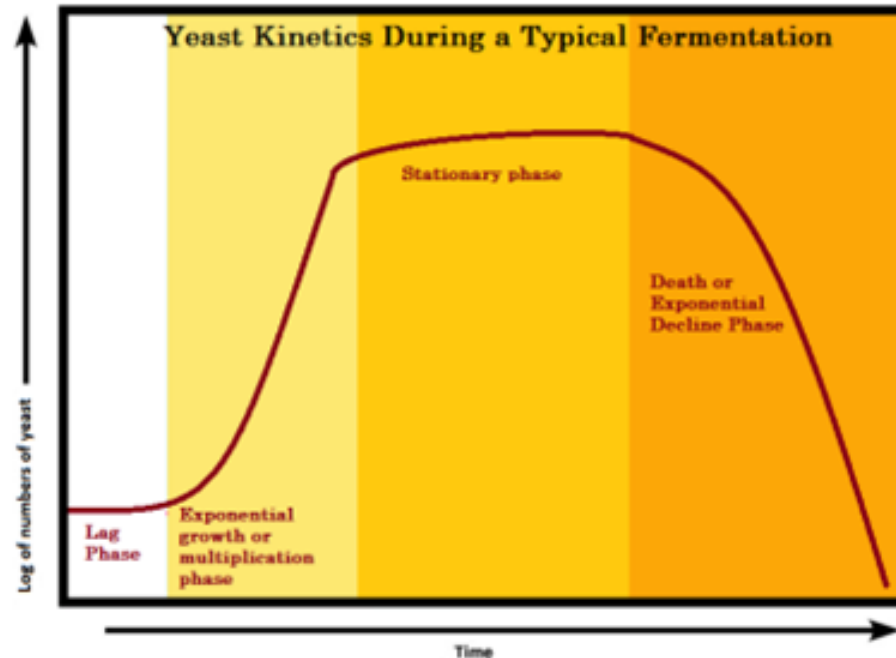
Oxygen in Breweries



Oxygen – The Friend

Yeast Growth

- Oxygen is required for aerobic growth of yeast
 - Aerobic metabolism is preferred as it generates more energy
- Where is this important?
 - Yeast propagation
 - Wort aeration





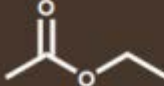
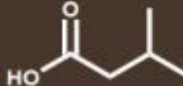
Oxygen in Breweries



Oxygen – The Enemy

Hops Components Get Oxydized

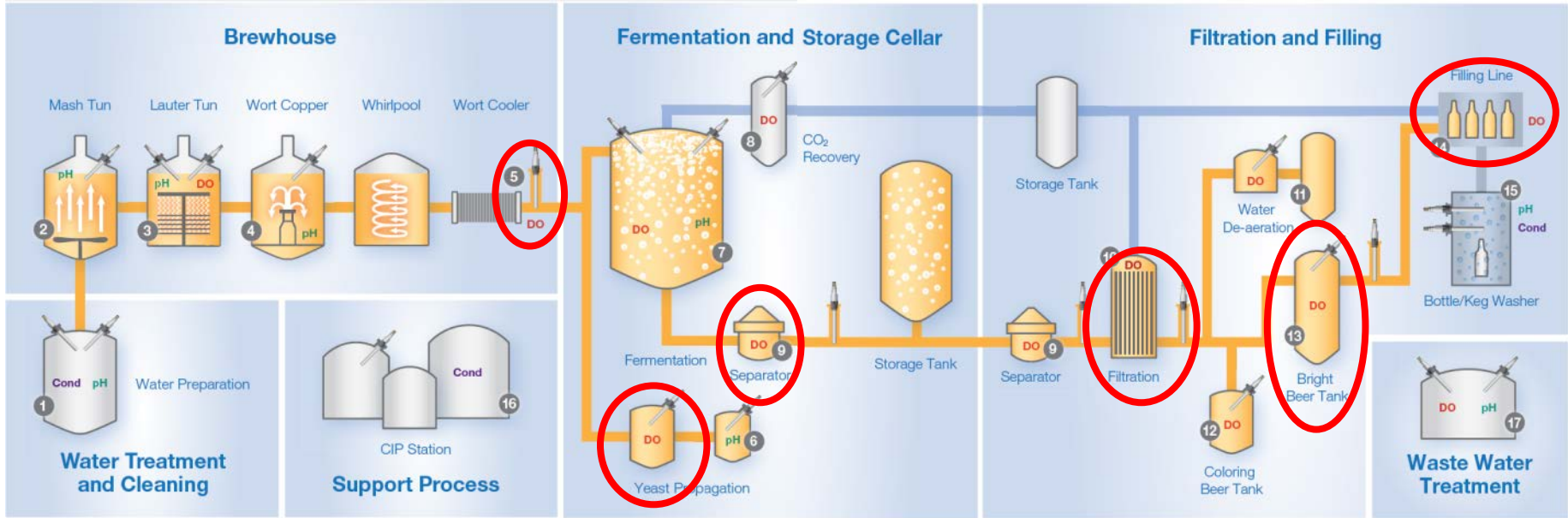
- Off-flavors are caused
 - Unsaturated character of hop components makes them prone to oxydation

<p>"BANANA" <i>isoamyl acetate</i></p>  <ul style="list-style-type: none">• Yeast by-product• Low O₂ levels• 1-2 mg/L threshold	<p>"SKUNKY" <i>methyl thiols</i></p>  <ul style="list-style-type: none">• From isohumulone• Certain lights• IH + riboflavin• 4 ng/L threshold
<p>"SOLVENT" <i>ethyl acetate</i></p>  <ul style="list-style-type: none">• Yeast by-product• Excessive O₂ levels• Wild yeast• 30-50 mg/L thresh.	<p>"CHEESY" <i>isovaleric acid</i></p>  <ul style="list-style-type: none">• Hop oil oxidation• Alpha acid oxidat.• Bacterial contam.• 1 mg/L threshold

Oxygen in Breweries



Where To Be Measured?



- 1 pH: Polilyte Plus / Cond: Conducell 4USF
- 2 pH: EasyFerm Bio
- 3 pH: EasyFerm Bio / DO: VisiFerm DO
- 4 pH: EasyFerm Bio

- 5 DO: VisiFerm DO
- 6 pH: EasyFerm Bio / DO: VisiFerm DO
- 7 pH: EasyFerm Bio / DO: VisiTrace DO
- 8 DO: VisiTrace DO

- 9 DO: VisiTrace DO
- 10 DO: VisiTrace DO
- 11 DO: VisiTrace DO

- 12 DO: VisiTrace DO
- 13 DO: VisiTrace DO
- 14 DO: VisiTrace DO

- 15 pH: Polilyte Plus / Cond: Conducell 4USF
- 16 Cond: Conducell 4USF
- 17 pH: Polilyte Plus / DO: VisiFerm DO

= most popular / important measuring points

Overview



1 The Role of Oxygen

2 **Enemy & Friend**

Oxygen in Breweries



Enemy & Friend in the Storage Tank

Background for CO₂-Removal prior to CIP

- CO₂ reacts with caustic soda:



(gas) (aq.) (aq.) (aq.)

- Consequences:
 - Waste of caustic soda, resp. less efficiency
 - Pressure drop can damage vessel



Oxygen in Breweries

Enemy & Friend in the Storage Tank



Sterile Air to Purge Tank Prior to CIP

- Sterile air replaces CO₂
- When to start CIP?
 - Very often time-controlled
 - Question: is sterile air for free?
- Improvement by oxygen measurement
 - Example from a German brewery:
 - «Traditional» procedure: purging the vessels 1 h prior to CIP
 - Results of oxygen measurement: vessel is purged after 25 min
 - Question: How much time & money can be saved?
Number of vessels x time saving x number of CIP x costs of sterile air
 - ROI for inline optical dissolved oxygen sensor: ~1-2 years

Oxygen in Breweries



Purging Tank with CO₂ Prior to Refill

- Air in storage tanks needs to be replaced by CO₂
- When to start filling the tank with beer?
 - Very often time-controlled
 - Question: is CO₂ for free?
- Improvement by oxygen measurement
 - Estimation: CO₂ purchased externally 100 €/t → ~2 €/m³
 - Question: How much time & money can be saved?
Number of vessels x time saving x number of fillings per vessel x costs of CO₂

Martin Luther



Whoever drinks beer, he is quick to sleep; whoever sleeps long, does not sin; whoever does not sin, enters Heaven! Thus, let us drink beer!

Thank You!

AZ QUOTES

www.hamiltoncompany.com

Zeger de Vente, Sales Manager Netherlands

zdevente@hamilton.ch; +31 615 349326

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