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Bluetooth and Beer: IoT condition monitoring in breweries

By Brad Canham

The following use case describes the identification of challenges in the craft brewing industry, obstacles to solving those issues, actions to address those issues with an IoT condition monitoring service using Cassia Networks long-range Bluetooth routers, and the results - better brews.

SITUATION

The brewing industry is booming. However, behind the "good times" marketing vibe of neighborhood microbreweries, the craft brewing business is focused on timing and brewing conditions, all tied to critical infrastructure.

The owner of that infrastructure, the founder, is also often the brewer. Typically, when the brewer/founder goes home at night, the risk factors in the brewing process increase as the direct manual monitoring of the delicate brewing process and infrastructure stops.

The infrastructure includes production tanks, transfer pipes, venting pipes etc… which are critical because they're used to produce the core result of the business, a brewed product. Many people are familiar with the basic brewing infrastructure, such as cylindrical stainless-steel brewing tanks, which often include a jacket around them. Typically, the jacket contains a tank coolant around a filter connected to a chiller on the roof.

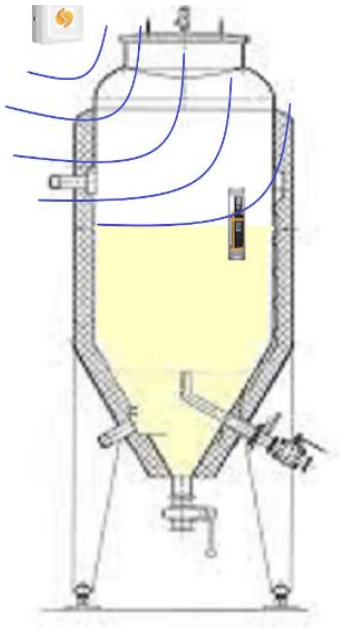
The reason for the jacket is temperature. Temperature is key during several steps in the brewing process. For example, inconsistent and failed temperature systems interfere with the fermentation activities of yeast. As a result, brewers experience ruined batches, inconsistent taste, flat carbonation, and other issues.

OBSTACLES

As brewers scale their production and seek consistent batches (and a way to sleep at night and relax on the weekends) they look for additional layers of continuous batch and infrastructure monitoring. A typical method, drawing 1-2 pints daily from a tank, increases waste, contamination exposure, and requires time-intensive manual attention. Moreover, once-a-day monitoring may miss issues until its "too little, too late."

Often using wired sensors is impractical and costly. The equipment used for brewing is large scale and ceilings are typically high making wiring challenging. Moreover, using wired sensors inside tanks, for example, is a contamination risk and hanging and routing wires in a brewery adds complexity.

Bluetooth Signal Penetration



Cassia Bluetooth router signals penetrate steel brewing tank to reach BLE sensor floating in liquid.

However, monitoring from within metal brewery tanks, also poses significant difficulties for wireless sensors. As CraftMetrics CEO, Luke Cyca noted “First we tried using a Raspberry Pi Bluetooth radio. However, a big steel brewery tank is basically a Faraday cage. It’s very difficult for a battery powered low energy device to get a signal out.”

Moreover, he noted that using a tablet and phone as a Bluetooth gateway also was a challenge. “Sometimes phones cannot pick up a signal even when pressed against the tank.” The thickness, electrical grounding profile, and electrical interference in a brewery makes for a hostile environment for Bluetooth low energy (BLE) sensors.

ACTIONS

In order to address brewer concerns about time-management and infrastructure and batch conditions, CraftMetrics monitoring duty cycles. Specifically, a sensor and battery in a sanitized acrylic tube is placed *inside* the metal tank (during a sanitation and cleaning stage) where it floats. A Cassia E1000 long-range Bluetooth router connects with the BLE sensor as it floats and monitors liquid density and temperature within a steel tank.

“That’s amazing connectivity,” noted Cyca, and the white Cassia Bluetooth router is an “ideal form factor,” which “works well and looks good in a brewery.” The system is also much more cost-effective and scalable than trying to use a hardened phone or tablet, he noted.

Moreover, the long-range Bluetooth E1000 doesn’t need an electrical plug-in on the ceiling because it can receive Power-over-Ethernet (PoE), so it is mountable on a ceiling or can be placed directly on a tank, said Cyca.

Inside the tank, the sensor floats in the fermenter and measures the *density* of the liquid. As the yeast eats sugars during the fermentation process the density decreases as the alcohol content of the liquid increases. This process takes about a week and variations in the temperature and activity of the yeast impacts the flavor of the brew. Continuous monitoring during this time is important to address “alert” conditions, create product consistency, and increase production efficiency.

RESULTS

In contrast to once-a-day manual monitoring, the continuous monitoring from inside a brew tank results in the brewer knowing in “real-time” how the yeast is performing in the fermentation process, such as:

- **Interventions** - is the yeast “stuck” and in need an intervention? Knowing yeast activity has significant impacts on taste consistency and the speed of production.
- **Speed** – at what speed are things happening? Changes in temperature impact the flavor of the wort during the brewing process, Sugar gets translated into alcohol and the density decreases. This lets brewers know a sugar rich wort is changing to an alcoholic beverage. Timing the process impacts the *quality* differences between a consistent brew and a brew with too much of an “alcohol” taste.

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- **Capacity** - is the batch done? Brewers managing *capacity* by turning over the process in a small craft brewery can move to the next stage in brewing more efficiently. Breweries typically have six-or-more stainless-steel tank cylinders, as small as 250 gallons, but more typically 1000-1500 gallons. Different tanks provide fermentation, conditioning, carbonating. Timing is important for brewers managing tank capacity and scheduling transfers between tanks to improve their bottom line.
- **Failures -** What if a cooling system loses power, a leak occurs, temperature fluctuations occur? The alerting function monitors for catastrophic issues impacting entire batches of beer, as well as conditions which change consistency.

Creating consistency: Yeast monitoring

Cyca notes, close monitoring of yeast in a small tank enables careful propagation of that yeast culture. In turn, propagating a yeast after its first-use provides for consistency in a variety of brewing scenarios, such as a "starters, probiotics, kombucha etc…for customers doing yeast propagation."

By reusing yeast maintained in a small tank coupled with ongoing monitoring, brewers can "maintain a productive yeast population for many generations," said Cyca.

By using a consistent yeast, the consistency of the brewed product also improves.

The Cassia E1000 Bluetooth router provides the backhaul connectivity (via ethernet, Wi-Fi, and if needed cellular) moving sensor data to the Internet and the CraftMetrics cloud-hosted application. There, using the data gathered in the CraftMetrics application, the brewer can monitor and manage the process on weekends while away from the brewery, in fact, from anywhere in the world.

Moving beyond "tank health" conditions, to better brews

Moreover, as increased amount of data is gathered into interactive graphs and charts, additional business models, process improvements (see "Creating consistency…" sidebar), and specific areas for batch and infrastructure improvements and insights are generated for individual brewers. "As we've gathered brewing data, we've learned a lot about the science behind brewing and we're using that data to help our clients," said Cyca.

As CraftMetrics data analysis capacities grow its extending beyond monitoring and saving time for brewers. The data is creating predictive value-add capabilities using more sensors and graphical data analysis. Said Cyca, "We're delivering data to brewers they use for more consistently high-quality brews."

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