Oil & Gas Industry Energy Collaboration with the Food & Beverage Sector

Panel Discussion Talking Points

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Oil & Gas and Food & Beverage Industries – A Quick Comparison

	Food & Beverages	Oil & Gas (inc. Downstream)
Edible	Yes (mostly)	No (mostly)
Equipment	heat exchangers, heaters, refrigerators, vessels, filters & centrifuges, pumps, compressors, piping	heat exchangers, heaters, refrigerators, vessels, filters & centrifuges, pumps, compressors, piping
Size, tpa	1-1,000,000	10-30,000,000
2014 US Energy Consumption, TBtu	Food: 1113 Beverages: 86	Petroleum & Coal Products (mostly Oil Refining): 4168 Chemicals: 6297
Typical Operating Mode	Batch	Continuous
Process Temperatures, ^{o}F	-10 to 500	-400 to 1400
Process Pressures, psia	0.1-30	0.1-45,000

Thermal Efficiency, Generation, and Storage Themes

- Boiler & Furnace Efficiency
  - ➢Low temperature stack heat recovery
- Heat Integration
  - ➢Simple vs. complex systems
- Utility Systems
  - ➢Integration of renewables
- Thermal Storage
  - ➢Appropriate applications

Process Optimization Themes

- Design Optimization
  - ➢Technologies – e.g., new catalysts
  - ➢Equipment – e.g., separations, saturators
  - ➢Systems – e.g., heat integration
- Real-time Optimization
  - ➢IIoT
  - ➢Smart Manufacturing
- Process Intensification
- Electrification

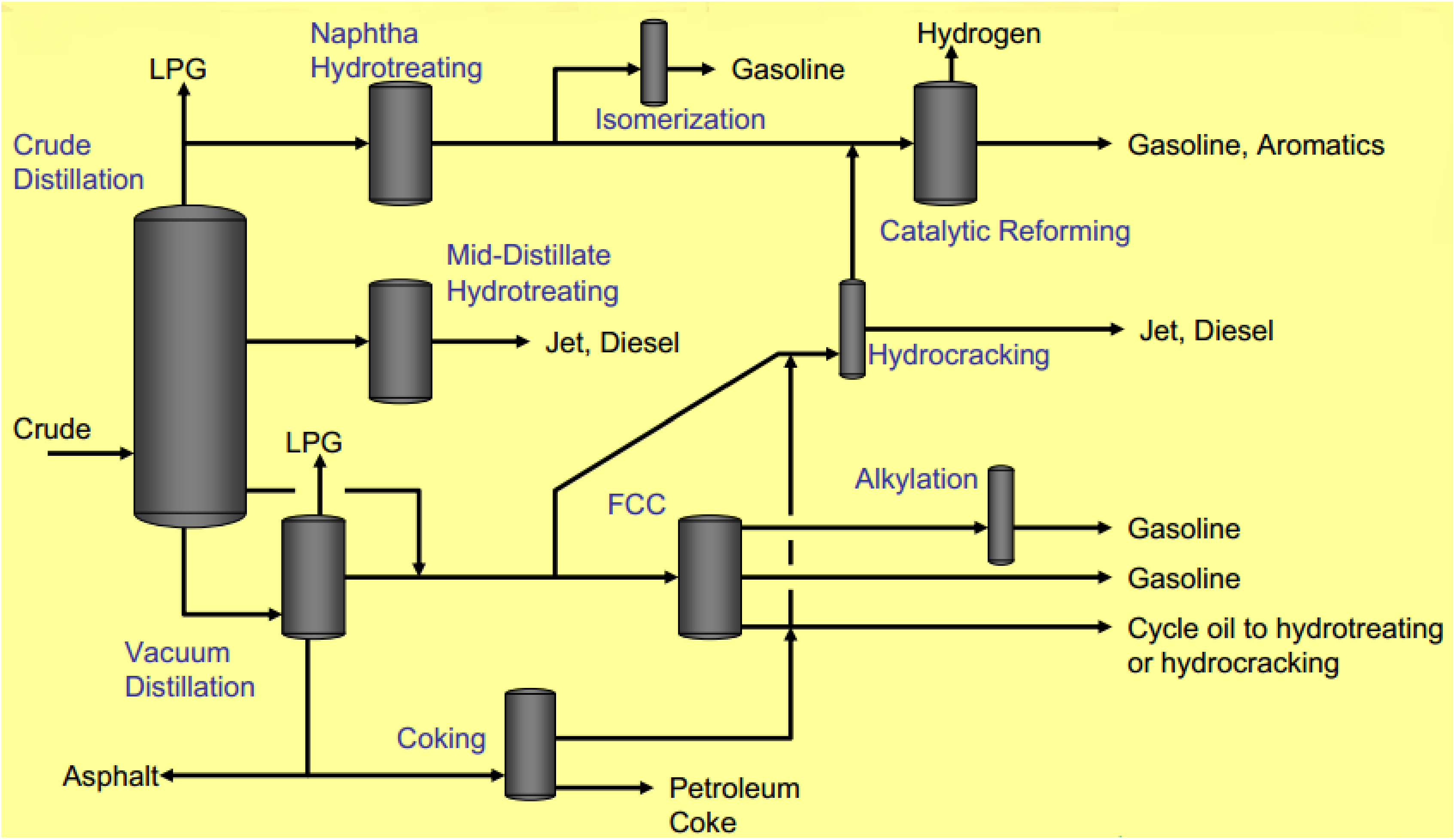
Process Optimization

Martinez Refinery

Janae Adams

CO2 and Energy Coordinator

Generic Overview



Key Considerations

- Continuous operation with maintenance outages every 4-6 years per unit
- Electrification is great, but we have a very old/overloaded electrical infrastructure system ☹
- Oftentimes, saving energy competes against margin on day-to-day operation OR gets lost in the noise, so our main handles are control/automation or major capital projects
- Installing energy recovery equipment can increase backpressure on the process side, which can reach equipment pressure limits or require additional pumping/compressing capacity

Major Energy Users

- Fuel gas to furnaces
- Steam to columns/exchangers
- Steam to generate hydrogen
- Natural gas to COGENs for electrical supply
- Steam-driven turbines

Process Control Opportunities for Fuel Gas Reduction

- Analysers for better O2 control in furnaces
- Heat integration – optimization of this
- Control on energy targets; calculation for opportunity with established target (max or min)
- Pre-heater or economizer to recover stack heat
- Electrification of heaters

Process Control Opportunities for Steam Reduction

- Efficient management of hydrogen system so we don’t over produce
- Compressor control – recycle, surge
- Temperature/pressure control on columns to improve separation efficiency
- Non-optimization but STEAM LEAKS/traps!! -- IoT
- Energy targets; calculation for opportunity with established target (max or min)
- More efficient compressors!
- Make steam system portable
- Process simulation software of steam system (incl. Driver swaps)

Process Control Opportunities – Misc.

- Energy analytics! Identifying and grouping bad actors
- Smart-grid with solar
- Blowdown control

Industrial Energy Efficiency Symposium

Process Optimization

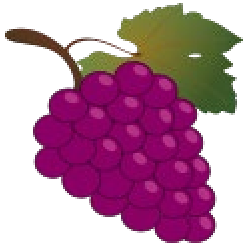
Bob Coleman

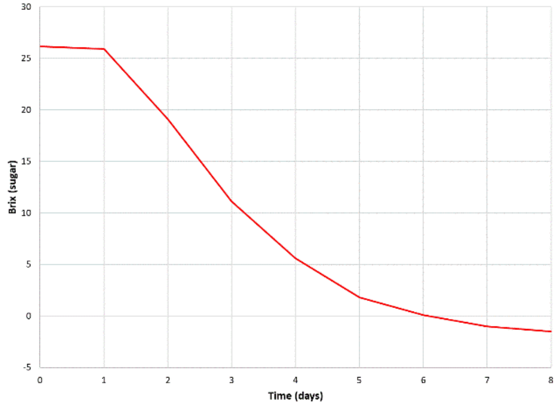
Davis, CA July 31st 2019

Winery Process Flow

Grapes → Crush → to Tank → Fermentation

Crush → Press → to Tank





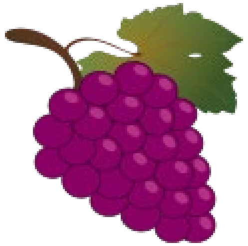
Ageing → Stabilization (heat and cold) → Filtering → Bottling

Stabilization
(heat and cold)

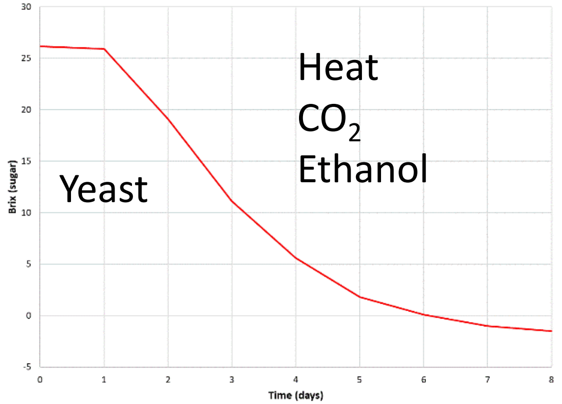
1. Proteins
2. Potassium

Winery Process Flow

Grapes → Crush → to Tank → **Fermentation**



Crush → Press → to Tank



Fermentation → Ageing → **Stabilization (heat and cold)** → Filtering → Bottling

Stabilization (heat and cold)

1. Proteins
2. Potassium

Real-Time Brix Measurements

Real-Time Brix Measurement

Benefits:

- Quality Assurance during fermentation
    - requires high resolution and accuracy (pressure transducers)

Allows for prediction of:

- Fermentation success
- Refrigeration requirements
- CO_2 and ethanol emissions (opportunity for capture)

Allows for optimization of:

- Production (quality, automation, energy, water)

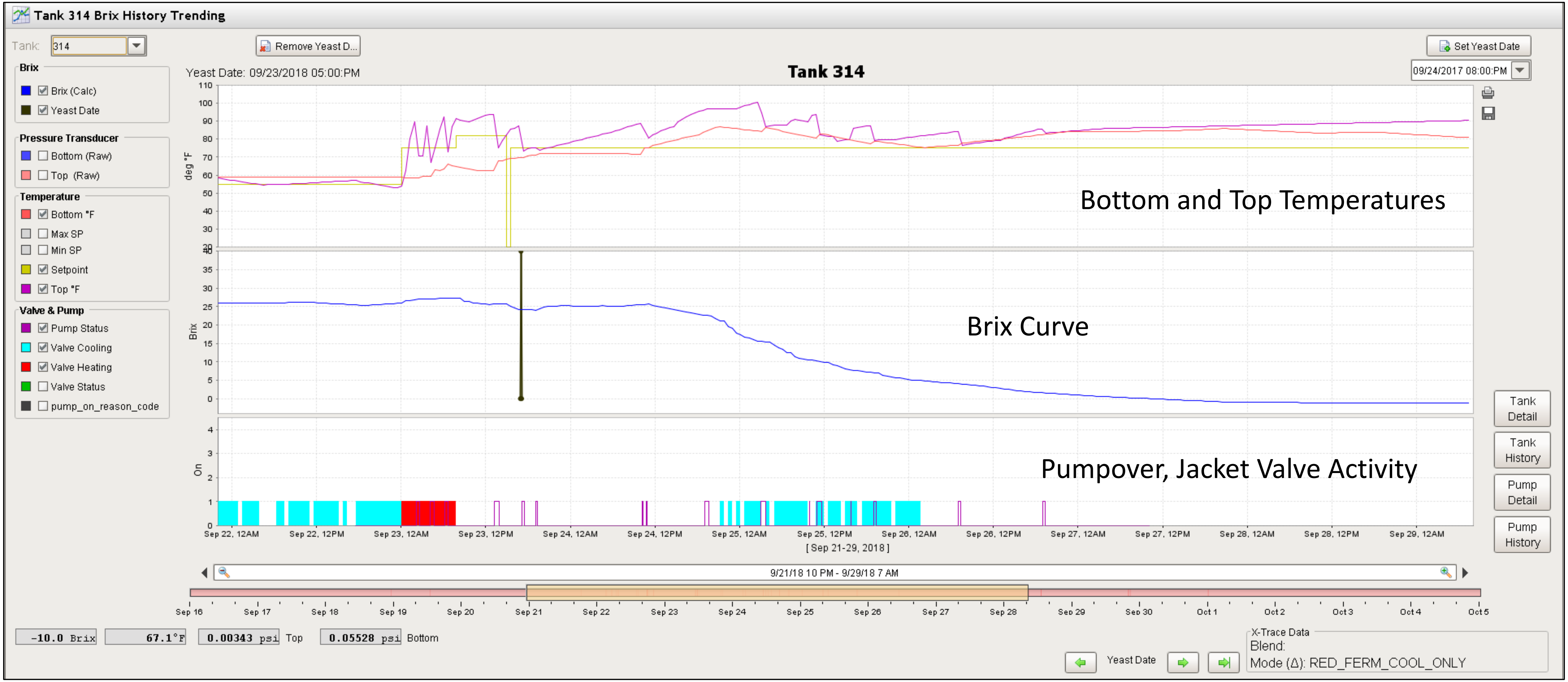
Brix Measuring

Pressure Transducers

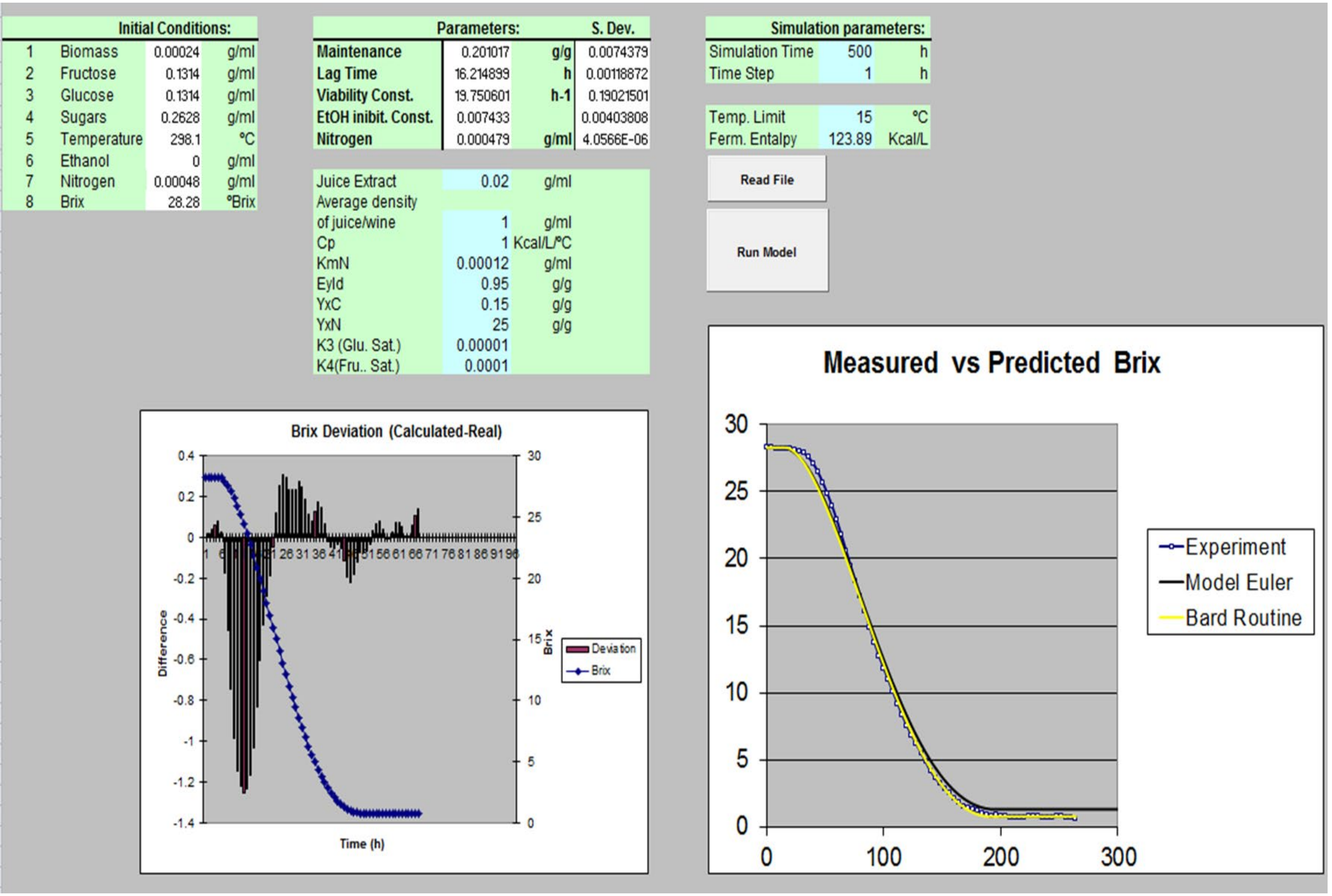
Density = ΔP/h/g

- reduces sampling error
- real-time, not people limited
- Online and able to be shared
  - feedback control for pumpover and cap and tank temperature management

Temperature, Brix, Pumpovers



Brix Modeling



Predict fermentation success from enological parameters and maximum rate calculations

Added benefits:

- predict cooling load
  - refrigeration KW power management
- predict CO_2 emissions
- predict ethanol emissions

Boulton, R. (1980). The prediction of fermentation behavior by a kinetic model. *American Journal of Enology and Viticulture, 31*(1), 40-45.

Cold Stabilization

Fluidized Bed Cold Stabilization

Innovative Tool

- Efficiently cold stabilizes wine
- 'In-place' process crystalizing potassium-bitartrate
    - eliminates a tank to tank wine movement
    - eliminates a tank cleaning
    - reduces water usage
    - less cleaning chemicals/salts to wastewater

- Recaptures refrigeration energy
    - reduces energy usage

- Focal point for winery refrigeration evolution

Pacific Coast Producers

Erick Watkins

Director EHS

Pacific Coast Producers

Tomato Processing and Energy

- The Basics:
  - Tomatoes are approximately 95% water.
  - Our tomato finished products have two primary production processes.
    - Formulated– These products are made by evaporating the water content of the tomato away and concentrating the product. (Sauce, spaghetti sauce, paste etc.)
    - Peeled– We peel these tomatoes and make diced style product lines.
    - Both production models utilize steam and electricity.

Process Flow

- Peeled tomato products are primarily peeled using steam peelers. They are further processed based on product style (diced, stewed, whole etc.).
- Formulated products are run through a variety of processes to evaporate water off the tomato. This is done to concentrate the Brix of the product dependent on product type (paste, puree and juice).
- Canned products are then run through a filler/seamer process to seal the product.
- The final step is a heating/cooling process to ensure food safety.

The Food Energy Concern

- All our processes require steam to function.
- All this steam comes from natural gas fired boilers.
- Why does this matter?
  - Reducing energy usage in steam generation is tough. Steam production techniques have not changed much in the last 50 years. Regardless of fuel type, boilers put pollution in the air. Food production needs steam and thus far tech has not kept up with the sustainability needs of modern food companies. With decarbonization in our future a rapid change is needed.

What has PCP Done?

- Low hanging fruit – Steam trap upgrades, insulation and improved pressure vessels.
- Medium Hanging Fruit - Steam driven turbines
- High Hanging Fruit - New state of the art boilers.
- With these upgrades Pacific Coast Producers reduced our Greenhouse Gas (GHG) emissions by nearly 20% between 2012 and 2019.

Now What?

- Success was followed by questions and an analysis.
  - We replaced a 1972 boiler with a 2017 unit. How much more efficient was it? After the addition of emission controls the new boiler only improved efficiency by about 8%.
  - The remainder of our efforts resulted in significant reductions, but those are now completed and cannot be repeated.
  - What is our next step? Is it possible to decarbonize these processes and still produce food in California?

What is the Answer?

- Problem: Steam is currently the most efficient means of producing food products.
- Food production needs steam and electricity and a lot of both.
- The energy industry has not (yet) produced a technology that can meet our current energy needs (financial and production) and significantly move the needle on efficiency.

Tomatoes and Water

- At the start of this presentation we spoke about what constitutes a tomato.
- 5% solids and 95% water on average.
- In processing a formulated product we evaporate the water off the tomato.
- Where does this water go? It goes to a discharge site. Sustainable? No.
- So the question becomes can we be more sustainable?

YES

- We currently draw water from a well for our production needs. We also evaporate water off tomatoes and discharge it. All this water was being discharged. What did we do?
- We changed. We reconfigured our plant to pull less water from the ground and to reuse more evaporation water wherever possible.
- The results?

Sustainable Water Use

- The average use per day in 2009 was 2.87 MGD
- The average use per day in 2010 was 2.23 MGD
- The average use per day in 2011 was 1.83 MGD
- The average use per day in 2012 was 1.58 MGD
- The average use per day in 2013 was 1.25 MGD
- The average use per day in 2014 was 1.23 MGD
- The average use per day in 2015 was 1.21 MGD

Can Improvement Continue

- Good question?
- We reduced our water usage by over 50%. Since that point we have only had low level incremental improvement.
- Impediments?
  - Cost
  - Technology
  - Need