The Northern Craft Brewers

"We Live We Brew"

Beer Flavours: Oxidation

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Oxygen in beer production and maturation plays a key role. In mashing and boiling oxygen is generally considered a bad thing, although there is much controversy over whether so called hot-side oxygenation is as bad as some people think. When the wort is cooled and ready for pitching with yeast is the only time when there is a need for plenty of oxygen to ensure division of yeast cells and a healthy fermentation to produce quality beer. This is more important when using liquid yeast than with dried yeast.

Once the beer is ready for packaging oxygen should be excluded as far as possible. In cask conditioned real ales, some people say that for certain beers a little contact with air that contains oxygen can change the flavour in beneficial ways over the first day or two of going on sale. This is debateable and in my view unlikely to improve most beers that are already matured properly and ready for sale, although some strong and dark beers may benefit.

However, contact with oxygen will allow contamination by airborne bacteria and yeast and can produce high levels of acidity and other off-flavours, including Diacetyl. Hence a cask of Real Ale left on sale for more than about three days will go off as a result of contact with air, mainly due to some combination of oxidation and acidity. [See separate articles on Diacetyl and acidity.] The majority of stale beer flavours are formed by chemical reactions called oxidation. Oxygen is the main agent but other chemicals can act as an oxidizer – elements or compounds that take elements from others.

So what does an oxidized beer taste like? In a word, stale. Assuming that the flavour is not also affected by other potential off-flavours, my preferred description is that it is like sucking on damp cardboard. Whilst preparing this article a friend opened a bottle of an 8% ale from a commercial brewery and commented that it tasted like sherry. I did not find that particularly notable (people have different flavour thresholds) but noticed that it had a sweet honey character that was out of line with the brewer's description of a fine citrusy hop character. The flavour was dull and fell away quickly. All of these are typical characteristics of an oxidized beer. The fact that the beer had a very low level of carbonation was suspicious too and may have been linked to a faulty seal. Other descriptions of oxidation are that it is like stale bread crumbs or even lipstick!

Beer packaged in bottles and cans is not subjected to the levels of oxygen that occur in part used casks but the beer can still suffer from oxidation due to oxygen that may have been present at packaging, or if the crown cap is not making as effective seal as it should. In the 18 and 19th centuries one means of preventing oxygen in bottled beer was to put a layer of

oil, such as olive oil, on top of the beer and for the drinker to mop this up with a piece of cotton before drinking – feel free to try this if you wish, but we are not recommending it! This practice may well have stopped the beer going off but it would have killed the head and would not be appreciated by drinkers, at least here in the north of England.

Fortunately breweries now rely more on modern brewing procedures and equipment to reduce levels of oxygen in the finished beer and sometimes also the use of antioxidants such as sulphites and/or Ascorbic acid (Vitamin C) to reduce oxidation. As little as 1 ml of air in a 300 ml bottle of light ale or lager, giving an oxygen content of about 1 mg/l, or 1 part per million, can be enough to oxidize all the reductones and produce off-flavours. High temperatures and agitation can increase the rate of oxidation. This is one reason pasteurized beer usually tastes relatively dull and bland – and why many prefer to bottle condition their beer to serve it as a Real Ale. Oxygen in bottle conditioned beer is less of a problem, as the remaining yeast cells are likely to use up most of any oxygen introduced at bottling. Oxidation can also be a problem for cask conditioned beers even prior to broaching, if moved through various depots by unrefrigerated transport in summer and may be one of the reasons some people say certain beers do not travel well.

The use of the Autovac in Yorkshire to produce a tight creamy head can also be an issue as it knocks carbon dioxide out of the beer and introduces oxygen carrying air. If there is a rapid turnover of beer this is unlikely to be a problem in beers brewed to be served this way, but if the beer sits in the system for periods of time between servings this is likely to have an adverse effect on beer quality, ranging from flat and dull to stale and sour.

The rate of oxidation is roughly inversely proportional to the original gravity and colour of the beer. So a light coloured, low alcohol beer will be most noticeably affected, with flavours like paper and lipstick showing though due to the formation of aldehydes. The malt character also becomes honey-like, due to the formation of 2,3-pentanedione, a vicinal diketone, which whilst not as objectionable as the aldehydes, will not be what the brewer intended.

Stronger and darker coloured beers are less likely to oxidize quickly and the oxidation flavours are more likely to contribute positively to the flavour here. Some beers are brewed with the intention of them maturing over long periods of time, for example barley wines like Thomas Hardy's Ale. In beers like this the rich malt aromas are replaced by sweet sherry-like tones due to the oxidation of malt derived melanoidins, giving a range of flavours, including nutty notes. Flavours of over-ripened dried fruits such as raisins and prunes are often found – a bit like an alcoholic liquid Christmas cake. These are normally not perceived

as off-flavours but as part of the desired charter in barley wines and some dark Belgian beers, but even here too much oxidation can become problematic and render the beers dull or even offensive (possible cheesy notes) depending on your personal flavour thresholds and taste preferences. Having said that, for the majority of beer styles oxidation is a bad thing and to be avoided.