Low Dissolved Oxygen Brewing

Hot Side Theory, Cold Side Practice

By Aaron De Boer, w/ info from Stout Tanks & Kettles, HBC2018

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Hot side vs Cold side

- Hot side:
  - Everything before Chilling
    - Liquor Collection
    - Mash
    - Sparge
    - Boil
    - The start of Chilling
- Cold side:
  - Everything After Chilling
    - The End of Chilling
    - Fermentation
    - Cold Crashing
    - Conditioning
    - Packaging
    - Storing
    - Serving

Hot side aeration is myth, right?

- Does hot side oxidation (AKA aeration) matter?
- Can you make better beer if you eliminate hot side oxidation?
- The Theory is yes. Previous experiments suffered from a fatal flaw: The malts and wort were already oxidized before the experiment took place.
  - Strike water is already oxygen saturated
  - Additional oxygen ingress from dough-in and diffusion from ambient air

Low Dissolved Oxygen Brewing (LoDo) Preserves the fresh grain flavor that exists in your malt.

- Theory
  - Ascorbic Acid Oxidase (AAO) is a malt antioxidant that, when preserved, provides a fresh-tasting, lingering grain flavor.
  - Because it is an antioxidant, any oxygen in the brewing process will destroy AAO and the flavor it provides.
  - You can smell it when you dough-in. That awesome grain aroma you smell is the evaporation of AAO.
  - Low oxygen hot-side brewing methods have practically zero odors, preserving the flavor and aroma until you serve the beer.

What is LoDo?
Why do it?
And
What is the threshold of DO?

- What is LoDo brewing?
  - Methods and procedures for each step of the brewing process to reduce oxygen uptake.
- Why LoDo?
  - Obtain that "lingering fresh grain flavor" you only find in fresh Continental styles.
  - Improve the overall quality, flavor, and freshness of all your beers, even ales.
- What is the threshold of D.O.?
  - 1 ppm is the upper threshold.
  - <= 0.5 ppm is better.
  - Lowest possible is best.

What are the sources of dissolved oxygen?

- SOURCES OF D.O.
  - Splashing
  - Copper, Brass, Aluminum (Brewtan-B may help)
  - Loose Hose & Pump Connections
  - Liquor (Brewing Water) (8-12 ppm)
  - Dough-in (1-3 ppm)
  - Atmosphere (1-2 ppm per hour)

LoDo Techniques

- Liquor conditioning
- Malt conditioning
- Mashing and Sparging control
- pH control
- Rapid chilling
- Yeast Health
- Fermentation temperature control
- Spunding
- Closed Transfers
- Kegging (Not required, but helps)
- Eliminating copper, brass, aluminum

Liquor Conditioning

- Water Source
  - RO / distilled water is best (lowest source of metals)
    - Use Brewtan B if using tap water
- D.O. Reduction Option 1 - Boiling
  - Pre-boil brewing liquor vigorously for 5 minutes to reduce DO to < 0.5 ppm
  - Chill strike water using an internal HERMS coil or stainless immersion chiller
  - Chill water to 200°F; add metabisulfite
  - Continue chilling water to strike temp
- D.O. Reduction Option 2 - Yeast
  - Deoxygenation using dry bread yeast, dextrose and 2-3 hours
- How to keep O2 out?
  - Metabisulfite (sodium or potassium metabisulfite) will remove O2 from water and provides active protection
  - Use sulfite test strips to determine ppm and ongoing reduction
  - 5 ppm Metabisulfite scavenges 1 ppm O2
  - The goal is to have 0 ppm just before oxygenating wort

Malt Conditioning

- Use fresh malt
- Crush malt immediately before use
  - Malt starts oxidizing 15 minutes after crushing
- Condition malt before crushing
- Mill slowly: <100 rpm

Mashing, Lautering and Sparging

- Mashing
  - Bottom fill / underlet
  - Stir gently / no splashing
  - Use Mash Cap or purge with CO2 (or N2)
  - Recirculate wort below the liquid surface

- Lautering/Sparging
  - No-sparge is the most efficient
  - If sparging, treat sparge water same as mash water with metabisulfite
  - Purge headspace, add gently, or underlet water
  - Add first-wort hops to kettle during lautering
  - Use lauter cap in boil kettle or purge headspace to limit O2 pickup

Boiling

- Boiling - Heat stress accelerates oxidation
  - Limit boil time to 60-70 minutes
  - Simmer; not a robust boil
    - 15 mins robust boil enough to get full hot break
  - Partially close boil kettle to limit O2 exposure
    - Target evaporation rate 6-10%
  - Consider effect on gravity, volume and hop utilization
  - Think about eliminating O2 from hop additions.
    - Purge hop container with CO2 or N2, etc
  - If pH is not <5.1 at end of boil, add lactic acid to drop pH
    - Improves hot/cold break, reduces lag time and yeast stress.
  - Chill wort as quickly as possible after boil

Fermentation

- Remove hot break
  - Keep it out of the fermenter
- Pitch yeast first, then oxygenate wort
- Check metabisulfite levels before oxygenating
  - May need to add extra O2 to consume remaining metabisulfite
- Don't skimp on pitching rate
  - Ales: 1.7 million cells / ml /°P
  - Lagers: 2.5 million cells / ml / °P
    - (FYI: these are massive)
- Reduce lag time, lag time is oxidation time
  - Add active yeast

Spunding

- Carbonate beer by sealing fermentor near end of fermentation
- Optimal method to maintain low oxygen and protect flavor
- Do a “fast ferment” to predict final gravity
- Target 1% remaining extract before transfer
- Use closed transfer to eliminate O2 pickup
- Set spunding valve to proper setting for temperature of beer
- Cut gas tube as short as possible
- Allow beer to finish fermenting in the spunding vessel

Transfering & Packaging

- Closed Transfers
  - Fill clean corny keg or other vessel to brim with low oxygen sanitizer (e.g., iodophor or Saniclean)
  - Push entire volume out with CO2
  - Perform a closed transfer:
    - Fermenter output port to keg liquid out
    - Fermenter blowoff to keg gas-in post

- Packaging
  - Keg
    - You can serve from spunding vessel
    - If transferring to a fresh keg do a closed transfer (same concept as the transfer into spunding keg)
  - Bottling
    - Ferment to final gravity and add priming sugar to provide active protection
    - Counterfill the bottle with CO2 purge
    - Bottle straight from fermenter

Do commercial brewers care?

- In the early 1970s fundamental work was done by N. Hashimoto. He identified oxidative processes during wort production as a source of nonenal (cardboard).
  - https://www.morebeer.com/articles/oxidation_in_beer

- In the 1970s manufacturers of German brewing equipment funded research into this topic at the Technical University of Munich–Weihenstephan. This research had a profound impact on the design of brewing equipment in Europe.
  - https://www.morebeer.com/articles/oxidation_in_beer

- Professional, modern brewing systems such as those manufactured by Krones have a variety of measures in place to keep oxygen in check. All brewing water is degassed as a standard part of water treatment, and delivery pipes for malt can be purged with steam or inert gases, such as nitrogen.
  - W. Kunze. Technology Brewing and Malting. VLB Berlin, 2007.

Should I care about LoDo Brewing?

< 1ppm seems likes its really hard to achieve?

- No, you don't have to, plenty of good beer is made without care of hot side oxidation. But, great beer is never accidental and these tools and techniques can help make great beer.
- I do think there are a number of techniques that translate to non-LoDo brewing.
  - Malt conditioning
  - Underletting
  - pH control
  - Boil control
  - Rapid chilling
  - Yeast Health
  - Fermentation temperature control
  - Spunding
  - Closed/Low O2 Transfers

Thank you

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