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Protein Producer Saves 25% in Energy Costs with AI Process Optimization

Value-Driven Benefits

25%	**$9M+**	**24 weeks**
Estimated annual energy savings for ammonia refrigeration systems through optimal compressor usage	Estimated annual economic benefit when C3 AI Process Optimization is deployed across all operational footprint	To initial production deployment, configured for the ammonia refrigeration systems and its compressors

Introduction

A leading, vertically integrated North American protein producer operates over 40 protein processing plants across the globe. However, the company lacked an effective method to track and manage its facilities' energy usage and aimed to implement an AI-driven solution to reduce its global energy consumption and costs, starting with its most energy intensive systems – the ammonia refrigeration systems.

Challenges

Ammonia refrigeration systems and its compressors are essential for maintaining cold operating and storage temperatures but are one of the main drivers of energy consumption in protein processing. Due to stringent regulations and to avoid any risk of temperature increase, plants run compressors at full capacity even when ambient temperatures are low and invest in 100% backup compressor redundancy. However, poor load balancing of compressors led to higher energy consumption and increased maintenance cycles.

Moreover, the plants depended on OEM systems to monitor refrigeration health. However, these conventional systems were difficult to navigate and lacked the analytical tools to project and recommend optimal process parameters based on historical and

real-time data. Consequently, engineers reacted in real-time to abrupt changes in ambient temperatures and resorted to costly short-term risk mitigation strategies.

Solution

To address these challenges, the company partnered with C3 AI to implement C3 AI Process Optimization, an AI-enabled application to optimize its energy consumption. Within 24 weeks, the C3 AI and customer team configured and deployed C3 AI Process Optimization at one of its processing plants to recommend optimal process setpoints every four hours for the ammonia refrigeration system. With C3 AI Process Optimization, the operators gained a comprehensive view of all the decision variables and a new capability to predict maximum consumption load every four hours to optimize energy usage continuously.

Results

During the initial production deployment, C3 AI demonstrated that C3 AI Process Optimization can help the company save over 25% in energy costs for its ammonia refrigeration systems. When deployed across its operational footprint, the company anticipates C3 AI Process Optimization will help it achieve up to $9M in annual economic benefit from energy cost savings and improvements in operational efficiency.

Challenges

Prior to partnering with C3 AI, the company had limited resources and capabilities to track energy usage and capture energy savings. Due to the limitations in tools and analytics and to avoid any risk of temperature increase, process engineers and production personnel often resorted to conservative settings for the ammonia refrigeration systems and rarely adjust setpoint settings to accommodate for changes in ambient temperatures.

Furthermore, to avoid the risks of compressor failure and production downtime, the company made substantial capital investments to ensure 100% backup compressor redundancy at the plant. However, poor load distribution among the compressors resulted in higher energy consumption and contributed to faster degradation of the systems and increased maintenance costs.

Additionally, operators depended on conventional OEM systems for decision-making and had to navigate across multiple screens to obtain an accurate snapshot of the system state. However, these systems lacked the necessary analytical tools to project future compressor load and set process parameters based on historical worst-case scenarios to help operators balance compressor load in near real-time.

Approach

To address these operational inefficiencies and constraints, the company partnered with C3 AI to implement the C3 AI Process Optimization. The C3 AI team began by virtualizing, normalizing, and unifying over six months of historical data from more than 200 sensors, along with operating manuals, piping and instrumentation diagrams, and other contextual information.

Next, C3 AI collaborated with customer experts over 2 months to create a digital twin for the ammonia compressor system. To model refrigeration thermodynamics based on Pressure-Enthalpy (P-H) diagrams, the team developed over 15 machine learning models, which included over 100 derived features that captured the complex interactions between various components of the refrigeration system.

Furthermore, the team created a detailed empirical analysis of potential energy savings to determine the optimal recommendation cadence of every four hours. The team then developed a forecasting model to predict worst-case load every four hours based on weather forecast data to optimize compressor load.

Finally, the C3 AI team configured the application user interface based on user specifications, including KPIs such as kilowatt-hour energy savings and greenhouse gas emissions reduction, a visual representation of the process flow and a single-pane-of-glass view of the system state.

By integrating process setpoint recommendations for various components of the compressor such as suction pressure, slide valve position, compressor on/off combinations, and discharge pressure, C3 AI team demonstrated that C3 AI Process Optimization can help the plant achieve up to 25% energy savings annually for the refrigeration system.

About the Company

- 40+ protein production facilities
- 600 GWh in annual energy consumption for ammonia refrigeration systems
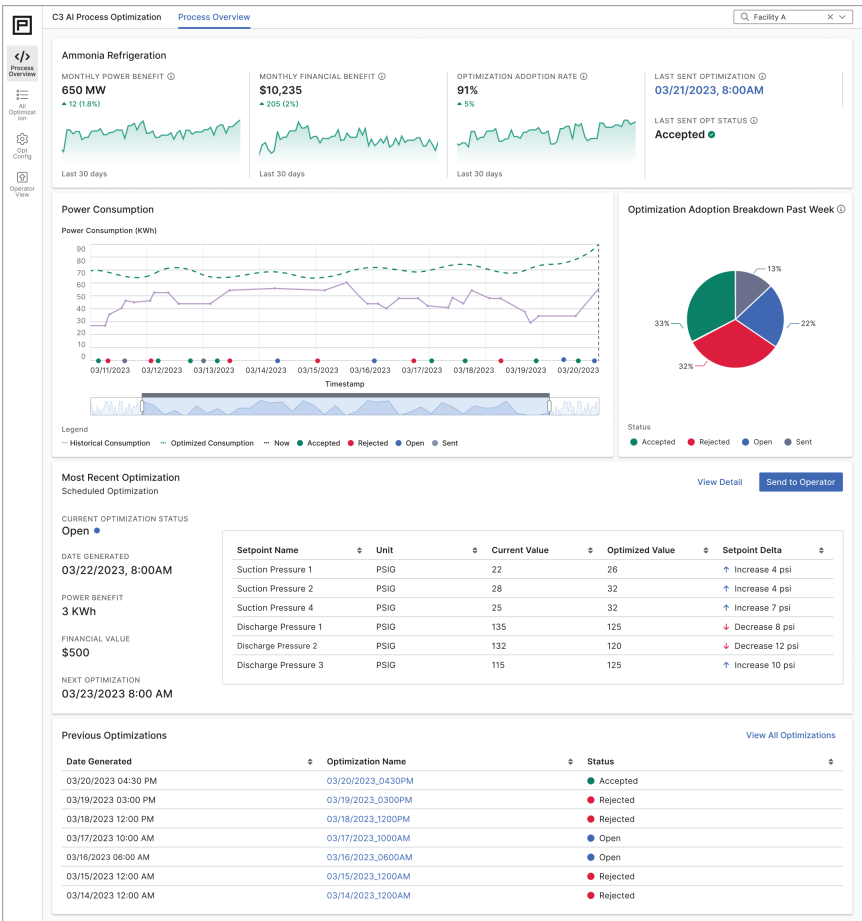- 30,000+ employees

Project Highlights

- 24-week initial production deployment
- 200+ sensors and historical minute-level data integrated from across the refrigeration system
- 15 ML models with 100+ underlying novel features developed to track and simulate the refrigeration system
- C3 AI Process Optimization application user interface configured
- 24 users trained

Solution Architecture

C3 AI Process Optimization

Enterprise Data

- Sensor Data
- P&ID Diagrams
- Operating Manuals
- Asset Hierarchy
- PLC Data
- Maintenance Data

C3 AI Process Optimization   Process Overview   Facility A

Ammonia Refrigeration

MONTHLY POWER BENEFIT	MONTHLY FINANCIAL BENEFIT	OPTIMIZATION ADOPTION RATE	LAST SENT OPTIMIZATION
650 MW	$10,235	91%	03/21/2023, 8:00AM
▲ 12 (1.8%)	▲ 205 (2%)	▲ 5%	LAST SENT OPT STATUS
Last 30 days	Last 30 days	Last 30 days	Accepted ✓

Power Consumption

Power Consumption (KWh)

Timestamp

Legend — Historical Consumption   ⋯ Optimized Consumption   ● Now   ● Accepted   ● Rejected   ● Open   ● Sent

Optimization Adoption Breakdown Past Week

13%
22%
32%
33%

Status ● Accepted   ● Rejected   ● Open   ● Sent

Most Recent Optimization
Scheduled Optimization   View Detail   Send to Operator

CURRENT OPTIMIZATION STATUS
Open ●

DATE GENERATED
03/22/2023, 8:00AM

POWER BENEFIT
3 KWh

FINANCIAL VALUE
$500

NEXT OPTIMIZATION
03/23/2023 8:00 AM

Setpoint Name	Unit	Current Value	Optimized Value	Setpoint Delta
Suction Pressure 1	PSIG	22	26	↑ Increase 4 psi
Suction Pressure 2	PSIG	28	32	↑ Increase 4 psi
Suction Pressure 4	PSIG	25	32	↑ Increase 7 psi
Discharge Pressure 1	PSIG	135	125	↓ Decrease 8 psi
Discharge Pressure 2	PSIG	132	120	↓ Decrease 12 psi
Discharge Pressure 3	PSIG	115	125	↑ Increase 10 psi

Previous Optimizations   View All Optimizations

Date Generated	Optimization Name	Status
03/20/2023 04:30 PM	03/20/2023_0430PM	● Accepted
03/19/2023 03:00 PM	03/19/2023_0300PM	● Rejected
03/18/2023 12:00 PM	03/18/2023_1200PM	● Rejected
03/17/2023 10:00 AM	03/17/2023_1000AM	● Open
03/16/2023 06:00 AM	03/16/2023_0600AM	● Open
03/15/2023 12:00 AM	03/15/2023_1200AM	● Rejected
03/14/2023 12:00 AM	03/14/2023_1200AM	● Rejected

Proven Results in Initial Production Deployment
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