

Brewing Process

Industry: Food and Beverage
Product: DO202, OxyGold B

Background Information

The level of dissolved oxygen is critical to the quality and consistency of any brew. Too little dissolved oxygen results in the fermentation step of the process will lead to: off flavors (e.g. poor removal of diacetyl and acetaldehyde), poor yeast crop in terms of quantity and vitality, and low ester and alcohol production. Too much dissolved oxygen causes: rapid fermentations (resulting in excessive yeast growth and beer losses), and high ester production, resulting in a fruity-tasting beer. The amount of oxygen added to the brewing process is dependent on a wide range of factors, including wort gravity, temperature, oxygenation/aeration method and the desired end-product.

The Process

There are five different stages in the brewing process: malting, mashing, cooking, fermentation, and cellaring.

Malting

Barley is first steeped in cold water for 45 to 72 hours with the water drained off about once a day. Then the barley is placed in slowly revolving drums or shallow tanks equipped with plows. As the wet grain is stirred and aerated, it begins to germinate. This produces several enzymes in the grain, the most important being malt diastase, which has the property of changing starch into sugar.

Mashing

Brewing begins by crushing the malted grain between iron rollers. The grist is then mixed with warm water until it forms a mash of porridge-like consistency. Then supplementary grains are added, and the temperature of the mash is raised from 38 °C to 77 °C, at a rate that allows time for the various enzymes to act. The mash is then allowed to rest for a period time during which time the spent malt settles to the bottom of the mash tub. It forms a filter bed through which the liquor, now called wort, is drawn off. Hot water is run through the residue to rinse out any remaining wort from the spent grain.

Cooking

The wort is drawn off into copper kettles in which it is boiled with hops. The hops are then screened out, and the wort is passed through a cooler and run into vats, where fermentation takes place.

Fermentation

Fermentation is started by adding a pure yeast culture, and continues for a number of days, depending on the beer being brewed. Air or oxygen is added just prior to fermentation to stimulate yeast growth. Live active yeast has a huge capacity to absorb oxygen and is rapidly assimilated before any chemical oxidation can occur. At the end of fermentation the green beer is totally anaerobic and free from oxygen. The yeast is then skimmed off or allowed to settle, and the beer is drawn off for cellaring.

Cellaring

Once the brew is fully matured, a small amount of fresh wort or sugar is added, and the beer is placed in pressurized tanks for the final fermentation to produce the carbon dioxide gas that gives the characteristic head, or foam. Finally, the beer is usually pasteurized and filtered, then sealed in pitch-lined kegs or packaged in individual bottles or cans.

Measurement Solution

Oxygen has an impact throughout the malting and brewing process. It is impossible to malt barley or ferment wort without the contribution from oxygen. However, oxygen reacts with many compounds present in mash, wort and beer, which have an impact on the quality of the product.

During hot process steps, such as boiling or pasteurization, oxidation is very rapid. However by far the largest uptake of oxygen comes from the brewing water (in mashing and sparging) which unless de-aerated will contribute around 30 ppm oxygen per kilo of malt mashed. Measures must be taken to avoid oxygen ingress: After fermentation, care must be taken throughout the remaining process steps to minimize air pick-up. Monitoring to detect leaks at transfer points, such as pumps, filters, coolers and pipes is essential.

A good process design can virtually eliminate oxygen pickup. Beer should have less than 50 ppb dissolved oxygen when it reaches the packaging lines. Inevitably during small pack filling (bottling and canning) a small amount of oxygen pick up is inevitable, but brewers should be capable of achieving less than 500 ppb. total "in package oxygen". Keeping the oxygen content down in the finished product makes a very

significant contribution to delaying the onset of staling or ageing of the brew during storage which leads to undesirable taste, cloudy/ hazy beer, increased beer astringency, and darkened beer color.

To maximize the fermentation process and minimize the amount of oxygen uptake, dissolved oxygen should be measured at the following stages: Fermentation, Aging, Filtration, Fill lines, Water Purification/filtration, Boiler/Steam generation, and waste water treatment.

Product Recommendation

Transmitter

DO202 2-Wire Looped Powered



Measuring range

- Dissolved Oxygen : 0 - 50 ppm (mg Oxygen per kg water);
0 - 1999 ppb (mg Oxygen per 1000 kg water) and 0 - 600 % Saturation of Air in Water.
- Temperature : -20 to 150°C.

Temperature compensation

: Automatic using Pt1000 or 22k NTC or manual. Range 0 - 100°C.

Features

- Universal input accepts Galvanic and Polarographic sensors and various temperature compensating elements (Pt1000, 22k NTC)
- HART® communication standard with 4-20 mA loop powered model
- Fieldbus models for Fieldbus Foundation
- Wide measuring range including ppb, ppm and % saturation
- Certification for hazardous area (ATEX, FM, CSA)
- Recommended sensors model DO30(G), PB30, OXYFERM, OXYGOLD (for ppb measurement)
- Intrinsically safe version <EEx> II 2(1)G EEx ib[ia] IIC T4/T6.
- Automatic temperature compensation from 0°C up to 100°C

Sensor

OXYGOLD B

Dissolved oxygen sensor for measurements in media containing acidic gases CO₂ in beer

O₂: 8 ppb to saturation or
0.1% - 200% of air oxygen
0 - 100 °C, max. 12 bar
TC: 22 kOhm NTC

- Absolutely no cross-sensitivity to CO₂
- Developed for use in brewing, Cola, fruit-juice, sparkling wine and special chemical processes
- Pressure and CIP stable
- Easy to maintain
- Inner body can be replaced by user
- Shortest response time on the market from air to pure CO₂: $t_{90\%} < 60$ sec
- Materials and inspection certificate
- Works cleanly with the same polarization voltages in calibration and measurement operation. So you don't get the usual false measurement values when measuring beer or the like
- 12 mm shaft, VP plug

