Optimizing Energy Consumption in a Biofuels Plant

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Step Wise Methodology for Energy Management

- This presentation is based on a several years of communications with customers in the process industries and is a summary of those observations that are adapted to the biofuels industry.
- Energy management is a widely discussed and broadly defined subject and this discussion will focus largely on power monitoring and asset management as it relates to process applications.
Power Monitoring & Data Collection Strategy

**Requirements**

- Reduced operating costs
- Identification of power reserves in the consumer-side distribution network
- Integration into existing operations
- Understanding the amount and quality of power provided from the utility

**Today:** data collection is often done with paper and person taking manual measurements

**Added value**

- **Reduced operating costs**
  - Support of the energy purchaser
  - Savings thanks to reduced demand rates
- Improved energy cost awareness
- Optimized capital expenditures
- Identification of energy-intensive consumption devices
- **Increased system availability**
  - Maximized operating hours
  - Avoidance of overload situations
  - Optimized maintenance expenditures

Power management system – for a more efficient use and maintenance
Load Management – Expected Average Power

The basic functionality of load management is to calculate a forecast, i.e. **expected average power** until the end of a time period based on the current consumption. This value is compared with the given power limit. Depending on this result, pre-defined loads are switched off or on, stagger startups, idle processes based on your priority list.

- The goal is to **keep the power consumption within the power limits** set by the utility to avoid costly demand charges.

- Then **perform “Automatic” Switching & Alarming** according to a preset priority list and rolling sequence. A priority list table can support individual or groups of devices that can be switched at the same time.
Example Load Management Screen
– notice the load
Example Load Management Screen
– Multiple loads Offline to reach target
Cost Allocation & Duration Reporting—
Help you understand your production energy costs

- Cost Allocation by devices, areas, buildings and more.
- Fixed energy rates with holiday deviations can be used to calculate the energy usage.
- Reports can be supplied in Excel and data can be stored in the control systems database.
Demand Management & Cost Allocation
Boiler, Lighting and Utility Strategies

- New efficiencies from modernization cut hundreds of thousands of dollars in operating costs and **paid for itself in only 3 months** on the (3) 35,000 pound steam boilers
- Mechanical, safety and automation upgrades including alarm management and reduced manual reporting were outcomes of the project
- Ability to **monitor how long they were peaking** – shut off three general ventilation units and 500 lights that they did not need
- **Tuning** the boiler reduced the amount of steam produced by 5 – 8 million pounds per year and with specifically targeting trends and stopping deviations they have reduced steam production up to 30% and fuel costs 18%.
- Overall the project has made them **20% more efficient** in their operations at Ellis Hospital, Schenectady, NY

Integrated Boiler Strategy
With process demand

New Lighting Strategy
Large oil company tank farm investigated their main pumps and found they were using the wrong operating point.

The surplus energy was dissipated mechanically by slides and valves.

They relooked at the process adding drives and found an energy savings of approximately $35,000 per year.

The pipe network has been relieved of the mechanical impacts that occurred in the prior design thus reducing maintenance costs and increasing system availability with a drive system.
Pumps such as Blackmer’s ProVane sliding vane pumps offer a high level of energy savings thanks to their **volumetric efficiency**, consistent performance over time and high mechanical efficiency.

- Under many operating conditions there is no bearing wear because the shaft rides on a **fluid boundary** to eliminate bearing-to-shaft (metal-to-metal) contact.
- Because friction is significantly reduced, heat build-up and energy loss are greatly reduced resulting in higher mechanical efficiency and energy savings.
- In fact, sliding vane pumps are up to **24%** more efficient than gear pumps on thin to moderately viscous fluids found in biodiesel transesterification, separation, recovery and purification wash/dry applications.
Purchasing Efficient Motors, Running them Effectively, Avoiding Peak Demands, Predictive Maintenance Saves Energy

Monitoring the operations helps maintenance: motor tripping so take 1 minute snap shots of amps on all 3-phase & detect maintenance need (filters) or mechanical wear proactively
Power Monitoring and asset motor management provides preventative and predictive maintenance to help reduce trouble shooting time, avoid lost production & decrease energy usage.

- Voltage fluctuation can cause degradation in motor winding
- Lowering voltage cause excessive current draw may result in decreased motor efficiency
- Winding problems can be identified with individual line currents
- Iron saturation can cause excessive heat to build-up, resulting in degradation of the winding insulation
Cost Savings Opportunities Are Driven by Energy Use Reductions

Replace motors as they fail with premium product

Analyze motors in service and replace low efficient units with NEMA Premium before they fail

Continue to repair motors Paying higher energy costs

Evaluate and tune complete motor system and sizing
Look to new technologies like the copper rotor motor to find more efficient options even on smaller motors.
Motor Operational Efficiency Needs to Be Measured Over the Life of Your Investment

50 HP example over ten years
- Repair motor cost = $1,114
  - Energy use per year = $24,687
- Replacement cost = $2,080
  - Energy use per year = $23,683
  - Energy savings per year = $1,184
  - Year to pay back = 0.8
  - Ten year savings = $11,841.27
  - The ROI is over 400%

Based on $.15 at 4000 hours per year no peak charge included
4.5 point of efficiency spread
Chipper & Shredder in Sugar Cane Applications – Traditional Approach with Turbine

Range: 1500 ~ 10,000 HP
Application: Chipper

Range: 1500 ~ 10,000 HP
Application: Shredder
Shredder

**Range:** 1500 ~ 10,000 HP

**Drive:** How we can start motor?

This picture shows the oldest solution, by turbine.
How we can start the Chipper and Shredder Machines?

Let’s talk about some possibilities:
Classic Starts
DOL 13.8 KV or 4160 KV
Slip Ring Motors (high torque)
Starting with Softstart, really not good, because the low torque available during the starting time.
DOL (Direct On Line)

In some installations the generator can’t support this motor starting. The reason is the voltage drops more than 10%, sometime will be up to 25%, it will be impossible to start, the plant generator goes to trip.
Solution with Slip Ring Motor

Outdated solution.
In sugar and Ethanol Plant, we can replace all the slip ring motor application to squirrel cage motor and drive.
Slip Ring Motor needs regular maintenance.
Alternative Solutions

1. Starting using MV Drive, using only one drive to two Motors – Chipper and Shredder.
2. Starting with Pony Motor
3. Starting using two drives, one to chipper and other to shredder, better control, optimize the power, efficiency – $\eta$, Power Factor – p.f.
Cooling Tower – suggestions for operations/monitoring

- Efficiency and Operations of the motor
- Measuring inlet and outlet temperatures of chiller to watch efficiency
- Slow the fan
- Integration with basic process automation system to coordinate with demand & environment
Heat Exchanger Fouling
Use predictive tools to measure decreased efficiency

• Uses more energy when fouling

• Monitor for attributes that are leading indicators of degraded operations
Energy Savings with Heat Exchanger Operations

Plant Example: 100MGPY Dry Grind Corn Ethanol Beer/Mash Interchanger
Application: losing five degrees of heat from the Beer going to distillation vs. original spec
Calculations of Costs

$230,260 / Yr added cost

\[ Q = \text{Mass Flow} \times \text{Specific Heat} \times dT \]
\[ 880,000 \times 0.89 \times 5 = 3,916,000 \text{ Btu/h} \]

Assuming $7/Million Btu in Natural Gas cost
\[ $7 \times 3.916 \text{ M/Btu} = $27.41 /\text{h} \]
\[ $27.41 \times 24 \text{ hours} \times 350 \text{ days of operation} \]
\[ $230,260 \text{ dollars per year.} \]

• The 3.9MBtu/h would need to be removed from the Mash going to fermentation; a major issue during the peak summer months.

• Options include: Add instrumentation, revised CIP procedure and added heat transfer area potentially resulting in a savings of twice the above costs

Courtesy:
John Robertson
Alfa Laval
Energy Reduction from Managing Air Consumption
Diagnostics and Condition Monitoring
Monitor loaded and unloaded compressor usage - Membrane Leakage
Understanding the Costs of Air Consumption

Low air consumption

- A valve positioner that does not use an I/P or spool valve rather a piezo valve which decreases the air consumption by the device
- Positioner Bleed Loss (Electrical Energy) - - - - Approximately $74 / yr
- Per D.O.E. the cost of electrical energy is only about 2/3 of the total cost to generate, filter, dry & lubricate a cubic foot of air at 90 psig.
- Approximate balance of total cost is: $37 / yr / positioner
- Annual Cost For using a positioner bleeding at @ 90 psig is: $111 / positioner
Optimizing Energy Consumption in an Ethanol Plant

Conclusions:

• Monitor your energy input

• Demand Management and Cost Allocations – to understand your needs, avoid peaks and assign costs

• Utilize power monitoring, process knowledge and diagnostic tools to help determine where you can save energy and reduce maintenance

From finite reserves...

... to infinite possibilities.