HYDROCRACKER UNIT

Application Solutions Guide

THE CHALLENGE

The refining industry market dynamics are global with refined products being shipped around the world creating a competitive environment that is unprecedented in the history of the industry. The hydrocracker unit within a refinery is important to meet low sulfur diesel while taking advantage of opportunistic market conditions between gasoline and diesel, thus this unit needs to operate reliably and effectively. In addition to reliable performance, safety is always a challenge with this unit with high pressures, hydrogen, hydrogen sulfide, fired heaters, and potential reactor temperature excursion.

Today's operational demands require breakthrough performance, and Emerson Process Management can enable refiners to achieve new levels of safe, reliable performance in key operational areas of the hydrocracker units. This same breakthrough performance can also be applied to other refinery units.

Improving Hydrocracker Unit Operations with the Smart Refinery

The Hydrocracker Unit is an essential process for the overall refinery profitability in converting low value heavy feedstock into higher value fuels such as diesel and gasoline. Improved unit operations allows flexibility between gasoline and diesel production by maximizing yield cuts depending on favorable market conditions.

The keys to profitability in Hydrocracker unit operations depend on operational excellence in the areas of safety, energy efficiency, optimal reactor temperature (yield) control, and consistent and reliable unit operations, every day. Emerson has a long history of providing total automation solutions that improve performance in these key operating areas. The result is a competitive advantage that puts you ahead of other refiners in today's global refining marketplace. Read on to see how Emerson can work with you to move your refinery toward top quartile performance with higher reliability, lower maintenance cost, and lower energy consumption per barrel processed.

Performance Challenges	Business Consequence	Improvement Opportunities
Energy Efficiency impacted by: • Tube fouling leading to inefficient heat transfer • Poor combustion air control • Burner tip plugging leading to poor heat distribution	**Increased Energy Costs**	Reduce energy costs through improved measurement of fuel gas flow, heater pass flow, flue gas O_2, CO/combustibles content and tighter control of combustion air.
Hydrocracker Unit Reactor Performance impacted by: • Poor fired heater temperature control for the reactor inlet • Poor hydrogen quench on reactor temperature control	**Shorter Catalyst Life** **Reduced Yield**	Increase quality and yields with better regulatory controls that improve temperature control of the fired heater and hydrogen quench controls
Field Asset Reliability impacted by: • Lack of visibility to rotating and fixed equipment health • Unplanned slowdowns and shutdowns • Reactor excursion with emergency depresurring if asset fails that controls reactor temperature (such as hydrogen quench valve)	**Reduced Production** **Earlier Catalyst Replacement** **Increased Maintenance Costs**	Maximize reliability with device diagnostics to predict field asset failures and enhance visibility into the health of rotating and fixed equipment.
Safety, Health, & Environment impacted by: • Regulatory agency codes and standards • Operator and maintenance training • Inconsistent startup and shutdown practices • Unreliable emissions monitoring	**Increased SH&E Risks**	Improve plant and community safety and operate within increasingly stringent environmental regulations with automation solutions that deliver better measurement, control, and diagnostic information.

Refining Application Solutions Guides are available on the following applications:

Crude Unit Fired Heater **Hydrocracker**

EMERSON™
Process Management

PLANTWEB™ – DIFFERENT, BETTER, AND WHY

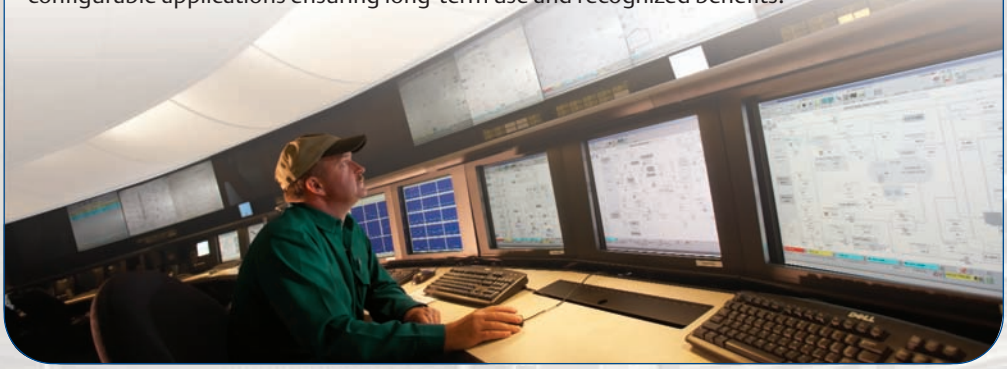
PlantWeb digital plant architecture offers leading edge technology giving you a greater view to your process operations and equipment health. The Hydrocracker unit is the popular choice for a heavy oil conversion unit, upgrading low value oil into cleaner, high value fuel products. Many refineries around the world are adding hydrocrackers to address low and ultra low sulfur diesel requirements while providing some flexibility in product yields between gasoline and diesel.

The key process challenges in a Hydrocracker unit, which can drive down overall refinery performance, are optimizing unit reactor yield (performance), improving overall unit reliability, and increasing energy efficiency, all with safety as a first concern.

Emerson provides best-in-class measurement devices, final control elements, analytical products, safety solutions, asset management, and control systems to address your key operating challenges. The DeltaV™ control system provides regulatory control, APC, and asset management within one platform with a common database, for ease of information distribution, process data correlation, and maintenance. The embedded APC applications, best-in-class regulatory control dynamic performance, seamlessly integrated diagnostics from instrumentation and critical production assets, human centered design of the operator interface, detailed operator training simulators, with a common engineering toolset from basic process control to safety systems, integrated together within PlantWeb, enables you to achieve breakthrough process performance.

Performance

SmartProcess® fractionator optimization applications improve Hydrocracker unit separation efficiency with greater yield flexibility. These applications are pre-engineered, embedded multi-variable control that allows the unit to safely operate closer to constraints without violating them. Although the applications are pre-engineered for faster implementation and lower cost, trained refinery staff is still able to customize, implement, and maintain the configurable applications ensuring long-term use and recognized benefits.



Energy Efficiency

Inefficiency in energy management is one of the greatest contributors of high operating costs. SmartProcess heater optimization combines advanced regulatory and combustion control modules to operate at maximum efficiency while maintaining safe operations. PlantWeb allows you to get the most efficient use of energy by improving heater combustion, managing energy efficiency of process equipment, and operating with tight and robust temperature control.

Reliability

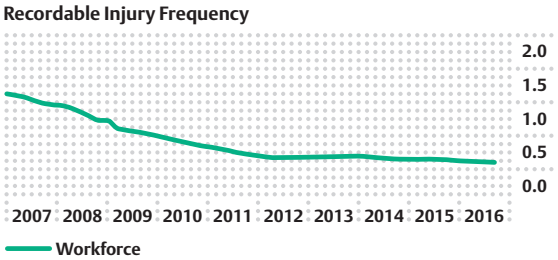
Hydrocracker unit reliability is essential to ensure refinery production. Rotating equipment (pumps, compressors, motors, air fans, etc.) assets fail with greatest statistical severity, causing refinery-wide slowdowns and shutdowns. Poorly performing control valves negatively impact process unit operations and reduce the benefits of APC.

AMS Suite applications also allow for real-time information from critical rotating assets, providing quick access to information on active alerts and events. These applications are tightly integrated with DeltaV, enabling effective decision support to diagnostic viewing for operations and maintenance. Emerson's PlantWeb offerings simplify implementation of predictive maintenance with actionable information required to maintain safe and optimized performance.

Safety

Safety, health, and protecting the environment are top priorities in every operation. There are two reasons that a strong safety, health, and environment program is "Job One" in virtually every refinery: The risks are real, the consequences are serious, and incidents can affect the surrounding community directly.

Emerson provides SIL-rated transmitters, final control elements, and logic solers, as well as the engineering expertise to deliver an integrated safety instrumented system in accordance with your safety requirement specifications.



Customer Proven

"Looking at the results in terms of smooth plant start up and continuous uninterrupted operations, the plant has simply exceeded our expectations. It is operating to our satisfaction and we are happy that we made the right selection of Emerson's PlantWeb architecture with FOUNDATION fieldbus technology."

Zhang HuaPing
Manager, Instrument Team
Fujian Refining and Petrochemical Company Limited (J.V. between ExxonMobil, Sinopec, Saudi Aramco and Fujian Government)

"Emerson's SmartProcess, which includes DeltaV advanced control technology, PredictPro has given us a significant improvement in the Crude Unit operations, both in terms of improved product value and plant operability."

Gheorghe Oprea
Senior Process Control Engineer
Rompetrol Refining

HYDROCRACKER UNIT CHALLENGES

Poor reactor quench temperature control has higher variability resulting in lower yield and shorter catalyst life, reduced feed rate, and higher probability of a temperature excursion requiring an emergency depressuring.

Safe and effective start-up, operation, and shutdown are critical

Environmental impact and energy efficiency depend on good combustion control

Fractionator flooding disrupts operations

Fluctuating fuel gas composition causes operational disturbances

Measurements are missing that enable the ability to fully optimize the plant

Spurious trips caused by malfunctioning instruments and control upsets

Variability in heater outlet temperature causes process disturbances in the hydrotreating section of the reactor, resulting in shortened reactor catalyst life due to poisoning

Operating flexibility to shift between maximizing diesel versus gasoline production is challenging to take advantage of opportunity market demands

Low NOx burners are a maintenance challenge

Pump seal failure can cause a release of hazardous material and possibly fires

You can achieve a safely optimized Hydrocracker unit that is reliable and energy efficient.

Emerson Process Management has the technology and expertise to make it happen.

STRATEGY FOR A SMART REFINERY

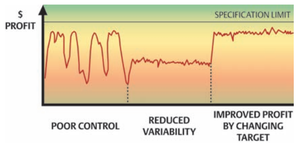
Predictive Intelligence and the Power to Use It

Emerson's PlantWeb digital Smart Refinery architecture enables you to harness the power of predictive intelligence to operate more efficiently, safely, and effectively.

With PlantWeb you gain unmatched capabilities to improve profitability through reduced cost and improved output.

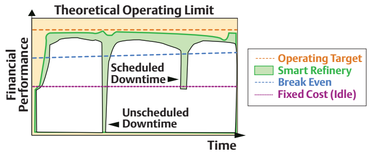
PLANTWEB IN ACTION

Performance



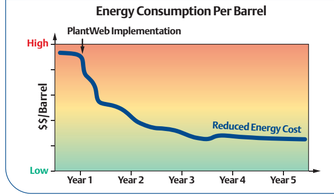
Better reactor inlet and bed temperature control not only allows better yield of desired products, but longer catalyst life. High temperature variability results in accelerated catalyst coking when the temperature is cycling high, and lower yield when the temperature is cycling lower than setpoint.

Reliability



PlantWeb enables refiners to implement predictive maintenance thereby avoiding unplanned slowdowns and shutdowns that are the key source of lost profits in refining. PlantWeb easily allows refiners to distribute diagnostic information and alerts to those that need it to operate closer to theoretical limits.

Energy Efficiency



Emerson has implemented the SmartProcess Heater Optimizer advanced control application on multiple refinery processing units with documented improvement of 1-2% in heater efficiency, resulting in a significant reduction in emissions and operating costs.

Control, Protection, and Asset Optimization

The PlantWeb smart digital control, smart safety, and smart asset management systems power PlantWeb by enabling safe, reliable and optimized operations.

Only PlantWeb provides breakthrough performance in refining through:

- Best control loop speed of response, resulting in tighter control, providing operational excellence and increasing profitability.
- Continuously running diagnostics to readily distinguish an instrument problem from a process problem.
- Clear direction on which assets – including automation, electrical, process, and rotating equipment – are in need of attention, avoiding upsets, slowdowns, and shutdowns.

SMART DIGITAL CONTROL

PlantWeb, with DeltaV, offers better basic process control by providing best loop speed of response and ensuring health of process assets.

- I/O on Demand allows for faster and increased flexibility with project implementation
- DeltaV has a broad portfolio of easily configured embedded advanced control applications, including multi-variable model based predictive controllers, neural networks, fuzzy logic, and adaptive control.
- DeltaV continuously identifies and accurately diagnoses the root causes of any poorly performing control loop.
- DeltaV uses the same database for regulatory and advanced controls, simplifying configuration, setup, and long-term use – eliminating all problems/costs associated with connectivity to third party systems.

www.EasyDeltaV.com

SMART SAFETY

The key to safe Hydrocracker unit operations is early visibility to deteriorating conditions – with a reliable, integrated safety loop should the situation become critical.

- DeltaV SIS harnesses the power of device diagnostics improving both availability and reliability, avoiding costly spurious depressurization of the reactor circuit while providing the required level of safety integrity.
- DeltaV SIS automatically tests the elements in the safety loop with documentation of the results, including online partial stroke testing of shutoff valves.
- Lower the total cost of ownership and improve operator effectiveness with PlantWeb's simulation, configuration and graphics engineering tools that are common to both DeltaV and DeltaV SIS.

www.EasyDeltaV.com

SMART ASSET OPTIMIZATION

Only PlantWeb's native device intelligence delivers the foundation for predictive maintenance strategies and comprehensive turnaround planning to optimize asset reliability.

- Instrumentation – Understand the situation(s) prior to going into the field by detecting and diagnosing field device problems.
- Control valve – Catch problems before they escalate using extensive valve diagnostics.
- Rotating assets – Collect and display the condition of pumps, motors, fans, compressors, and other rotating equipment to proactively maintain these assets for optimum unit operations.
- Asset health information is accessible to reliability personnel and operators through DeltaV and AMS Suite, thereby increasing their effectiveness.

www.EmersonProcess.com/Optimize

Field Intelligence

With the right intelligence, your field assets not only provide more precise and reliable information on the process, but they also self-diagnose their health and alert you to potential problems.

PlantWeb seamlessly integrates inputs from FOUNDATION™ fieldbus, AS-i, DeviceNet, ProfibusDP, and HART® devices, providing flexibility and enhanced control strategies while saving money, time, and resources.

Devices, instruments, and software designed with best-in-class intelligence power PlantWeb by enabling you to extract rich and reliable data from your process to optimize control.

Process Variables | Health Diagnostics

SMART FINAL CONTROL

Fisher® final control elements lead the world in refining, delivering:

- High reliability in the harshest of process environments such as the hot and cold separator letdown control valves and numerous cycling within PSA units
- Superior control performance providing lower variability in controlling reactor hydrogen quench valves
- Automated documentation and historical reliability records of advanced process diagnostics, including valve signature tests and partial stroke testing
- Greatest breadth of supply from basic to engineered products, providing solutions for most refining applications

Featured Technologies:
Fisher Digital Control Valve and FIELDVUE® Digital Controller
Fisher® Dirty Service Trim (DST) is a multi-stage anti-cavitation trim

www.EmersonProcess.com/Fisher

SMART MACHINERY HEALTH

Rotating equipment failure is the leading cause of plant slowdowns and shutdowns. Vibration across unit assets causes a high percentage of asset degradation and failure.

While highly critical assets are often monitored by other plant systems, the balance of process pumps and assets are not continuously monitored. Emerson's effective, economically viable solutions for vibration detection help extend this capability to all unit assets.

Monitoring rotating equipment vibration gives valuable insight into predicting:

- Pump mechanical seal or bearing failure
- Overhead receiver off gas compressor seal or bearing failure
- Air-cooled exchanger loss of heat removal capacity due to fan or motor failure

Emerson also offers complete protection and prediction solutions for critical assets.

Featured Technologies:
CSI® Machinery Health Monitors

www.AssetWeb.com/MHM

SMART ANALYTICAL

Reliable process heater flue gas oxygen and CO/combustibles measurements are key to optimizing heater efficiency and improving operator confidence in the measured values to ensure safe operation.

- Advanced features measure the extent of oxygen deficiency in the event of substoichiometric combustion, assisting the operator to recover from unsafe conditions
- Combined O_2 and CO/combustibles analysis enable increases in efficiency while maintaining safe operations

Reliable Continuous Emissions Monitoring Systems (CEMS) for environmental compliance and reporting.

Featured Technologies:
Rosemount® Analytical Oxygen, CO/Combustibles Analyzers

www.EmersonProcess.com/raihome

SMART MEASUREMENT

A complete line of technically advanced pressure, temperature, flow, level, and safety measurement instrumentation to fill almost every one of your process and asset health measurement needs.

- Redundant temperature element capability provides for consistent yield and quality
- Extensive diagnostics can avoid process upsets by detecting plugged impulse lines, burner flame instability, and the onset of fractionator flooding
- Industry-leading long term stability, lowering total cost of ownership
- Proven, reliable vortex, , and Coriolis flow technology to fully optimize the plant
- Safe and accurate reactor differential pressure utilizing two 3051S transmitters rather than long, unsafe impulse lines for a single differential pressure transmitter
- Accurate direct mass flow fuel measurement to improve energy efficiency and reduce operational disturbances

Featured Technologies:
Rosemount® dual sensor input temperature and
Micro Motion® Measurement Technologies

www.EmersonProcess.com/Rosemount
www.EmersonProcess.com/MicroMotion

SMART WIRELESS

Most refineries were built with the minimum amount of instrumentation to operate the unit. However, operating with improved utilization, reliability, and efficiency often require additional information. Emerson's wireless technologies lower the barrier to acquire the information needed to attain operational excellence.

- Add key process measurements to help optimize operations and determine automation asset health, including trending
- Economically monitor rotating equipment health
- Cost-effectively apply wireless solutions for remote operations, worker safety, and mobile asset tracking
- Reliably and continuously monitor devices and minimize energy consumption through self-organizing mesh technology
- Smart Wireless products are supported and fully compliant with the IEC 62591 (*Wireless*HART®) standard

Featured Technologies:
Emerson's Smart Wireless Solutions

www.EmersonProcess.com/SmartWireless

SERVICES & SUPPORT

Emerson's extensive global experience in petroleum refineries helps clients create sustained operational improvements worldwide.

Consulting Services
Emerson's consulting expertise covers the full life of an automation investment from conceptual design and justification to on-going control performance audits, including:

- Master Plan Consulting – Multi-year automation investment analysis
- Pre-FEED Consulting – Conceptual design, benefit, and cost estimates
- Advanced Process Control Consulting – Design, justification studies, and implementation services for APC projects
- Control Performance Audits – Expert control loop testing, troubleshooting, and tuning
- Smart Turnaround – Instrumentation and asset reliability audit, turnaround planning, and realization
- Safety – Largest staff of certified functional safety experts and professionals, following IEC 61511 certified procedures

Education and Training Services
Emerson's 65 years of training experience, delivered through a global network of certified training centers, result in effective learning that provides a framework for maximum availability, sustainability, and operational excellence.

- Specialized training in Maintenance, Safety, Engineering, and Operator Training Solutions
- Award winning services and training
- Customize training to meet site specific needs
- Flexible delivery options – Instructor-led courses either on-site or off-site, virtual-Learning and eLearning

Modernization and Migration Services
Emerson helps maximize return on automation investments by providing Total Migration Solutions – combining best-in-class technology, systems expertise, consulting, and project services.

- Flexible Approach – Migration solutions and capabilities to work within your operating and budget constraints
- Platform Expertise – Extensive knowledge of Emerson and non-Emerson control systems
- Migration Experience – Proven migration solution from planning to implementation
- Automated Conversion Tools – Reduces the risk of improperly converting your existing system data
- Business Case – Assist in developing the justification for migration/modernization projects based on site specific needs

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