THE CONNECTED BREWER

Leveraging Real-Time Fermentation Monitoring to Elevate Product Quality & Operational Efficiency
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What You Will Learn Today

• Challenges with the traditional methods of fermentation management
• What is real-time fermentation monitoring?
• Key metrics of fermentation
• Key benefits of graphical representation of data
• Correlating empirical data with subjective evaluation to maintain quality
• Additional business benefits associated with real-time monitoring
The Challenge: Product Control, Repeatability, and Efficiency

- Fermentation management process has changed little for thousands of years
- Manual instruments
- “Snapshot” view of fermentation progress
The Challenge: Product Control, Repeatability, and Efficiency

Organic Raw Materials, Biological Processes, Industrial Setting

Gibson and Smart, FEMS Microbiol Rev, 2007
Effects of Manual Fermentation Management

• Lack of control
• Diminished repeatability
• Inefficient processes
• Mistakes, guesswork, and “popular” wisdom
• COVID-19: Manual sampling and analysis requires physical presence
The Solution: Real-Time Fermentation Monitoring

• Gathering and presenting empirical data
• Moment-to-moment analysis of trends
• Immediate and ongoing insight into biological processes
• Increased control of products over time
BrewMonitor® System

- Real-time, comprehensive fermentation monitoring
- Components:
  - Sensor Hub – physical device records and transmits data
  - BrewMonitor Console – web application for data tracking and analysis
- Automatic email/text alerts
- Remote visibility and comparative analytics
What Data Does a Brewer Need?

- Dissolved Oxygen
- Gravity
- pH
- Temperature
- Pressure
- Conductivity
“Data to Decision”

- Real-time, high-frequency data
- Early detection of yeast vitality
- Early intervention
- Correlation of actions with outcomes
- Greater consistency and repeatability
Graphing

- Data collection vs. data presentation
  - 5 parameters, twice per day, for a 14 day fermentation = 140 data points
- Real-time monitoring provides exponentially more data – extremely high resolution
  - Over 1000 data points per day, for a 14 day fermentation = over 14,000 data points
- Graphing is a necessity to gain knowledge from a high volume of data
Graphs: Gravity

- Determining original and terminal gravities
  - Earlier detection of the end of fermentation activity.
- Determining that your fermentation is healthy
  - Alternatively, early detection of stuck or stalled fermentations.
Graphs: Dissolved Oxygen

- Total Knockout O2
  - Precise dosing for optimal performance
- Rate of O2 uptake
  - Early indicator of yeast activity and vitality
Graphs: pH

- The rate of change during log (growth) phase
  - Early indicator of yeast crop health
- The total change in pH
  - Flavor-positive, important for brand identity
Graphs: Pressure

• Useful as a relative, qualitative measurement
• Process changes such as multiple knockouts, spunding, etc.
Graphs: Fluid Temperature
Graphs: Conductivity
Developing A Baseline

- Differences in
  - every brewhouse
  - every ingredient
  - every brand
  - every batch
Comparing Fermentations

<table>
<thead>
<tr>
<th>Dissolved O2</th>
<th>pH</th>
<th>Gravity</th>
<th>Pressure</th>
<th>Fluid Temp</th>
<th>Ambient Temp</th>
<th>Conductivity</th>
</tr>
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**Gravity**

- Peristaltic Control 1
- Peristaltic Control 2
- Peristaltic Control 3

Graph showing the gravity over hours from pitch for different conditions.
Decisions Grounded in Data

Once a baseline has been established, variation from the baseline can give immediate insight.
Case Study: Fullsteam Brewery
Data to Decision

• Gaining knowledge from high volume of data
  • Slower fermentation rate
• Establishing a baseline
• Making informed decisions
  • Increasing pitch rate 50%
• Increase output through efficiency
• Subjective analysis alongside objective data
  • Tasting Panels!
Stalled Fermentation: Gravity
Stalled Fermentation: Gravity vs. Conductivity
Practical Benefits of Real-Time Monitoring

- Control – provides the opportunity to intervene if a change is desired
- Repeatability – understanding trends vs snapshots
- Efficiency – remote view allows less on-site sampling, and better allocation of resources
- Accuracy – helps minimize the guess work for establishing fermentation endpoints
Q&A

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