PRO Engineering
Craft Brewers Tech Notes

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How to Decrease Oxidation in the Brewing Process

From a brewer's point of view it is generally accepted that oxidation of wort and beer causes a variety of undesirable analytical problems such as premature staling, haze and shorter shelf life.

From a consumer's point of view, comments about the effects of oxidation are more ticklish: "Why does my beer look cloudy"? "Why does my favorite beer taste different every time I buy it"? "Why does this beer taste like cardboard and have an odd color"? "Why can't the brewery control this"?

Once again we are reminded that our reputation with our consumers is made with the sale of each container and that we have the responsibility for excellence. Control of oxidation in wort and beer is often subtle, yet the problems with oxidations are additive as product passes through the process.

This paper looks at the more subtle sources of oxidation in the process. Methods for identifying and correcting oxidation potential through carefully executed **procedural** and **engineering** changes are reviewed.

Brewhouse Procedural Opportunities:

- Avoid **grinding in** more than a couple hours in advance of mashing in. In my years of brewing, I actually saw the weight on the scale hopper increase while we were grinding in 12 hours in advance of mash-in. The ground malt was absorbing the humid air and of course the air resulted in oxidation of the malt.
- Avoid having **exhaust fans** in operation above the mash tub and hot wort receivers while they contain product. In practice, it takes only 15 minutes or so of fan operation to oxidize the mash or the wort. It will result in a change of color, pH and flavor. Personal experiences allow for this comment.

- Observe for **vortexing in the mash tub** while the agitator operates. Vortexing pulls in air and results in mash oxidation. Improvements MAY be as simple as slowing the rotation rate, though extreme care must be taken to assure heat transfer is unaffected! Engineering changes may be needed.

How can I tell if my changes have made improvements? Test a **special** and **control**, where the special is the beer from the new procedure and the control is the old procedure.

Wort Oxidation in the Brewhouse requiring Engineering or Maintenance Changes

- **Failed pump seals** are a subtle source of wort oxidation! Look in the Hot-wort Receiver after it fills. A foam "cap" on the wort in a freshly filled Hot-wort Receiver suggests that pump seals in a pump between the kettle and the hot wort receiver have failed and are allowing air pick-up during wort transfer. Once air has been pulled into hot wort, oxidative effects happen quickly. Testing the hot wort for air content is possible with proper planning, equipment and regard for safety. We also recommend on-site observation of process pumps during CIP. Caustic leaking from the seal area of a process pump is a strong indicator of a failed seal. A long-term fix to this kind of problem involves improvements in seal design instead of simply replacing "in kind".
- **Sampling devices on the suction side of pumps** are a potential source of O_2 pickup. They can also create airbound conditions in a pump. Convenience or good intentions are the usual reasons for selecting this 'upstream position'. The device is often abandoned in place when the user realizes they cannot sample, nor can the pump function. As a general rule sampling devices installed upstream of a pump should be removed. This should be done by a welder qualified in sanitary welding procedures.
- **Valves on a Lauter tub are under negative pressure (suction) when in operation.** The valve seats will fail eventually, and air will enter the wort stream. This is particularly likely to happen when nearing the high ΔP at the

time of a cut. The pump(s) may become airbound or the brewer may see air bubbles in a sight glass, indicative of a problem.

Oxidation in the Cellars:

"*Flavour improves during the maturation process but this flavor improvement is difficult to characterize and optimize. There is the added factor of the effect of oxygen, which will generally cause adverse flavour changes, and so any discussion of flavour maturation must include a study of ways of preventing oxidation*" **Brewing Science and Practice** ; Briggs et al

Additional Procedural and Engineering Changes:

- The practice of **partially emptying fermenters**, leaving a heel to be pumped another day, is an almost certain source of oxidation. When a fermenter is tapped, the top vent is opened to prevent crushing the tank. Air is pulled in during this step. If a heel is left behind it will likely change its characteristics and develop higher levels of off-notes such as Diacetyl and/or Acetaldehyde. There are other unpleasant effects on the process and on tank CIP. The procedure recommended is to completely empty a tank once it is tapped and perform a CIP as soon as possible. Specials and Controls as described earlier will help show the cause and effect results.
- **Fill fermenters to capacity** in as short a time as possible to avoid prolonged air contact with product. This recommendation may also prevent stratification and its related issues
- **Tank Gassing**: After an aging tank is CIP'd it needs to be purged with CO_2 before being filled with beer from the fermenter. The right way to do this is from the ***tank bottom***, slowly. Because CO_2 is heavier than air, it will tend to displace the column of air upward and out the vent. The CO_2 injection rate can be increased over time and with experience. A well-designed flow regulator and purity measuring devices are required for success. The entire apparatus can be mounted on a cart for easy transport between tanks. Simply stated, we want a pure CO_2 atmosphere before bringing in beer. There are variations in how this can be accomplished in order to minimize the use of CO_2.
- **Beer Movement**: Utilizing deaerated water for line fills and presses helps minimize O_2 pickup during beer transfer. Use of CO_2 blanketed centrifuges helps prevent O_2 pick up in that process. Using chilled, deaerated water for

filler bowl prep helps drive out O_2 that could contaminate beer in the filler bowl.

- **Beer Filtrations**: If using a standard celite filter, the lines to and from the filter and the filter housing itself need to be purged of O_2 before introducing beer. Ideally DE make up should be done with Deaereated water and the DE make-up tank should be kept under a CO_2 blanket. At the end of filtration or between brands the filter press-out should be done with CO_2 and a final chase to the FBT should be accomplished with Deareated water. Beer filtration is one area with the high possibility for undesirable air pick up. It requires thoughtful planning for both equipment and rigid adherence to procedures.

We hope that this first issue of PRO Tech Notes has given you some ideas to explore for preventing or solving oxidation problems. **We welcome any feedback, discussion or questions that you may have. If you need assistance with your brewing process, please contact either of the individuals listed on the following page, they will be very pleased to help you.**

David Kapral, Founder
Brewing Consulting Services, LLC
The author, David Kapral, has over thirty years of brewing experience. Some of his credentials are:

- Experienced Brewmaster, with 8 years consulting experience to craft brewers across the U.S.
- Beer Steward Certification Trainer for the MBAA
- Practical Brewing lecturer at MBAA's annual Brewing course in Madison, WI
- Member of the InTota Expert network
- Received the "Inge Russell Best Paper Award" for a complex fermentation topic

Additionally, Mr. Kapral founded Brewing Consulting Services, LLC.
The firm provides a wide range of practical operational advice and solutions to clients in the craft brewing industry. The group includes the David Kapral and his associates; Mark Sammartino and Pat Frost. Collectively this group has about 100 years of experience in the industry.

Contact David Kapral if you would like to discuss the issues raised in the article or if you want to explore further assistance from his firm.

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