Fero Labs

Industrial Use Case Playbook

Catalyst Lifecycle Optimization

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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, 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 **Catalyst Lifecycle Optimization for chemical 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

The global chemical industry plays a pivotal role in driving economic growth and innovation, serving as a cornerstone for various downstream industries, including pharmaceuticals, agriculture, automotive, and consumer goods. With an ever-increasing demand for specialty chemicals, polymers, and advanced materials, chemical manufacturers face mounting pressure to enhance production capabilities while minimizing their environmental impact.

However, the chemical manufacturing process is inherently complex, characterized by stringent safety standards, strict regulatory compliance, and the need for precise control over chemical reactions and process parameters. Challenges such as raw material variability, energy-intensive operations, and waste generation pose significant hurdles to achieving operational excellence and cost-effectiveness.

One critical aspect of chemical manufacturing optimization lies in the concept of **Catalyst Lifecycle Optimization**. Catalysts play a pivotal role in numerous chemical processes, facilitating desired chemical reactions, increasing reaction rates, and improving product yields. However, catalyst degradation over time can result in reduced process efficiency, decreased product quality, and increased operational costs.

Catalyst Lifecycle Optimization involves the strategic management of catalyst usage throughout its lifecycle, from selection and preparation to regeneration and disposal. By leveraging data analytics, process modeling, and advanced characterization techniques, chemical manufacturers can optimize catalyst performance, extend catalyst lifespan, and maximize process efficiency.

Moreover, **Catalyst Lifecycle Optimization** contributes to sustainability goals by reducing raw material consumption, minimizing waste generation, and improving energy efficiency. By optimizing catalyst usage and regeneration processes, manufacturers can **achieve higher yields** with **lower environmental impact**, aligning with both economic and environmental objectives.

Catalyst Lifecycle Optimization contributes to **sustainability** goals by reducing raw material consumption, minimizing waste generation, and improving a factory's production energy efficiency.

By reducing energy consumption, minimizing raw material usage, and optimizing waste management practices, chemical plants can demonstrate their commitment to sustainable manufacturing practices while enhancing their bottom line. 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

Catalysts lower the activation energy for chemical reactions and are often necessary for feasible production at scale. In continuous process chemical production, catalysts progressively lose efficiency. Such catalyst deactivation may be measured in reaction temperatures, analytical product concentrations, and other metrics. Forecasting catalyst deactivation rates enable operators to optimally regenerate/replace catalysts, avoiding unplanned downtime and maximizing profitability. Understanding the root cause of catalyst deactivation enables plants to make operating changes to prolong catalyst lifetime.

Problem

Gradual catalyst degradation is challenging to proactively manage because degradation rates are **too complex to analyze with simple physics-based models**. While direct and indirect measurements of catalyst efficiencies are available, they rarely suffice to provide actionable forecasts of catalyst health. Known degradation modes combined with highly dynamic operating conditions can lead to unexpected but predictable catalyst degradation.

Plant operators use data visualization and analytics software to monitor catalyst efficiencies. Changes in catalyst health prompt reactive actions. Early actions may lead to premature catalyst regeneration. Late actions may lead to unplanned downtime. Both increase costs.

Problem Summary

Forecast catalyst efficiencies across varying process conditions and proactively address catalyst degradation to reduce costs and unplanned downtime.

In ideal conditions, catalyst consumption should be reversible and consistent. In practice, catalysts deactivate due to many reasons:

1. Poisoning: The catalyst comes into contact with a poisoning agent, like sulphur, lead, phosphorous, or other kinds of agents depending on the catalyst. The poisoning agent binds irreversibly to the catalyst and prevents reactants from binding, which deactivates the catalyst. Poisoning events can occur suddenly due to contamination in reactant lines.

2. Coking: Carbon buildup occurs on catalyst active sites, which can happen for a variety of reasons in petrochemical processes. The build up takes up space on the catalyst and therefore removes active sites from binding with reactants.

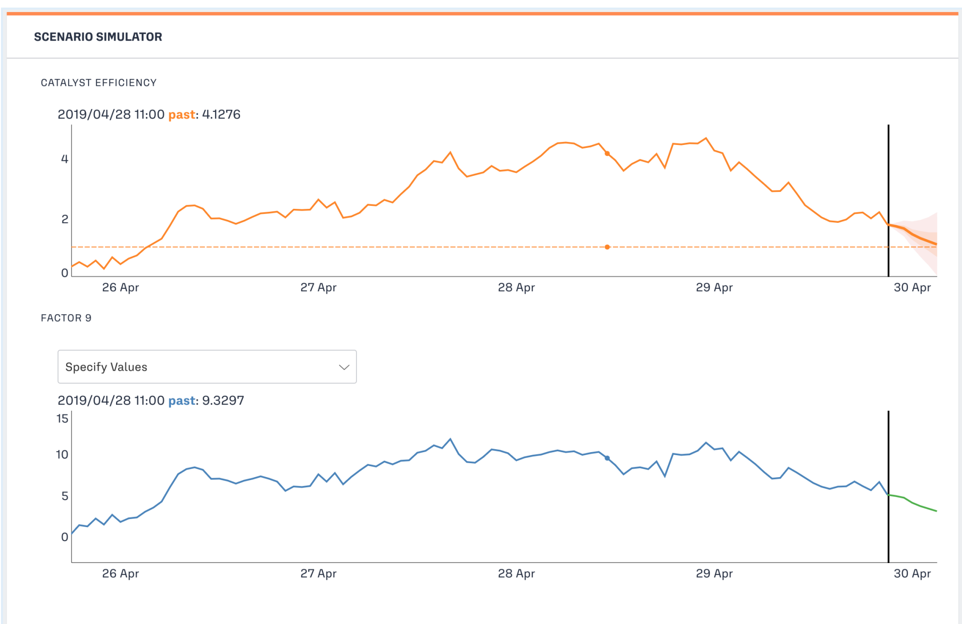
3. Thermal degradation: Temperatures can warp the active sites of the catalyst, which changes their geometry and therefore effectiveness of binding to the necessary reagents. Thermal degradation is oftentimes irreversible.

4. Transport loss: Under certain conditions, molecules present in reactant streams can bind with the catalyst in such a way that they can leech and remove the catalyst particle, and carry it off in the product stream. One such example is the formation of volatile metal carbonyls with CO in methanation reactions.

5. Crushing: The catalyst can sometimes get physically crushed, which irreversibly destroys its active sites.

Fero Labs Solution

A virtual soft-sensor can be configured to predict and monitor the catalyst efficiency at a specific part of production. Fero's machine learning technology can effectively incorporate progressive deactivation, such as coking, thermal degradation, and catalyst lost via transport. By learning how historical process conditions relate to catalytic activity, Fero provides plant operators with **forward-looking forecasts**, that not only enable operators to monitor process conditions, but take action to get the most out catalysts as they inevitably deactivate over time.



Process & Business Outcomes

Increased profitability by extending catalyst lifetime

With the Fero Labs platform providing forecasts for catalyst degradation days in advance, process engineers and plant operators can proactively increase profitability by extending catalyst lifetime. Since process engineers and operators gain access to predictions as early as **5 days ahead of time**, they can proactively adapt rather than react to catalyst degradation caused by dynamic process operating conditions

With a full adoption of Fero on the production line, plant operators can achieve up to **20% extension** of catalyst lifecycles.

Commensurate Scope 3 reduction through reduced catalyst usage

Reducing catalyst consumption directly reduces the Scope 3 carbon footprint of chemical processes. Since Scope 3 accounts for the majority (70+%) of chemicals production, reducing catalyst usage leads to a commensurate **14% reduction** in Scope 3 emissions. Fero Labs can provide reporting capabilities that directly track and account for this reduction.

Informed decision-making to mitigate unplanned shutdowns

Plant operators can be more confident when deciding to initiate an unplanned shutdown or make an operational change when catalyst degradation accelerates. Similarly, they can be more confident of when they achieve steady-state conditions and high catalyst activation.

With a full adoption of Fero Labs software, plant operators can expect to experience up to **36% decrease** in unplanned production shutdowns and startups.

Fero Labs Adoption Timeline

Plant teams can collaborate to set up and deploy Fero Labs. 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 Prediction	Set up Fero Prediction		Receive example report showing savings
Week 3	Live data connection	Live data connection		
Week 3	Live Prediction screen		Live Prediction screen	
Going forward	Monitor deployment	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 catalyst efficiency data

- Catalyst efficiency, as measured through a relevant proxy. Typically involve reaction temperatures, analytical product concentrations, etc. as indexed once every 8–12 hours

Production data

- Process parameters, as relevant to the desired reaction. These may involve mass flow, reactant component concentrations, inlet/outlet temperatures, pressures throughout reactor, gas recycle ratios, reactor feed properties, etc.

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 Augmented Intelligence 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.