Molecules, Methods and Myths: Dissolved Oxygen in a Brewery

by Emily Wang, Fermly

Oxygen is everywhere but it shouldn't be in the beer that is produced. All genres of beers are susceptible to damage by this one element to varying degrees and results in a variety of off-flavors:

● Oxygen transforms ethanol into acetaldehyde, a common off-flavor that can come across palates in green apple, pumpkin, latex paint, or fresh-cut grass. Acetaldehyde can continue to be oxidized into acetic acid, otherwise known as vinegar which is also an undesirable flavor in beer.

● Hop compounds are also susceptible to oxidation. When these acids come into contact with oxygen, they can become fatty acids and impart soapy and fatty flavors to a beer.

● The best-recognized off-flavor produced by oxidation is trans-2-nonenal, which tastes like old cardboard or wet newspaper. This compound has precursors that are naturally produced during the fermentation of certain malts. Trans-2-nonenal is produced when these precursors condense with aldehydes from the oxidation of alcohols.

All it takes is 1 mL (or cm^3) of air in a 1.7 barrel tank of beer to cause up to 100 parts per billion (ppb) of oxygen. There are several ways to avoid that 1 mL of oxygen:

● A brewery should be using properly sized Oetiker tri-clamps when appropriate. Alternatives like worm clamps can loosen and are not properly sized or designed for a tight hold, allowing space for oxygen to sneak in.

● Along with tri-clamps, gaskets should be regularly replaced. Proper gaskets are composed of EPDM rubber or Buna which are designed to be temperature and chemical tolerant, but also flexible. These are affordable but do degrade with time so rotation is key.

● A good purging procedure for the brite tank (but also applicable to any tank) is important for avoiding oxygen. In a tank under 10 barrels, use boiled water passed through the heat exchanged and then flushed with CO2 will finish off with a perfectly purged, oxygen-free tank.

● Another good purging procedure for larger tanks or with a focus on water conservation, a Clean In Place (CIP) under pressure may be appropriate. The tank remains closed and the CO2 is used to push the beer out. There are several cleaners that are ideal for a CO2 environment and can be used at cold temperatures.

● Check equipment for damage before any transfers. Hoses that are damaged, loose tri-clamps, or worn-out gaskets can all cause problems if not checked regularly so don't wait for a transfer for this opportunity.

There are several myths that abound about what can be done to avoid dissolved oxygen and should be known when writing Standard Operating Procedures:

● CO2 does not settle like a blanket because gases naturally mix over time and can be affected by turbulence and temperature.

● CO2 should never be smelled or used as confirmation that a tank has been purged. Timing a purge is preferable to using human senses.

● Yeast does not remove oxygen from the beer once the environment has a low pH and is alcohol rich because it goes dormant.

● Oxidation does not take its time to develop off-flavors so once it comes into contact with the beer, it will start affecting alcohol and other compounds.

At the end of the brew day, beer should be below 50 ppb of dissolved oxygen in the brite tank. This can be confirmed through multiple devices that are affordable for most breweries, regardless of whether or not packaging is involved. Cheers to oxygen-free beer!

Contributing Author

Emily Wang **Founder/Lead Scientist, Fermly**

Emily is a TTB Certified Brewing Chemist with a passion for microbiology and beer, eventually leading her to found Fermly in 2018. Unafraid to dive into a pint glass or a cuvette, she utilizes her science degree to help breweries develop and maintain a QA/QC program from sensory to tracking information from batch to batch.