Fero Labs

Industrial Use Case Playbook

Heat Exchanger Maintenance Optimization

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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 **Heat Exchanger Maintenance Optimization 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 chemical manufacturing sector, the efficient operation of heat exchangers is vital for maintaining process integrity, ensuring product quality, and maximizing energy efficiency. Heat exchangers play a crucial role in various chemical processes, facilitating heat transfer between different process streams to achieve desired temperature levels and reaction kinetics.

The global chemical industry serves as a cornerstone for numerous downstream sectors, including pharmaceuticals, agriculture, automotive, and consumer goods. With increasing demands for sustainability, cost-effectiveness, and regulatory compliance, chemical manufacturers face mounting pressure to optimize their operations while minimizing environmental impact.

However, the operation and maintenance of heat exchangers present unique challenges for chemical manufacturers. Issues such as **fouling**, **corrosion**, and **mechanical degradation** can compromise heat exchanger performance, leading to **decreased efficiency, increased energy consumption, and reduced product quality**.

One critical aspect of optimizing heat exchanger performance lies in **Heat Exchanger Maintenance Optimization**. This approach involves implementing proactive maintenance strategies to minimize downtime, maximize reliability, and extend the lifespan of heat exchanger equipment.

By leveraging advanced analytics, predictive maintenance algorithms, and condition monitoring techniques, chemical manufacturers can identify early signs of heat exchanger degradation, prioritize maintenance activities, and schedule interventions to minimize production disruptions.

Heat Exchanger Maintenance Optimization not only enhances equipment reliability and process efficiency but also contributes to sustainability goals by reducing energy consumption and minimizing waste. By implementing optimized maintenance practices, manufacturers can achieve higher levels of operational efficiency while reducing environmental impact and operating costs. 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

Heat exchangers play a crucial role in numerous industrial processes and refineries by enabling efficient heat transfer between fluids. They are typically used in continuous production and are consequently exposed to gradual fouling — the accumulation of unwanted materials on the surface of heat exchangers — which can significantly impair their performance. Since the amount of fouling can be difficult to measure, operators typically monitor it by measuring parameters like pressure drop or (overall) heat transfer coefficient, which serve as indirect measures of the overall fouling behavior in the unit.

Problem

The rate of fouling in heat exchanges vary even under consistent operational conditions. This variability presents a significant challenge for **plant operators and managers** in scheduling maintenance of heat exchangers and planning operational shutdowns. This lack of understanding of the root causes behind such differences complicates efforts to predict when maintenance is needed.

Problem Summary

Prolong heat exchanger lifetime by projecting future values of the heat transfer coefficient and presenting a clear timeline for when heat exchanger maintenance should occur.

If not properly maintained, heat exchangers with **high fouling can become a serious operational safety risk**, prompting plant operators to default to a cautious maintenance protocol, opting for regular scheduling of maintenance activities. This strategy tends to reduce the operational cycles of the heat exchanger, leading to frequent, often premature, production halts. Such a strategy comes at significant operational costs. Furthermore, the requirement for various cleaning methods ranging from thermal and mechanical to chemical and steam cleaning adds to the complexity and financial burden of upkeep.

Fero Labs Solution

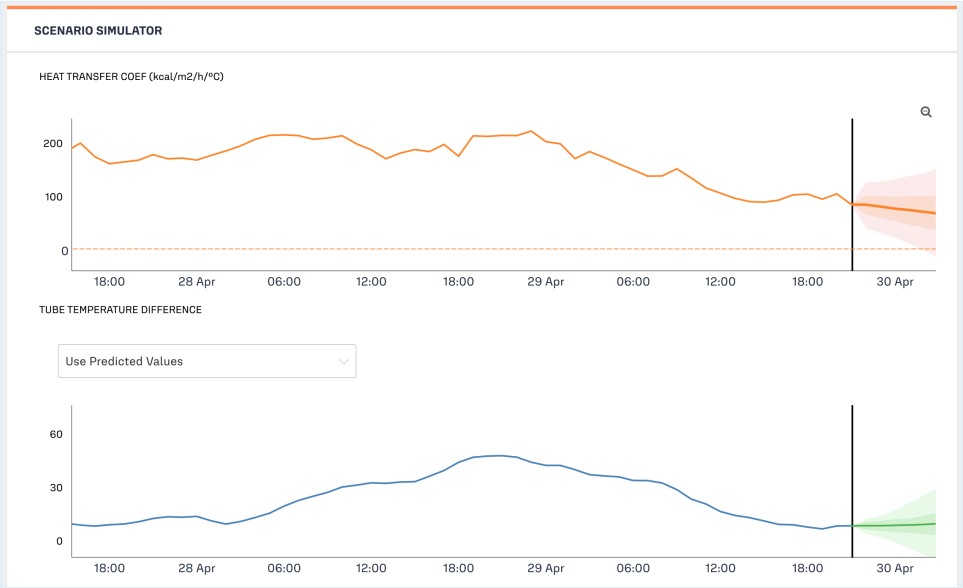
With Fero Labs, plant operators can closely monitor and forecast the heat transfer coefficients of heat exchangers under various operating conditions. More specifically, Fero pinpoints the key operating parameters affecting performance based on root cause analysis and leverages machine learning-based forecasting methods to project future values of the heat transfer coefficient,

providing a clear timeline for when maintenance should ideally occur to mitigate significant degradation due to fouling. This proactive approach, can maximize the operational lifespan of the heat exchanger during each operational campaign.

A “Live Fero Asset” for this use case presents the following interactive screen:

- Forecast view: in the top panel, **plant managers** can monitor past heat transfer coefficients and observe forecasts, with the transition from historical to forecasted data marked by the solid black vertical line. Here, Fero projects how past and current operating conditions and heat transfer coefficients might evolve, highlighting potential increases in fouling that may necessitate maintenance. To aid in decision-making, Fero provides **forecasts surrounded by confidence intervals**. If operators wish to proactively manage fouling risks, they are guided to schedule maintenance when the forecast’s lower confidence boundary intersects with the lower specification limit, as shown by the dashed orange horizontal line.

- Scenario view: in the bottom panel, **plant operators** can monitor the corresponding past operational parameters and observe their forecasts. This allows for the adjustment of forecasted values to assess their impact on projected heat transfer coefficients displayed in the top panel. This enables operators to simulate adjustments in operating parameters or set-point values based on anticipated changes. Moreover, this simulation capability supports the exploration of strategic operational adjustments that could extend the heat exchanger’s operational lifespan.



Process & Business Outcomes

Increased profitability by extending heat exchanger lifetime

With Fero providing forecasts for fouling days in advance, process engineers and plant operators can proactively increase profitability by extending heat exchanger campaign durations. 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 fouling caused by dynamic process operating conditions.

With full adoption of Fero on the production line, plant operators can achieve up to **20% extension** of heat exchanger operational lifetime.

Conduct “what-if” simulations to gauge the effects of process modifications

Fero Assets allow the plant engineers to test **hundreds of different “what-if” operating scenarios** for future time horizons. This is particularly beneficial when operators possess insight into potential adjustments in operating parameters or setpoint values in the next 5 days and seek to understand their impact on the forecasted heat transfer coefficients. By enabling this level of predictive analysis, operators can identify effective strategies that not only prolong the operational lifetime of the heat exchanger, but significantly enhances overall operational efficiency and minimizes downtime.

Informed decision-making to mitigate unplanned shutdowns

Plant operators can be more confident when deciding to initiate a plant shutdown or make an operational change when heat exchanger fouling rates accelerate. With full adoption of Fero Labs software, plant operators can expect to experience up to **36% decrease** in unplanned production shutdowns.

How Fero works for this use case

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:

Heat Exchanger Process Data

- Source: typically PIMS (e.g., PI system, Aspen)
- Content: overall heat transfer coefficient, processed material flow, flow in wall, inlet/outlet temperatures and temperature difference of heat exchanger tube, inlet/outlet temperatures and temperature difference of heat exchanger wall, pressure drop
- Index: Indexed by time

Index	Heat Transfer Coefficient (kcal/m^2/h/°C)	Tube Inlet Temperature (°C)	Tube Outlet Temperature (°C)	Wall Outlet Temperature (°C)	...
timestamp 1					
timestamp 2					
timestamp 3					

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.