PRECISION FERMENTATION

THE CONNECTED BREWER: DATA-DRIVEN FERMENTATION FOR BETTER BEER AND BETTER BUSINESS

A Precision Fermentation eBook

BrewiQ

CONTENTS

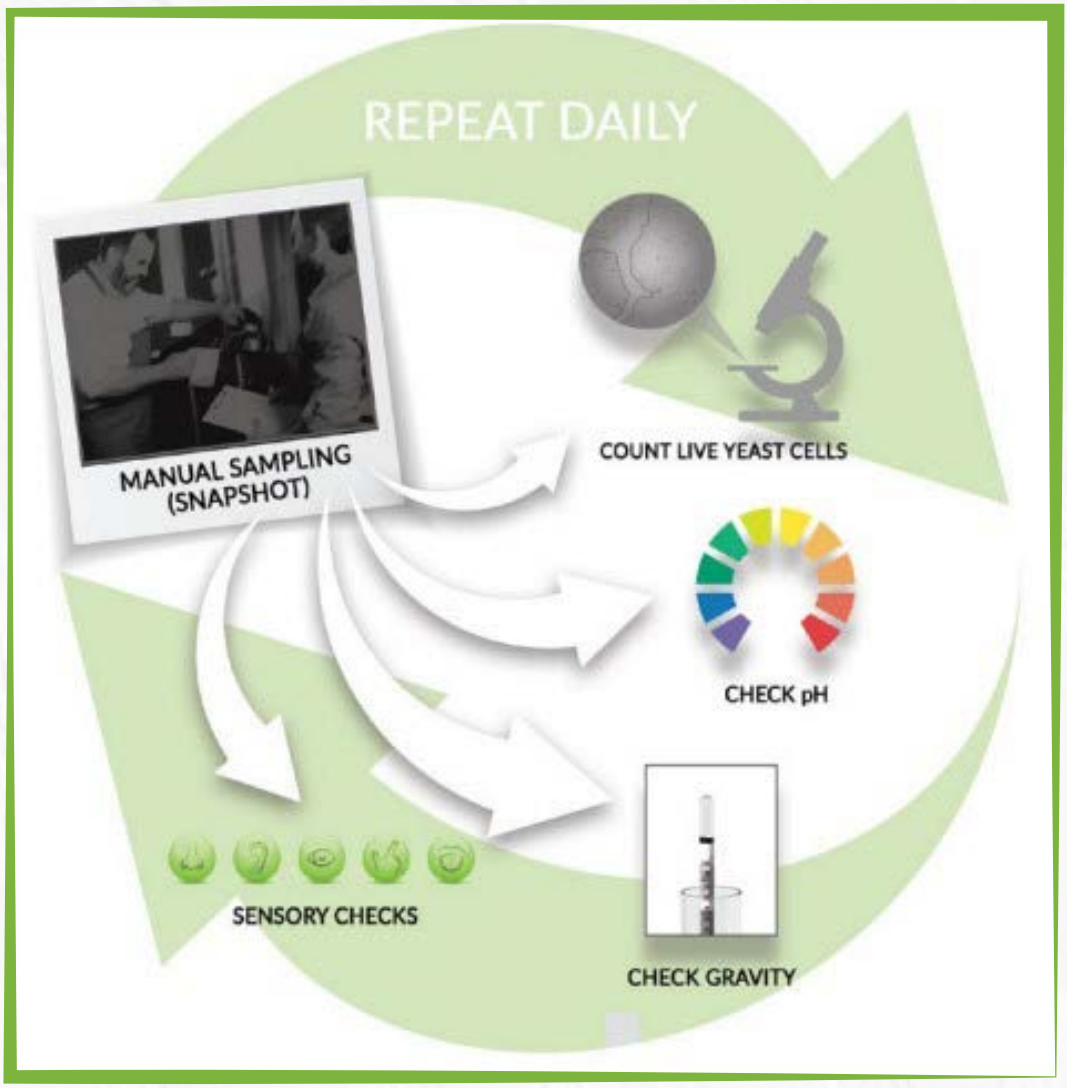
INTRODUCTION

While there are many factors that impact the success or failure of a brewery - location, funding, marketing capabilities, competitive environment, local economy, vendor relationships, staffing, etc., the most important factor is the beer itself. Brewers must deliver consistent quality and so efficiently. The brew is the main attraction, the driving product, and is at the heart of the brand. Great brewing empowers every other aspect of the business.

Craft Brewing depends on the expertise of each brewery's staff. Automation and technology can play a critical role in improving each brewery staff's ability to deliver consistently great beer. This paper looks at the critical factors that impact product quality and production efficiency during fermentation, the typical workflows that brewers use to manage these outcomes, and the new technologies and processes that can help elevate brewing processes. Advancing these processes will help individual brewing companies to thrive in today's competitive market landscape.

The Challenge: Product Control, Repeatability and Efficiency

The fermentation management process that many brewers use today still relies on daily manual measurements and data recording.



Taking a “daily snapshot” of the brew’s performance is better than not measuring at all, but it rarely produces timely, actionable data needed to improve process quality and efficiency in the moment, or the consistent data sets needed for batch-to-batch comparisons. Most brewers have discovered the need to intervene during a fermentation (such as pitching more yeast long after the last knockout) or alter the conditions of a fermentation based on an unsatisfactory performance (e.g. changing fermentation temperature, oxygen dose, or yeast pitch rate). Relying on “snapshot” observations of progress, the success of these interventions can vary widely.

EFFECTS OF MANUAL FERMENTATION MANAGEMENT

• **Lack of control:** Fermentation is a complicated process. Changes to any of several factors – water chemistry, mash temperature, grain bill, hop selection, yeast strain, pitch rate, fermentation temperature, and findings can impact the final product. With limited visibility into the fermentation, options for interventions are limited.

• **Diminished Repeatability:** Producing the same brew over and over again is accomplished today by maintaining the strictest possible management over controllable conditions for each brew, such as water chemistry, wort profile (grain and hops), fermentation temperature, and pitch rate. But what about other uncontrollable or unknown factors? Batches go bad in the fermentation tank for many reasons, and without data to record conditions in detail, the ability to understand and prevent bad outcomes is also very limited.

• **Inefficient Management:** There are many inefficiencies in manual fermentation processes, ranging from the management overhead required to train and oversee staff with varying experience, to the requirement that a brew master or other employee be physically present on-site multiple times during each day of the brewing process. Inefficient process leads to the costly loss of bad batches, increased labor costs coupled with employee burnout, and inefficient use of the brewery's capital equipment. All of these drive-up costs and reduce the brewer's ability to expand.

• **"Over-Fermentation" and Other Guesswork:** Over-fermentation is the practice of leaving beer in the tank longer than technically necessary. Although historically it was the only guaranteed method to avoid under-fermentation, unnecessarily losing the use of a tank for hours to days is an unfortunate and costly byproduct. Without visibility into the fermentation process, there was no other reliable method to ensure that a brew is complete.

Why does the "daily snapshot" approach fall down? Brewers need to see empirical data – typically temperature, pH, gravity/density, and yeast cell concentration. Temperature is often collected and analyzed automatically, but in isolation temperature cannot be correlated with the different events that occur during fermentation. Gravity/density and pH are often gathered through manual sampling, but the data is not continuous, and often is not recorded in a usable format.

So, deriving actionable and repeatable conclusions is not directly possible. Only a full set of continuous, real-time tank data that depicts the exact conditions for each batch at every stage of fermentation can support an objective blueprint for repeating brews with precision.

Batches go bad in the fermentation tank for many reasons. Detailed data capture gives brewers the ability to understand and prevent bad outcomes.

THE SOLUTION: REAL-TIME FERMENTATION MONITORING FOR COMPLETE VISIBILITY INTO EACH BREW

Real-time fermentation monitoring offers relief from the challenges of manual fermentation management. Gathering and analyzing empirical data collected directly from the tanks throughout the fermentation process provides a brewer with immediate and ongoing insights into each batch. Insights that are impossible to obtain through once-daily manual sampling. With a fully quantified view of the exact conditions that created a successful (or unsuccessful) product, the brewer can repeat and adjust both controllable and previously uncontrollable factors with great precision.

WHAT FERMENTATION DATA DOES A BREWER NEED?

To understand the practical impact of your brewing conditions and methods on the final product, end-to-end visibility into the chemical and physical properties of each fermentation offers the key data that a brewer needs to make informed decisions. There are several key metrics that individually and taken together give critical operational insights into fermentation status and eventual outcomes.

Real-time fermentation monitoring offers relief from the challenges of traditional, manual brewing management.

pH level:

pH measures acidity – the lower the pH the higher the acidity of the solution. Measuring pH gives insight into the efficiency of yeast metabolism of sugar into ethanol. Understanding pH is critical to giving an ideal flavor profile, and for providing yeast with the ideal fermentation environment.

Gravity:

Gravity measures the volume of fermentable carbon molecules in solution and is used to calculate the actual alcohol by volume (ABV). Gravity levels indicate the sugar left in solution for yeast to convert to ethanol. Seeing the rate of gravity change, in high resolution, provides insight into yeast health and fermentation performance. Knowing exactly when the yeast fully attenuates the beer means that the brewer can know the exact moment that primary fermentation is complete.

Pressure:

Pressure is a measure of how much gas is building up in the fermenter. Pressure is a useful parameter to analyze together with gravity to determine the consumption of fermentable sugars during fermentation. Measuring pressure is also an important equipment check, as rapid changes in pressure often indicate a mechanical malfunction.

Conductivity:

Conductivity is the measure of a solution's ability to conduct electrical current. Conductivity provides a valuable comparison point for water chemistry, and an important data point to understand the components of the wort as fermenting progresses. Conductivity offers enhanced insight into the metabolic efficiency of the yeast tasked with producing the finished beer.

Dissolved Oxygen:

DO is both a necessary supplement for yeast health and a problematic infiltrator of finished beer. At the beginning of fermentation, knowing how much oxygen is consumed by yeast is informative for measuring the yeast's health and vitality. At the end of fermentation, understanding how much oxygen is left in the finished product is a good indicator of beer stability.

Temperature (internal/external):

Temperature impacts fermentation at several steps during fermentation. Yeast responds to the environment; metabolic rate and flavor compound production are direct consequences of the fermentation temperature. Knowing the knowing temperature lets the brewer control the flavor/aroma profile of a beer as well as the fermentation ability of a yeast strain. Also, knowing the internal/external temperatures allows a brewer to observe efficiencies and inefficiencies in fermenter temperature control systems.

HOW DOES REAL-TIME FERMENTATION MONITORING HELP SOLVE A BREWER'S CHALLENGES?

• Control:

By measuring the environment within a fermenter, monitoring gives the brewer the alert to intervene should a fermentation go off track or change process in future fermentations. For example, if pH is too high after an early knockout, the next knockout can be adjusted to normalize the pH. If gravity does not begin to drop during the normal time frame, yeast can be repitched far earlier than if sampling was discontinuous.

• Repeatability:

Capturing digital data allows brewers to understand not only the end points of each fermentation (ABV/pH/pressure, etc.), but the way the fermentation proceeded. Watching the process unfold while continuously monitoring gives the brewery the ability to see not just points A & B but exactly how a fermentation went from A to B. This data set is invaluable for reproducing the same conditions in the future.

• Management Efficiency:

In the hands of a brewer, automatic data collection and storage helps to allocate resources to other aspects of the work. Lab and QA staff can use the data to improve process or recipe, perform microbiology work, etc. Packaging can be scheduled further into the future, and work schedules can be made more concrete. On-site sampling after hours can be reduced or avoided entirely by off-site monitoring of the data streams.

• Over-Fermentation and Other Guesswork:

The end of fermentation can be a subjective endpoint. Beer that satisfies sensory analysis, ABV thresholds, and pH measure can be moved to bright tanks (secondary fermentation), packaged, or sometimes must be left in primary for logistical reasons. Beer that sits in a fermenter or temperature controlled bright tank costs money, both for temperature control and in the unfulfilled potential for producing additional beer. Establishing chemical parameters from sensor data for finished beer minimizes the guess work for establishing endpoints.

With real-time fermentation monitoring across multiple parameters, brewers have the data they need to improve their brewing process, improve product quality and consistency, reduce labor costs, and manage operations for improved profitability.

THE BREWIQ SYSTEM – REAL-TIME AUTOMATED FERMENTATION MONITORING

The BrewIQ System is a real-time, end-to-end fermentation monitoring and analysis solution, that is purpose-built to enable brewers to increase quality and profitability through greatly enhanced fermentation process control. The BrewIQ System brings the “Internet of Things” (IoT) to the brewing process by collecting fermentation data from your existing tanks, and streaming it to your PC, tablet or smartphone, in real-time.

The BrewIQ System's pre-built dashboards transform your tanks into a powerhouse of insight that finally puts brewing control into your hands – ensuring brewed-product quality, increasing your production options, and saving you time and money.

Critical Measurements

- pH
- Gravity
- Pressure
- Conductivity
- Dissolved Oxygen
- Temperature (internal & external)

Solve Brewing Problems

- Fermentation failures
- Demand outstripping production
- Quality control issues
- Ensured consistency and reproducibility
- Shrinking profits
- Lack of data

For more information about the BrewIQ System, contact Precision Fermentation:
info@precisionfermentation.com / 919.717.3983

About Precision Fermentation

Precision Fermentation® offers a groundbreaking, real-time monitoring solution that dramatically enhances control over the fermentation process for producing brewed beverages. Its flagship product, the BrewIQ System continuously aggregates data from active fermentations, offering complete process visibility and control that replaces manual trial-anderror measurements, and enables excellent product and business outcomes. Precision Fermentation's complimentary ROI calculator helps brewers understand the dollar, labor, environmental and ingredient savings possible when using BrewIQ.

For more information about Precision Fermentation,
visit https://www.precisionfermentation.com/.