For Craft Brewers
PRO Tech Notes
From PRO Engineering

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Stratified Fermentations

One of the more frustrating events in a brewmaster's life is a fermentation that has gone bad with no apparent explanation as to why. Considerable time is spent "rounding up the usual suspects", analyzing the information with a conclusion that there **is** no firm conclusion as to what has happened! "The usual suspects" can include such items as brewhouse conversion evaluation, ingredients, air injection, yeast (storage conditions, age, pitching rate) and potential caustic contamination.
In the meantime, the beer from an abnormal fermentation may have high acetaldehyde and/or high "D". It may have taken far too long to ferment with the obvious conclusion that the fermentation is 'stuck' and the Balling will not drop properly. The recovered yeast may not ferment the next batch properly, taking 16 to 24 hours longer than it should and it is obvious that there is a problem but it does not show up in the data.

One abnormal fermentation that can cause all of these problems, and more, is **Stratification of Fermentations within the Fermenter**.

What is it: Stratification can occur in multi brew fermenters and even certain single batch fermenters if dry yeast is added through a top hatch. Stratification initially has two fermentations in the same fermenter, but will have a third fermentation as the fermenter contents eventually mix.

How does it happen: In multi-brew fermenters, the phenomenon can occur when yeast is added only in the first brew. Succeeding, unyeasted, brews can push the active fermentation, with almost all the yeast, to a point above the glycol control valve. Once this happens, the active fermentation is uncontrolled. The new wort that has been added will pick up some yeast from incidental contact and will have a cell count of 3-4MM cells / ml. The lower mass requires little to no cooling for 18 hours as the cell count grows. Meanwhile the upper fermentation is uncontrolled and can reach a point where it nearly finishes out. As this occurs, the upper fermentation becomes less exothermic. The lower fermentation becomes more exothermic as time passes and the cell count goes from about 3MM Cells/ml to about 10 – 12 MM cells per ml. As the lower fermentation requires more cooling the upper fermentation gets the same amount, more than it needs, depending on fermenter design. The upper mass was uncontrolled initially and became hot. Then it is **overcooled** as the lower mass becomes more exothermic and demanding of cooling.

Finally, the two masses will mix and this is quite active! In all cases observed, the mixing of the two masses will drop the fermenter contents by about 5°F or more. The Balling will drop significantly and the apparent cell count will increase. This is the signal that the **Third Fermentation** has begun within the fermenter. It may look like the glycol valve has stuck in the open position, but in reality a complex set of events has taken place inside the fermenter!

To summarize the stages of Stratification:

- Stage 1: New unyeasted wort displaces actively fermenting beer.
- Stage 2: The two masses ferment separately until the lower mass reaches a critical point.
- Stage 3: "The Event": The two masses mix turbulently with observable changes in Temperature, Cell Count and Balling.
- Stage 4: We have a "Problem Fermenter".
- Stage 5: Dealing with the long-term effects to yeast and beer.

Do we have the problem? The *potential* for stratification exists under many scenarios:

- Yeast only the first brew into a multi-brew fermenter
- Drauflassen operations
- Culture operations
- Yeasting a fermenter through the top hatch after wort has already gone in

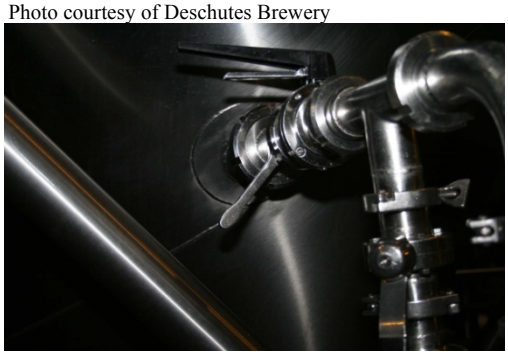
Detection: The symptoms have already been discussed. To this, I would add that sometimes a diminishment in CO_2 production followed by an "explosive" discharge as the contents mix. If the brewery discharges fermenter CO_2 into a bucket of water it is possible to see this IF someone is there at just the right time. If the symptoms of stratification exist, there are several things that can be done to confirm it is the problem. The most direct method is to provide a means to sample the wort and the temperature at the upper level of the beer in the fermenter, in addition to the lower sample point. After adding fresh wort, take simultaneous samples and temperature readings at the upper and lower data gathering points and compare them. By doing this every 8 hours to start and then every four hours after the first 16 hours, the difference in the conditions will become apparent. Having the second sample point aids with confirming the issue is corrected, later on. Higher-tech devices can also available.

Correction: There are two ways to prevent stratification:

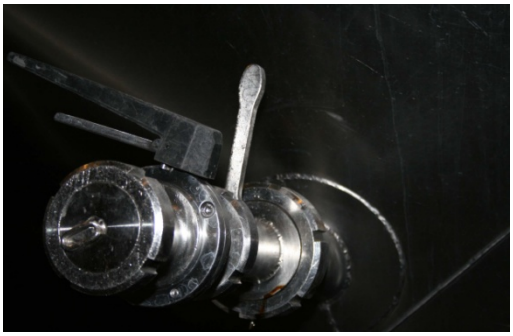
1. Yeast all brews going into a multi-brew fermenter.
2. Assure that contents mix thoroughly as fresh unyeasted wort is added to an active fermentation.

Fermenters having a racking arm have an advantage. The racking arm can be used to assure mixing of the contents. Brewers pitching yeast 'fermenter to fermenter' will usually add the yeast and then put the first brew in through the racking arm, putting it in the 'down' position. This helps mix the wort and beer for brew #1. By turning the racking arm 'up' to about the 11 o'clock position for succeeding brews while filling through the device mixing can be assured. Some plant-to-plant adjustments will be required.

Photo courtesy of Deschutes Brewery



Racking arm 'down' for brew 1



Racking arm "up" for succeeding Brews

In large, multi-brew, conical bottom fermenters the problem becomes more complex. Having fresh unyeasted wort enter the fermenter at high velocity can mix the contents thoroughly. This is difficult especially when directly entering the fermenter after the cooler discharge. It is also possible to circulate and it is possible to agitate in order to mix the two masses. If it is at all possible, yeasting of each brew is preferred.

For "Drauflassen" and cultures where significant amounts of fresh unyeasted wort are procedurally added to an active fermentation, the mixing system must be designed for such conditions.

The benefits of eliminating stratification include the following:

- Improve Beer Quality.
- Reduce Fermentation Cycle Times.
- Improve Yeast Health and Return rate.
- Improve Performance of Repitched Yeast.
- Reduce Blending for Taste / Quality Concerns.
- Improve Process Control.
- Improve Potential for Successful Project.
- Reduce Brewmaster Frustration Level.
- Excellent Training Opportunity.

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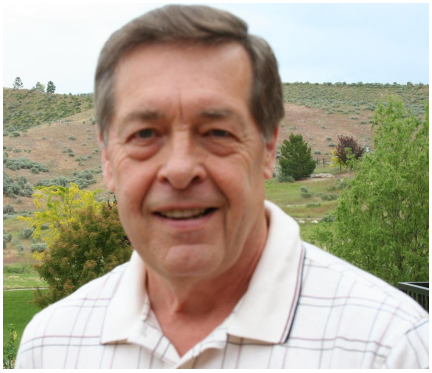
If you would like to discuss any aspect of this article or if you would like to engage the assistance of David Kapral of Brewing Consulting Services, LLC or Edward Michalski of PRO Engineering and Manufacturing, Inc., please contact either or both gentlemen using the contact information listed below.



David Kapral, Founder of
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 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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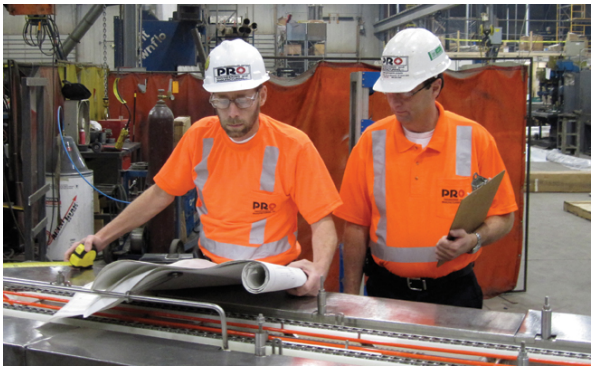

Ed Michalski (left) with brother Dave, checking specs for a customer

Ed Michalski, CEO
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