Deschutes Brewery Uses Predictive Analytics to Delay Glycol Capacity Expansion

Presented By: Tim Alexander and Kyle Kotaich

Agenda

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DESCHUTES BREWERY

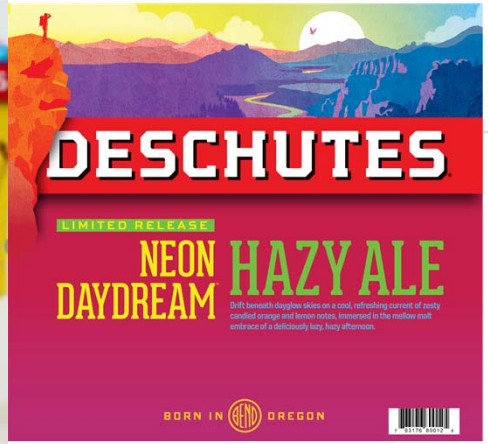
- Family and Employee owned since 1988
- Production facility in Bend, Oregon
- New research and development brewery
- Pubs in Bend and Portland, Oregon
- 10th Largest craft brewery in U.S.A

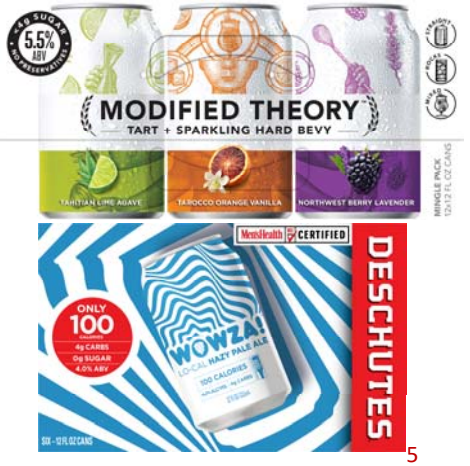
Our Mission

Profitably deliver the world's finest adult beverages and cultivate extraordinary experiences.

1. Craft distinct and diverse premium adult beverages that our customers value
2. Be the employer and brand of choice in craft beer
3. Be financially disciplined and eliminate waste

Products



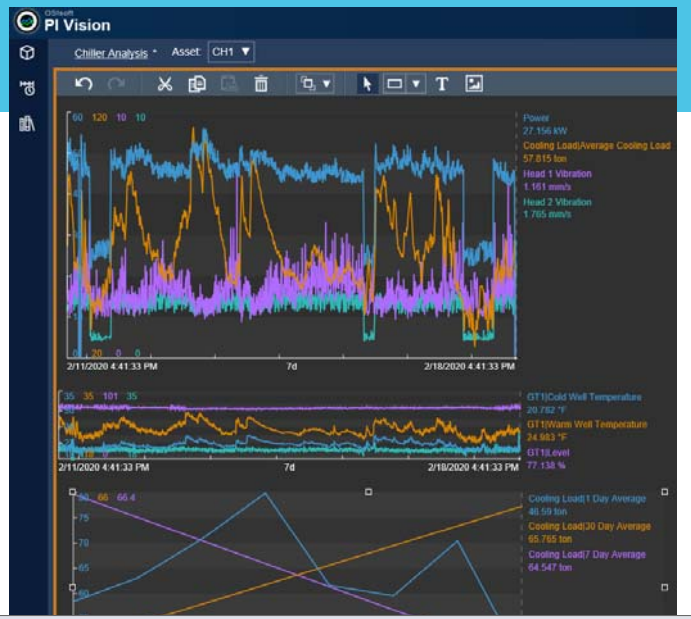


Chiller Challenge

- Backup chiller antiquated and not big enough to supply the whole plant
- Primary chiller not new, and also critical with no backup
- Primary chiller provides borderline capacity, occasionally kicking on the backup chiller during peak load times
- New fully redundant chiller project is $750,000
- Not in growth mode, but pay-down-debt mode, so capital is restricted

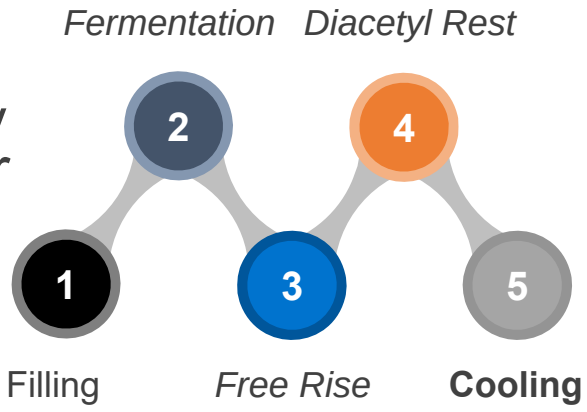
Chiller Solutions

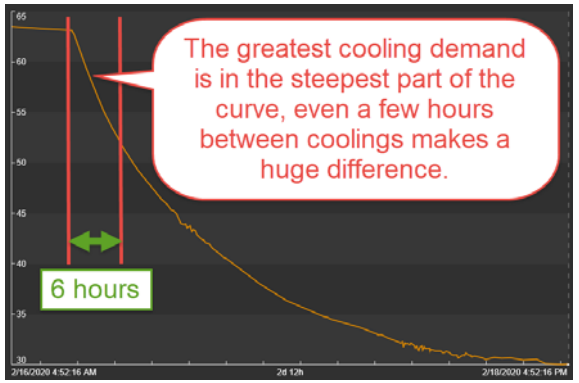
- Insurance: vibration and power monitoring on primary chiller, historized in the PI System
- Primary chiller inspection and rebuild
- Primary chiller provides plenty of capacity for our average load: spread out peak load
- Largest cooling load on our chillers: cooling fermentations after diacetyl rest
- How can we spread out coolings?
  - Put in automation to hold off on cooling tanks if chiller does not have capacity: not ideal for quality
  - **Fermentation predictions!**



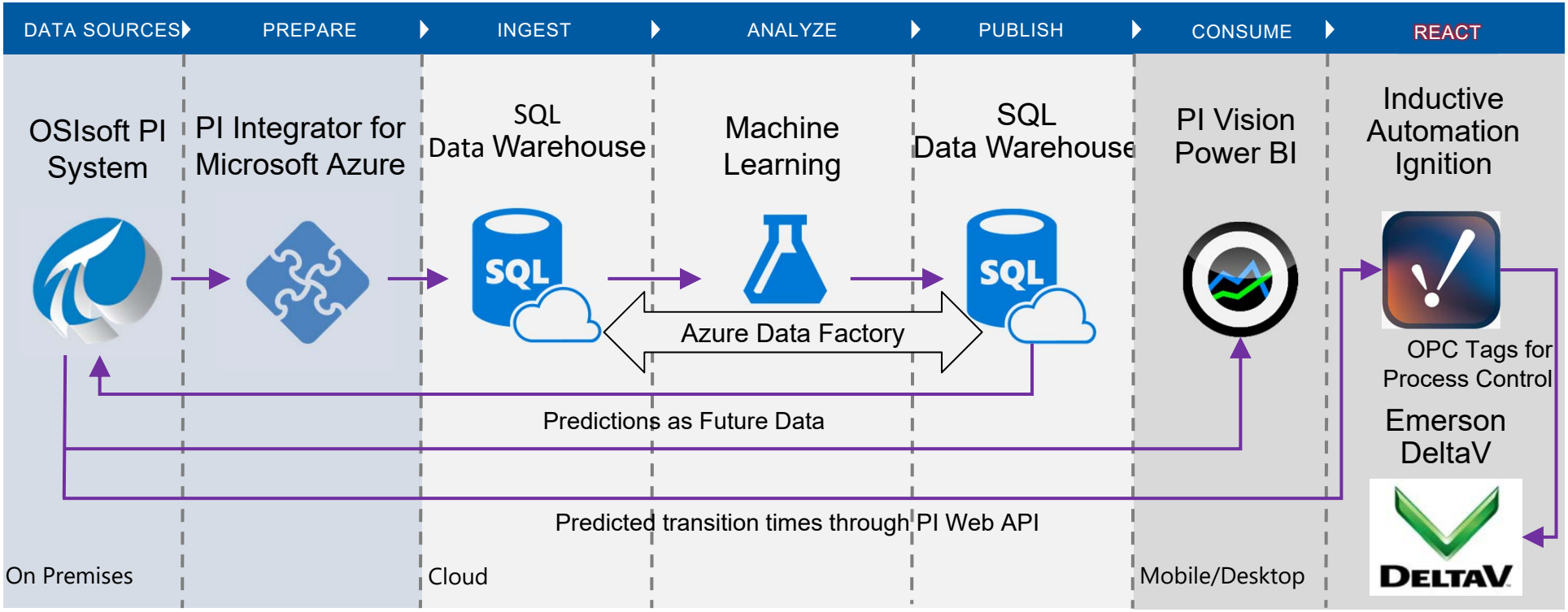
Predictive Analytics

- **Cooling** fermentations is the biggest load on our chiller
- Fermenters have a natural stagger when they start because of the time it takes to brew beer into them
(~18 hours for a large FV)
- Even a few hours between coolings greatly decreases our maximum chiller load
- Because manual measurements are done in batches, multiple tanks tend to move to the next step at the same time
- We have *predictions* for all the fermentation steps prior to cooling that can help retain the initial spacing



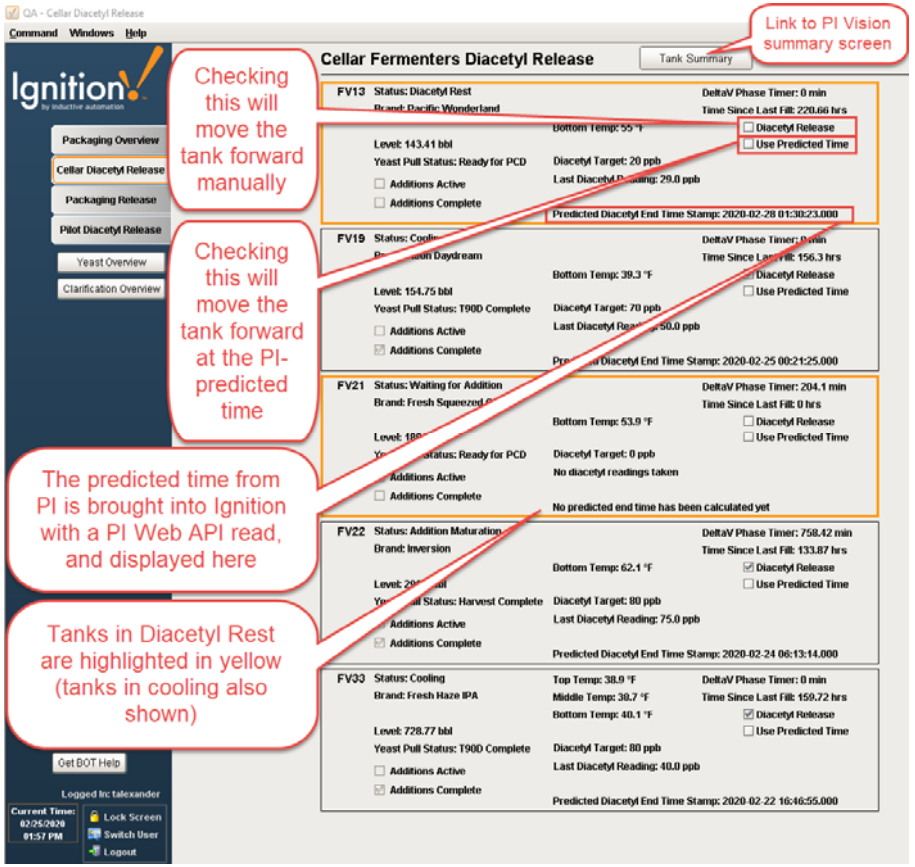


Predictive Analytics - Architecture



Operationalizing Predictions

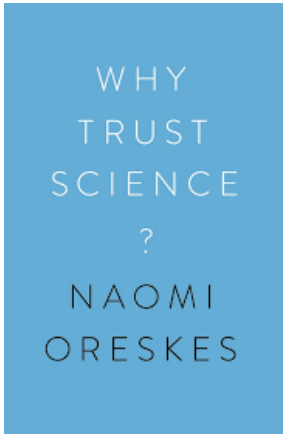
- Added architecture for reacting to the predictions
- Predicted transition times brought into Ignition via PI Web API
- Displayed for lab personnel with tanks filtered and highlighted based on status
- Ability to move tanks forward to cooling manually or using the predictions with the click of a button
- Process control writes to DeltaV done via OPC



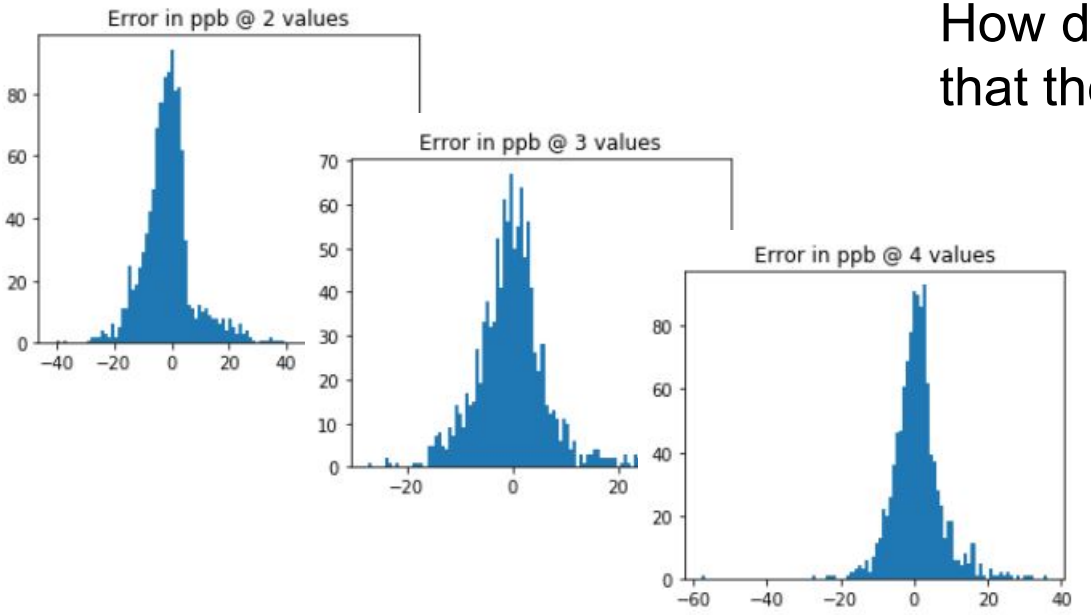
Convincing Operations

Predictions are working and we have made them easy to use. Why aren't they being used?

- **"Predictions are down."** Stability is very important, and with so many interacting systems it is not trivial.
- **"It looks wrong."** Trust must be earned. The Catch-22 is that people won't use it if they don't trust it, but they won't trust it unless they use it and see it works. Much more data is used predict than they use to judge.
- **"I want to see the data it is using."** People do not necessarily understand the scale of the data, and think maybe they can look at the data and get an intuitive feel for how good the prediction is. More trust problems.
- **"Remember that porter tank?"** People will remember failures for a lot longer than successes, even if they are few and far between. Need to focus on, explain, and exclude or adjust for outliers.
- **"We can use it under x, y, and z conditions."** This is one of the hardest objections to overcome, mainly because at first we encouraged it so at least the predictions would be used on some occasions. Be wary of this.



Algorithmic Improvement

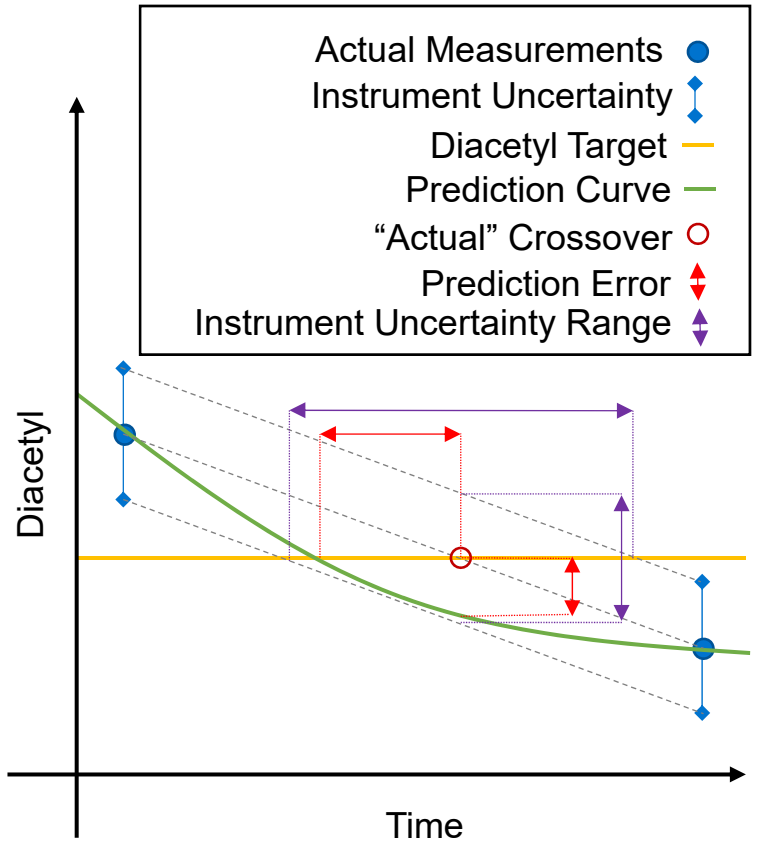


How do we convince Operations that the algorithm is ‘smart’?

1. Establish criteria for success.
2. Develop new or modified concepts for the model and error analysis.
3. Train and test.
4. Demonstrate successes.

Convincing Operations

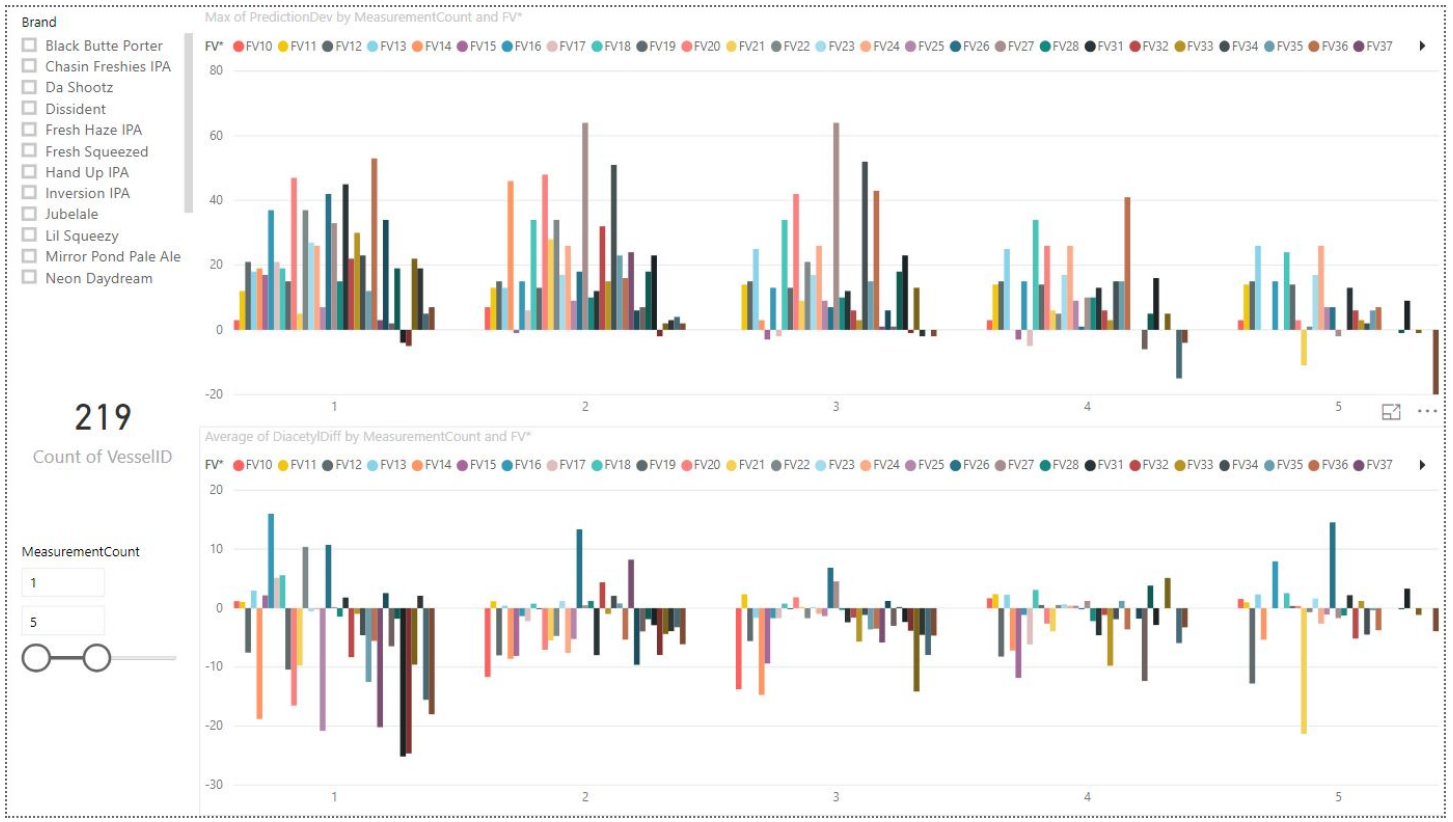
- Because of these reactions, we iterated on our analyses, and also developed analyses to test the effectiveness of the predictions
- Looked back at accuracy both in time, and then in diacetyl ppb, by using recorded data, and linear regression to estimate “actual” crossover times
- Instrument uncertainty is +/- 10PPB at initial measuring levels, and +/- 5PPB at diacetyl rest target levels; showed predictions within this range



Convincing Operations

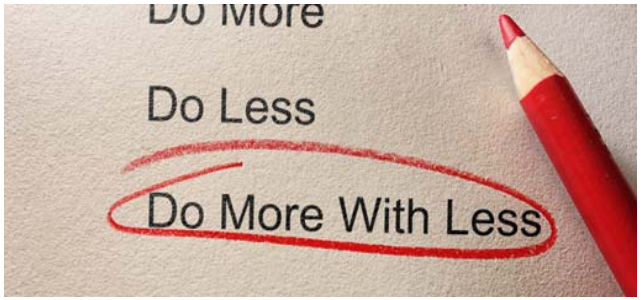
Using a test data set we simulated the prediction output at each measurement input.

Comparison of prediction endpoint at each measurement to real endpoint shows accuracy within instrument uncertainty.



Conclusion

- We have not used the backup chiller for production load support since July 2nd 2019
- We have used diacetyl predictions 38 times and saved 273 hours because of it
- Number of tanks waiting to cool has dropped by 90% since the diacetyl predictions were operationalized – this is partly seasonal as this happened in the fall
- Still working every day to increase prediction usage and increase their accuracy



Next Steps

- Operationalizing Fermentation and Free Rise predictions in the same way as we have for Diacetyl
  - More data with a shorter prediction interval
  - Lower hurdle to clear to convince operations to use
- Continuing to increase Diacetyl prediction accuracy
  - Separate prediction to predict the final diacetyl level of a given fermentation
  - The result of this prediction can then be handed to the current Diacetyl prediction as it is one of the parameters
  - Based on what we have seen with the model, locking in this final level parameter will make the Diacetyl predictions more accurate earlier with fewer data points

Capital expenditure avoidance

DESCHUTES BREWERY

CHALLENGES

- Aging glycol chiller infrastructure in the brewery
- Need to spread out glycol demand: plenty of capacity on average, but peak load is a problem
- Very limited capital budget

SOLUTION

- Using the PI System and the Integrator for Business Analytics we created predictions for ending Diacetyl rest (and starting cooling)
- Operationalizing these predictions with Ignition and DeltaV allows us to get away from cooling tanks in batches based on manual measurements

BENEFITS

- Peak load on chiller reduced
- $750,000 chiller project put off for all of 2019 and 2020.
- Minimal operational expenditure: < $1000/month

"We originally developed fermentation predictions to reduce manual measurements and increase product consistency, but using the predictions also naturally spread out our glycol chiller load, allowing us to put off an expensive glycol capacity expansion for multiple years."

Tim Alexander, Brewery Operations Technology Manager, Deschutes Brewery

Presenters

- Tim Alexander
- Brewery Operations Technology Manager
- Deschutes Brewery
- talexander@deschutesbrewery.com

- Kyle Kotaich
- Senior Data Analyst
- Deschutes Brewery
- kkotaich@deschutesbrewery.com

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