For Craft Brewers
PRO Tech Notes
From PRO Engineering

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Using the Senses for Brewery Observations and Process Control

The senses referred to are **Sight, Sound, Touch, Taste** and **Smell.** They are powerful allies for process observation and control with encouragement, training and proper application in the brewing environment! Brewers have keen senses and this is obvious when participating in taste panels with BJCP certified judges who taste a multitude of brewed products. The purpose of this paper is to discuss actively using those senses during the actual brewing process, well before packaging. Our goal is to find problems, to assure processes operate as we believe they should, and to monitor that our ingredients and output taste, as we believe they should.

A quote shared: "*There is no replacement for knowing how your equipment (and beer) should sound, look, feel, smell or taste. As part of the training I do here, I try to impress upon everyone that they will probably know when their equipment starts going bad because "something" will be different, and that's the best time to call maintenance*." Abraham Kabakoff, Dipl.Brewmaster.

Our senses **were** the QA systems of the past. Recall the story of the brewmaster in lederhosen testing fermentation by sitting on some of the beer: If it stuck to his seat, it was not finished (residual sugars) and needed a little more time. I believe our senses have an even more important role to play in the breweries of today [lederhosen optional]. The use of enclosed control rooms, the increased reliance on QA's analytical data and the reduced staffing of modern breweries has seemingly diminished the importance and the opportunity to use our senses for process observation and evaluation. In this writer's opinion, the proper and regular use of our senses is a low cost, pro-active step that can help assure the operation is under control. The senses are a strong complementary skill to process knowledge and training.

This issue of PRO Tech Notes will provide examples of everyday process issues found directly by sensory evaluations in the field. These include **flavor issues** of several types, **Plato** and **RDF** problems, lost **capacity**, lost **extract**, **yeast** issues, **sewer loading** increases, **microbiological** problems and **CIP problems**.

Additionally, we have outlined a five-step program to assist you with using your senses at your plant.

Brewhouse:
The responsibility of the brewhouse is make high quality wort. This wort must be fermentable, have the proper °ß, pH, IBUS, color and flavor, it must be sterile and free of 'contaminants'. Brew volumes should be consistent. So…..what could *possibly* go wrong if we understand the expectations? Let us count some the ways….

1. **Operating Environment:** The brewhouse environment is exceptionally challenging. Equipment is subject to high duty cycles, a wide range of pH, high flow rates, abrasive materials in the grain and mash and corrosive materials. Utility consumption is high and our process relies upon efficient use of various heat exchangers. Lauter tubs are mechanical in all operational steps. Our senses can provide detail unseen on the HMI touch screen. (Human Machine Interface)
2. **Contamination Potential:** Some (but not all) potential sources for 'contamination' of the mash, wort and brewing waters include the following: caustic, air, underdough, water, steam condensate, unmilled grain, over-milled grain, unmalted barley mixed in with malt, off quality malt, vent stack condensate, wort from preceding brews, spent hops, spent grain, left-over hot trub and pump-seal water.

Examples of brewhouse problems found by using the senses:

- **Vorlauf duration** can have a negative effect on wort **taste** after a particular duration. In some open or semi-closed grants, tasting the wort has shown flavor changes after about 8 minutes, with oxidized flavor notes appearing. **SAFETY NOTE:** Circulating wort is usually about 170°F. Caution is required during collection and tasting!
- **Wort flavor** during Vorlauf can be a predictor of beer flavor. This is especially true of harshness and astringency that can be part of a milling impact and the types of grain used. We encourage brewers to taste the wort (carefully!! it is **hot**!) on each brew, throughout the runoff stages to understand brand profile and to find issues. In a combination vessel, one brewer reported that he had detected low-balling wort through taste without using his hand-held device.
- **Tasting** wort during runoff has found **supplier issues.** In one case, a very low-level sourness inherent to the particular batch of malt was quickly identified through taste, during runoff. The brewer tracked the product through the process to make appropriate handling decisions.
- **Watching** Grain-Out has visually confirmed a layer of starchy material at the false bottom that was affecting run-offs. **Physically probing** the false bottom with a mash oar on succeeding brews indicated the stainless steel false bottom was coated over and could not be touched. Changes in mash procedures eliminated the starchy layer and improved the wort and the final beer flavor.

- **Watching** underlet water enter a lauter tub identified that one particular tub was tilted by about 1/2". This explained why it was the lowest yielding tub of all in operation. This physical observation combined with records of efforts to improve its yield were the justification for engineering changes.
- **Tasting** wort from lauter tubs with plant engineers identified that one of three pumps on a particular lauter tub was putting out slightly sour wort. We **touched** run-off tubes going to that pump until we found a cold section, indicating blockage. We followed through by **touching** the bottom flush system during its operation. We **heard** and **saw** the valve actuate but the valve stem did not turn. The pin had fallen out and no bottom flush water was going to a section of the tub. This was confirmed by **touching** the piping on the downstream side of the valve. Underdough was not being removed in one section of the tub. The Underdough built up and plugged some of the tubes. Souring started and wort quality had started to suffer. The problem was identified in advance of seeing it on QA records.
- **Air Vents and steam traps** are small but critical pieces of utility equipment. Air vents assure air is purged for proper heat transfer during start-up and they help prevent a vacuum when steam is shut off. Steam traps assure only condensate leaves the process. **Inspections** at vessels frequently find problems with both devices. In one case, the air vent lines were plugged with fittings from initial pressure testing, far in the past. Removing the plugs improved heat transfer.
- **Biofilm** in a wort line was identified by **touch** when the writer saw a valve being replaced in a wort transfer line. The writer put his hand in the pipe to verify the line was clean. It had an unexpected biofilm about 1/8th thick. Changes in cleaning equipment and CIP procedures cleared up the problem. Beer taste improved. The biofilm had contributed to the "house character" of the beer.

Fermenting:
Fermenting is less of a physically demanding process than the brewhouse operation. Observations change to cover those critical processes important to that process area. Problems found using the senses along with other analytical skills include:

- **Fermenter Stratification: Visual changes** of CO_2 generation in fermenters have provided clues to fermenter stratification. Additional analytical steps verified the conditions. See MBAA Technical Quarterly, Vol.45, #2, 2008.
- **Aroma** of CO_2 identifies brand fermentation characteristics and provides a clue to yeast health.
- Physically (and **cautiously**) **touching** the water side of the wort cooler lines during wort cooler CIP has identified plate failure due to heat stress corrosion. Plate failure is an eventual fact of operation. It can lead to other serious quality problems in the process.

- **Wort air injection** systems need to be checked **visually** and cleaned on a regular basis. Check valves fail; wort can back up into the system, causing micro problems.
- **CIP**: A number of CIP issues have been detected by simply listening to the CIP in operation. High-pressure jets have a **particular sound**. When they fail or have insufficient pressure the **sound** changes.

  We catch problems by **sight** as well: Vessel Pre-rinse-to-Drain shows solids for a period of time. If the time solids are flowing to the drain is too short, there may be problems with the cleaning jets. Catching such problems while in the field can prevent micro issues down the road. Visual tank inspection after CIP is important to assure cleanliness and drainage.
- **Crushing Tanks**: Tanks have been crushed in many ways over the years. The author has seen the effects of using a "cold" water rinse following a "hot" CIP. The hot CIP vapor in the tank is quickly condensed, resulting in negative pressure conditions. The tank can collapse quickly. **All senses** can detect that problem….it is noisy, it is ugly to see, you can smell trouble coming and the mouth goes dry! It is important to train the brewers on the potential of the issue. Active controlling instrumentation on the water supply line to the vessel is a wise precaution. Establishing a standard for the allowable difference between caustic temperature and rinse water temperature is critical. Cooling down of a sterilized tank with CIP rinse water can be disastrous.
- **Welds**: Welds in brewery lines should be full penetration with proper line purges. Sugared welds can and have been sources of bacteria growth*.

Filters:
After fermenting, the beer should have no contact with O_2! Unfortunately there are many process points where air contamination and oxidation can occur: Every beer transfer; tank purges, centrifuge cover gas, transfer hoses and transfer piping are some examples where O_2 contamination must be excluded with proper procedures and checks.

Similarly, we need to assure that deaerated water is actually deaerated. **Visual** checks inside deaerators help assure they have not scaled over and the same visual checks assure de-scaling is successful when undertaken. Tools such as a Zahm and Nagel gas purity-testing device are especially useful for checking the purity of purged tanks! **Tasting** CO_2 (bubbled through sterile water) helps assure quality standards are met and that we can be confident that no off odors will enter our product from the CO_2 we purchase. Similarly the DE we plan to use should be mixed with water and the product **sniffed** (not tasted), looking for off notes, especially moldy or musty notes than can be picked up in some storage conditions.

*Pro Engineering has certified welders and inspectors who can audit your process and help teach brewers to 'read welds', a useful skill.

One example of a problem found through the senses is below:

A beer filter at one brewery was experiencing short cycles, and therefore very high downtime and high process loss. The author and an associate were sent to assist. They **observed** blowback and filter cake rinsing from the filter body sight glass. It was not actually happening! The filter shell was opened and the filter cake 'blow down' system was started manually. The two observers were soaked. The seals on the water supply header had failed. Almost all the water sprayed out horizontally, along the shaft. The little water arriving at the spray nozzles was insufficient to rinse off any of the old DE. The filter screens were mostly bridged and rinsing was ineffective until repairs were made. The decision to **observe** filter blowdown in the field was the key to problem identification and resolution.

A brewery wishing to incorporate the use of the senses into their operation might consider the following:

1. A well-designed process audit is a good place to start. Process auditors such as those working with Brewing Consulting Services are good listeners, observers and problem solvers. We work with you and your staff to hear your concerns and see your process in action.

2. An audit can be followed with development of Critical Process Observation Standards and Expectations. Pro Engineering has the staff and expertise to correct problems found during such an audit. Alternatively, they can work with your staff to assist as needed.

3. Step three has options. Selected key personnel can be trained one-on-one with the idea being that they will train the remaining staff on the use of the senses for assuring quality and for understanding the process. Alternatively, groups can be trained. Time in the field is important, but discussion of key steps in the process is equally important.

4. Step four involves assuring that information about use of the senses becomes part of plant operating procedures. When properly done this become part of management expectations. The training is formal and includes the how-to, when-to, why and where to use our senses for process auditing and control. The plant must integrate safety into the training, since we are sometimes dealing with hot liquids and gas such as CO_2. Use of the senses should become part of internal process auditing and a part of future training for new brewers. As the process changes, as new equipment is purchased, as the business grows, the use of the senses for process observation and control should evolve as well. Issues found by use of the senses often have ROI justification for repair.

5. Step five, correcting identified issues: Pro Engineering has skilled craftsmen knowledgeable in the brewing process who can assist with repairs and upgrades in conjunction with your staff and with their cooperative relationship with Brewing Consulting Services, LLC.

We hope that this issue of PRO Tech Notes™ has given you some ideas on how to use your senses to brew better beer. **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 below, 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 company provides a wide range of practical operational advice and solutions to clients in the craft brewing industry. The group includes the David Kapral and 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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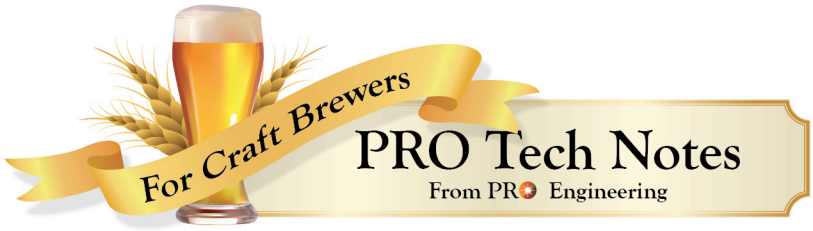

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PRO Engineering and Manufacturing, Inc
PRO Tech Notes™ is a publication of PRO Engineering and Manufacturing, Inc. PRO Engineering has been providing equipment and engineering services to the brewing industry for over 35 years. PRO has a commitment to serving the craft brewing industry through equipment and services specifically tailored to craft brewers.

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