Fero Labs

Industrial Use Case Playbook

Ammonia Process Energy Minimization

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Together we'll build a sustainable tomorrow

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Introduction

Welcome to the **Industrial Use Case Playbook**, crafted by Fero Labs for the forward-thinking professionals dedicated to enhancing factory production optimization.

Whether you're a Data Scientist, Process or Production Engineer, Quality or Plant Manager, this playbook is tailored to equip you with the strategies, insights, and tools necessary to drive transformative change within your organization.

In today's rapidly evolving industrial landscape, maximizing production efficiency and minimizing operational costs are imperative for maintaining competitiveness and sustainability.

Within each of our industrial playbooks, we present a curated collection of use cases designed to address the specific challenges faced by modern manufacturing facilities. Each use case is meticulously crafted to deliver tangible outcomes, ranging from increased productivity and quality to reduced waste and energy consumption to help achieve sustainability goals.

Featured within these pages is a use case which spotlights **Ammonia Process Energy Minimization for chemicals plants.** This case exemplifies how to tackle complex production optimization challenges head-on, leveraging data-driven approaches to drive measurable improvements in operational efficiency and cost-effectiveness.

As you embark on this journey for operational excellence, we encourage you to approach each Fero Labs use case scenario with curiosity, a willingness to embrace innovation and change.

By harnessing the power of your production data, domain knowledge, and collaborative problem-solving, we believe that you can unlock the full potential of your factory's production capabilities.

Together, let's redefine what's possible in industrial manufacturing and pave the way for a future of unprecedented productivity and sustainability.

Welcome aboard,

Fero Labs

Industry Overview

In the realm of chemical manufacturing, optimizing energy usage is essential for maintaining competitiveness, reducing costs, and minimizing environmental impact. Chemical plants, which encompass a diverse range of processes, rely heavily on energy-intensive operations to produce various chemicals, fertilizers, and other products essential for numerous industries and everyday life.

The global chemical industry serves as a critical driver of economic growth and innovation, providing the foundation for countless downstream sectors, including agriculture, pharmaceuticals, and manufacturing. With increasing demands for sustainability, energy efficiency, and cost-effectiveness, chemical manufacturers face mounting pressure to optimize their processes while meeting regulatory requirements and customer expectations.

However, the operation of chemical plants presents unique challenges for energy management, particularly in processes involving highly energy-intensive operations such as ammonia production. Ammonia, a key component in fertilizer production and various industrial applications, is typically manufactured through the Haber-Bosch process, which requires significant amounts of energy to convert nitrogen and hydrogen into ammonia.

One critical aspect of optimizing ammonia production processes lies in **Ammonia Process Energy Minimization**. This approach involves implementing strategies to **minimize energy consumption, improve process efficiency, and reduce greenhouse gas (GHG) emissions** while maintaining product quality and meeting production targets.

By leveraging advanced process modeling, real-time monitoring, and data analytics, chemical plants can identify opportunities to optimize energy usage, streamline operations, and enhance overall process performance. Key initiatives may include optimizing reactor conditions, improving heat integration, and implementing energy recovery systems to capture and reuse waste heat.

Ammonia Process Energy Minimization not only enhances operational efficiency and cost-effectiveness but also contributes to sustainability goals by reducing energy consumption and greenhouse gas emissions. By implementing energy-efficient technologies and best practices, chemical manufacturers can achieve significant savings in energy costs while reducing their environmental footprint. At Fero Labs, we refer to this as Profitable Sustainability.

Industry Challenges

In Industry 4.0, the promise of digital transformation often gets stuck in **"pilot purgatory,"** with **70% of initiatives failing to progress beyond testing phases**. McKinsey's research highlights that the choice of use case significantly impacts this phenomenon.

Selecting use cases that lack strategic alignment, clear value propositions, or encounter technical barriers contributes to pilot initiatives' failure.

Pilot purgatory not only wastes resources but also risks eroding confidence in digital transformation efforts. To navigate this challenge, organizations must strategically select use cases closely aligned with their objectives, offering clear pathways to value creation and scalability.

In each **Fero Labs Use Case Playbook**, we explore industrial use cases designed to address modern manufacturing challenges. Leveraging advanced analytics, AI, and machine learning, these use cases aim to drive tangible improvements in operational performance, cost-effectiveness, and sustainability.

By focusing on strategic and transformative use cases, organizations can break free from pilot purgatory and unlock new opportunities for growth and innovation.

Use Case Description

Background

The Haber process, a continuous chemical reaction, trades off yield maximization and energy efficiency. Through regulating parameters like temperature and pressure in the reaction between nitrogen and hydrogen over iron catalysts, ammonia production can be optimized. This process is highly energy-intensive, with ammonia synthesis accounting for 1.8% of global energy consumption. It's recognized as the largest carbon dioxide-emitting chemical process.

Problem

Process engineers are aware of production conditions that promote the forward reaction in the Haber process to maximize yield. This awareness will be in the form of experience as well as empirical historical data. Energy efficiency steps may be in place too but again these are typically implemented based on experience and historical trends.

Yield maximization is a critical aspect of the Haber process. The reaction is highly exothermic and reversible, and the ultimate yield of ammonia is influenced by various factors, including temperature, pressure, catalyst selection, and gas composition. Adapting these factors to maximize high yields **under varying production conditions, is challenging to do in real-time**.

While maximizing yield, process engineers also endeavor to maximize energy efficiency. Typically this is tackled by minimizing the cost of compressing feed gas by controlling for recycle and feed compressor ratios, operating conditions, etc. Additionally, engineers wish to reduce CO_2 emissions by minimizing the amount of methane burned to produce steam for the steam reforming reaction.

Problem Summary

Maximize ammonia yield while minimizing energy consumption and CO_2 emissions.

Ammonia production is incredibly energy intensive, predominantly due to steam methane reforming. Improving the energy efficiency of ammonia production is critical to producers. Not least because ammonia, primarily used for fertilizer production today, is increasingly being seen as a zero-carbon fuel. This is because ammonia can act as a medium store and transport for chemical energy, as a transport fuel, and as a store for thermal energy.

The current approach to ammonia yield maximization can lead to:

- financial loss due to unnecessary usage of fuel, and

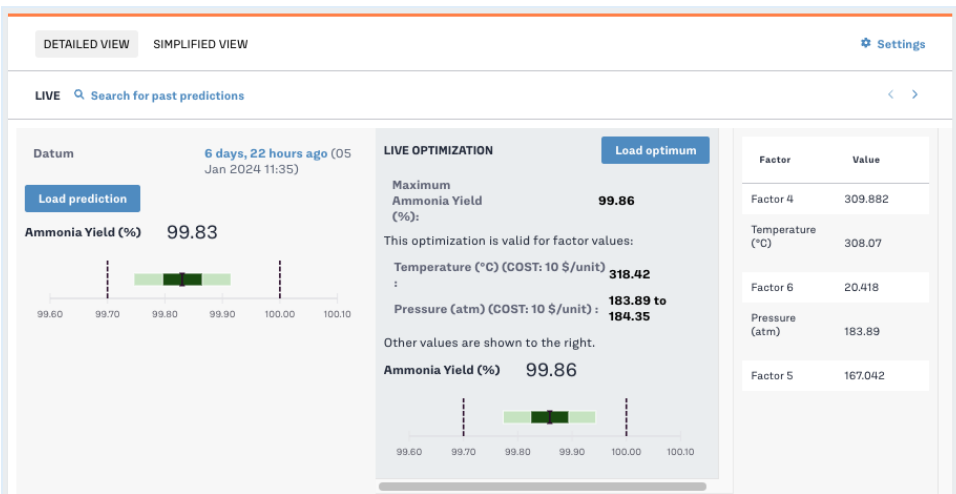
- environmental cost of incurring Scope 2 emissions due to unnecessary consumption of fuel.

Fero Labs Solution

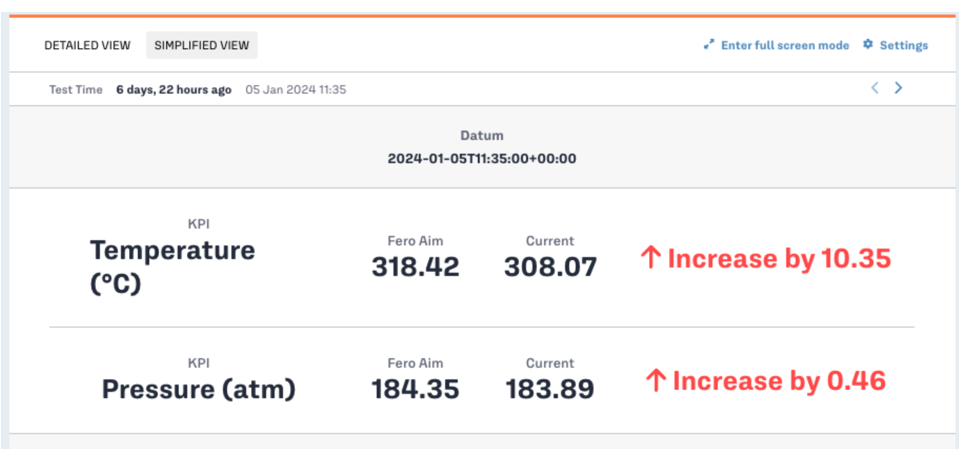
Ammonia producers can use Fero Labs software to ensure maximum yield of ammonia during the continuous Haber process while minimizing energy usage and CO_2 emissions. Fero can adapt to process restrictions such as minimum and maximum permitted temperatures and pressures in reactors, while adapting to variable production conditions.

A "Live Fero Analysis" for this use case presents two screens:

- Detailed View: for **process engineers** to monitor production and take action at any moment. Here, Fero recommends how yield can be maximized under current production conditions. Restrictions can be placed on the maximum allowed values for temperature and pressure, enabling engineers to safely explore energy minimization objectives while continuing to maximize yield.



- Simplified View: for **plant operators** to know exactly what action to take to maximize yield and minimize energy consumption.



Process & Business Outcomes

Increased production line profitability

Maximizing ammonia yield makes the production line more profitable for two reasons: fewer reactants are wasted creating by-products and increased profit potential due to a higher volume of end product being produced.

Ammonia plants leveraging Fero across their operations can expect **up to 1.5%** yield improvement, providing top-line growth opportunity.

Tightened yield control and stability

With Fero Labs providing optimal recommendations for maximizing ammonia yield, the variability of process yield over time will be reduced, allowing for a more efficient and stable process.

With full adoption of Fero Labs on the production line, ammonia plant operators can see up to **10% reduction** in yield variability.

Energy cost minimization

Ammonia plant operators seek to minimize the amount of energy consumed during production. Overly aggressive reduction campaigns deliver diminishing returns as the trade-off involves reduced yields. In turn, unnecessarily high temperatures accelerate catalyst deterioration and carry high costs.

With Fero deployed on an average-sized production line with average energy cost of $0.14/kWh, plant operators can easily surpass **$1 million in savings per year.**

Commensurate Scope 2 carbon minimization

Reducing energy consumption directly reduces the Scope 2 carbon footprint of ammonia production. Since Scope 2 accounts for about one-third of traditional ammonia production's footprint, reducing energy consumption leads to a commensurate **3–4% reduction** in Scope 2 emissions. Fero can provide reporting capabilities that directly track and account for this reduction.

Fero Labs Adoption Timeline

Plant teams can collaborate to set up and deploy Fero. Below is a timeline highlighting typical steps. With Fero's easy-to-use, no-code interface, this can be achieved in a matter of weeks, not months or years.

Time	**Process & Quality Engineers**	**Data Scientists / IT**	**Operators**	**Management**
Week 1	Pull data	Pull data		
Week 1	Upload to Fero			
Week 1	Configure Fero	Configure Fero		
Week 2	Corroborate results	Receive example report showing accuracy		
Week 2	Set up Fero Optimization	Set up Fero Optimization		Receive example report showing savings
Week 3	Live data connection	Live data connection		
Week 3	Live Optimization screen (Detailed view)		Live Optimization screen (Simplified view)	
Going forward	Monitor deployment		Follow Fero Optimization recommendations	Receive regular reports showing savings
Going forward	Run "what-if" scenario simulations, spot check production, run root cause analyses		Follow Fero Optimization recommendations	Receive regular reports showing savings

Use Case Data Requirements

The Fero Labs Platform has convenient integrations into common process information management systems, such as Aveva PI System, AspenTech, Wonderware, and SQL databases, as well as laboratory information management systems, such as SAP, Oracle, and other ERP systems. Initial data exploration can be done either through direct integration into these services, or data file uploads in Excel and CSV data formats.

The data requirements for this use case typically involve the following sources:

Laboratory yield data

- Percentage yield and relevant end-of-line measurements
  - Source: typically LIMS or ERP (e.g., SAP)
  - Content: Liquid ammonia, purge gas flow, measured as frequently as operations permit. (Ideally: CO_2 measurements.)
  - Index: Indexed by time

Process parameter data

- Can be in the form of different tables for different stages of process
  - Source: typically PIMS or LIMS
  - Content: steam reformer temperatures, compression ratios, water gas shift reactor data, methanator flows, heat recoveries, reaction pressures, temperatures, etc.
  - Index: Indexed by time

Activating This Use Case

Consider our **Industrial Use Case Playbooks** as inspiration and tactical ideas for your team to align on to maximize the efficiencies of your plant. Each Playbook has a matching **Use Case Blueprint** which provides detailed steps to activate each use case within the Fero Labs platform.

If you're curious to see these in action please book a use case demo with our team!

Together, let us continue to push the boundaries of what's possible, driving towards a future where industrial manufacturing is not just efficient and sustainable but truly transformative in its impact on society and the world at large.

Thank you for joining us on this journey, and we look forward to continuing to partner with you in your pursuit of excellence.

Sincerely,

Fero Labs

About Fero Labs

Fero Labs helps factories work better together by bridging the gap between the disconnected goldmine of production data and industrial knowledge inside every plant.

The Fero Labs Profitable Sustainability Platform collects data and knowledge, and augments it with powerful Fero ML so factories can make more confident changes that drive profit and sustainability.

Harnessing Fero Labs, a factory creates an augmented workflow which allows for better use of raw and recycled materials, production time, and energy utilization. Teams can work 90× faster, using Fero's AI powered simulated predictions or live optimizations. They can run root cause analyses in minutes, and make continuous process improvements that drive Profitable Sustainability.

Fero Lab's white-box explainable ML makes decisions clearer by showing the context and confidence levels behind every prediction and recommendation. This expands a plant's production knowledge and drives better production results for manufacturers, all while minimizing emissions. Together we'll build a sustainable tomorrow.