MEASUREMENT INSTRUMENTATION FOR SPECIALTY CHEMICALS

POWERING SMARTER, AGILE AND EFFICIENT OPERATIONS

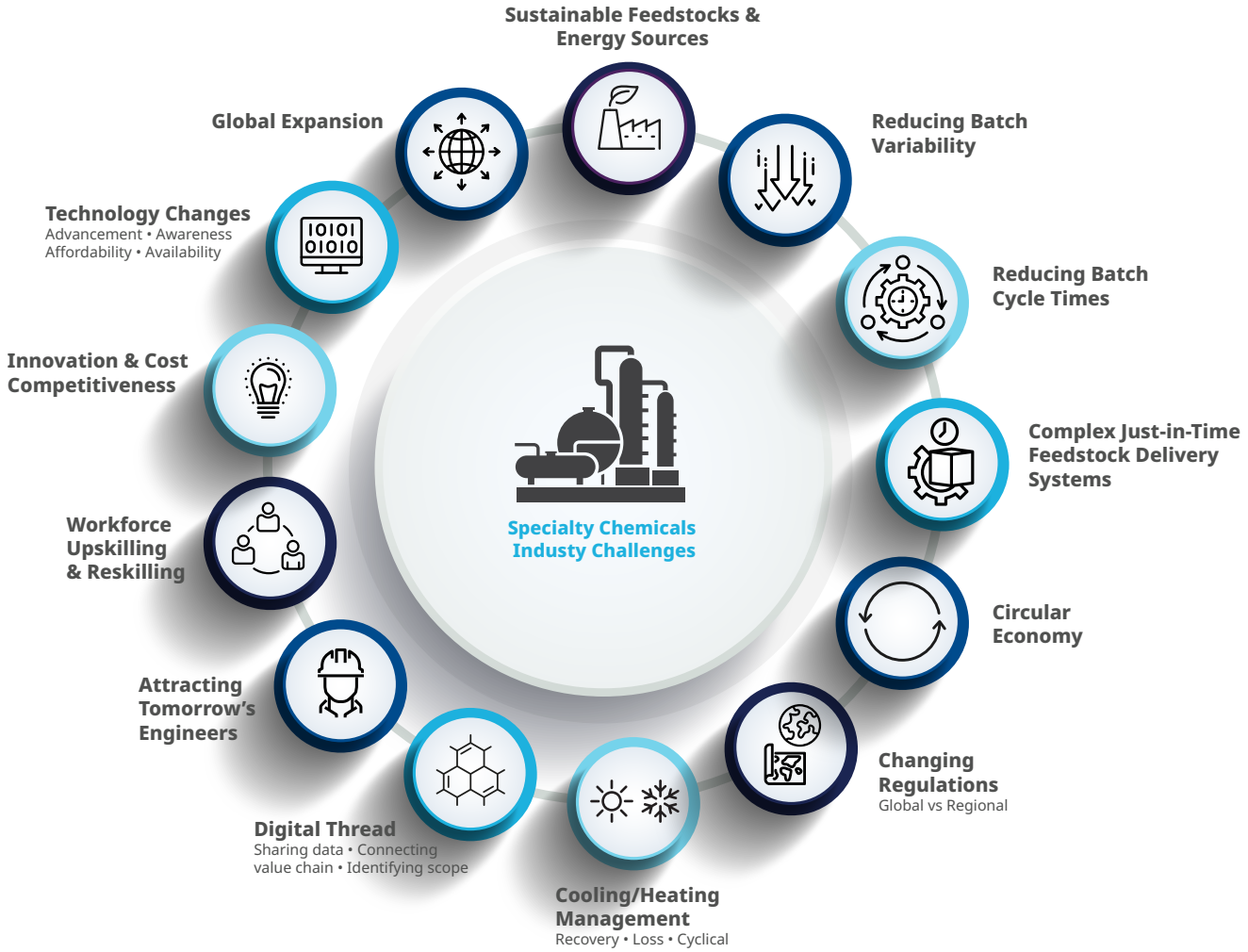
EMERSON™

ACCELERATING GROWTH IN A COMPLEX, EVOLVING MARKET

The specialty chemicals industry is a constantly changing sector that faces a range of challenges, including:

- **New regulations**
- **Growing sustainability demands**
- **Maintaining product quality across the supply chain**
- **Remaining cost competitive in a global marketplace**
- **Volatile raw material prices**
- **Keeping up with technological advances**
- **Talent development and retention**

As a result, manufacturers are challenged to adapt to an extremely complex and dynamic environment. This includes optimizing process operations, implementing decarbonization strategies, and training and upskilling staff—to be flexible enough to expand. They also need to maintain compliance and meet safety standards while transitioning to environmentally-friendly chemicals and production processes.



WHAT WE SOLVE

Producers of specialty chemicals have always strived to meet customers' demands for quality, reliability and safety, but today's operational challenges expand beyond ensuring asset availability, safety and quality control. Maintaining flexible and agile production, optimizing energy use, reducing emissions and improving workforce productivity are becoming paramount to delivering key operational and business performance indicators.

A foundational element to meeting these new performance expectations is partnering with the right automation and process measurement expert. With decades of experience helping chemical producers automate and manage their operations better, **Emerson** provides expertise on the best measurement instrumentation technologies, digitalization strategies and support to help chemical operations:

- **Enable flexible production to compete in a global marketplace**
- **Ensure asset reliability and operational availability**
- **Improve energy efficiency and reduce emissions**
- **Ensure the safety of people, plant and processes**
- **Empower a digitally transformed workforce**

With the global reach and diverse portfolio, Emerson can help producers of specialty chemicals power safer, smarter, sustainable and efficient operations no matter what the process challenges or requirements.

Digital transformation saves Top Quartile performers up to $80 million annually on maintenance costs for a $1 billion plant

Source: Innovations in Process Automation (2020)

HOW BOUNDLESS AUTOMATION™ POWERS OPERATIONAL EXCELLENCE

Today, process manufacturers encounter a widespread challenge: an overwhelming amount of data coming from various sources in a fragmented manner. This results in operational data being isolated from hardware and software systems, making it difficult for users to optimize their operations.

As a simplified, software-defined architecture, **Emerson's Boundless Automation** drives operational excellence by removing data silos. It enables **secure, freer flow and democratization of data across intelligent field devices, edge computing and the cloud** to help manufacturing facilities optimize operations in multiple domains, and balance production goals with reliability and sustainability goals.

INTELLIGENT FIELD

Expand connectivity between sensors and applications

Simplified access to more data from more sources and diverse applications.

- Streamlines connectivity
- Reduces installation costs
- Installs easily on operating processes
- Seamless addition of new measurement devices
- Simplifies integration

EDGE

Bring IT and OT innovations together

Collaboration between information technology and operational technology.

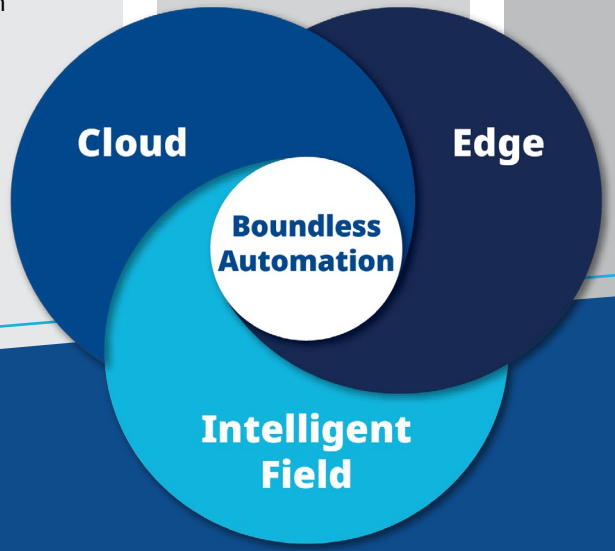
- Enhances security
- Simplifies networking
- Democratizes data
- Accelerates co-creation
- Better aligns IT and OT
- Improves robustness

CLOUD

Create a connected enterprise platform

Power operations and engineering capabilities on-premise and across the enterprise.

- Collaboration
- Lower up-front costs
- Easy deployment
- Limitless scalability
- Centralized security management



MYEMERSON DIGITAL TOOLS
ACCELERATE AND SIMPLIFY WORK TASKS

Lack of speed has been named as the biggest pain point in organizations' relationships with their suppliers. With a free **MyEmerson** account that can be accessed through **Emerson.com**, users can access digital tools to accelerate tasks such as:

- Engineering design and collaboration with Emerson experts
- Managing software and installed assets
- Accessing training opportunities
- Streamlining procurement processes
- Improving visibility into buying history and trends

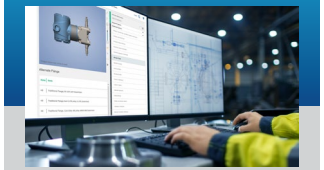
MyAssets

A comprehensive view of plant instrumentation, documentation, spare parts and walkdown reports.

MySoftware

A single location to manage software needs for downloads and drivers, applications and firmware.

MyWorkspace



Increase efficiency with engineering tools to size and configure, generate drawings, and collaborate.

MyTransactions

Streamline procurement process, improve order accuracy, manage lead time and purchase orders.

MyTraining

Upskill and reskill your workforce with product training available online, in-person or onsite.

86% of B2B users prefer digital self-service tools to conduct business

Source: McKinsey & Company (2017)

FLEXIBILITY & SPEED

CHALLENGES

Specialty chemical batch manufacturing is challenged with ensuring consistent product quality while maintaining the flexibility to handle frequent formulation changeovers and the variability of raw materials and production processes. With increased market competition and evolving customer demands, operational flexibility and speed are paramount to meeting production targets while addressing the needs for quality, traceability, efficiency and waste management.

Operational challenges

Process Variability

- Batch-to-batch inconsistencies due to variations in raw material quality, additions and manual processes
- Uncontrolled reactor conditions affecting product quality and yield

Longer Batch Cycle Times

- Complexity of managing multiple recipes and formulations
- Excessive changeover time causing production delays
- Longer cycle times due to inability to adapt to changing process conditions

Energy Waste, Scrap and Rework

- Manual operations causing scrap and rework
- Managing waste streams and emissions
- Heat transfer limitations increasing energy usage and negatively impacting reaction rates and product quality

SOLUTIONS

Advanced measurements and batch automation solutions enable real-time process control for faster corrective actions and the flexibility to manage diverse formulations efficiently. Reduce cycle time and connect production with quality control using sensors for mass flow, pressure, temperature and level to ensure accurate dosing and material tracking.

Control Process Variables to Ensure Quality

- Leverage mass-based measurements to ensure accurate material additions to the reactor
- Enable real-time monitoring of critical parameters (pH, temperature, viscosity, density, pressure) using smart sensors and analyzers

Reduce and Predict Batch Cycle Time

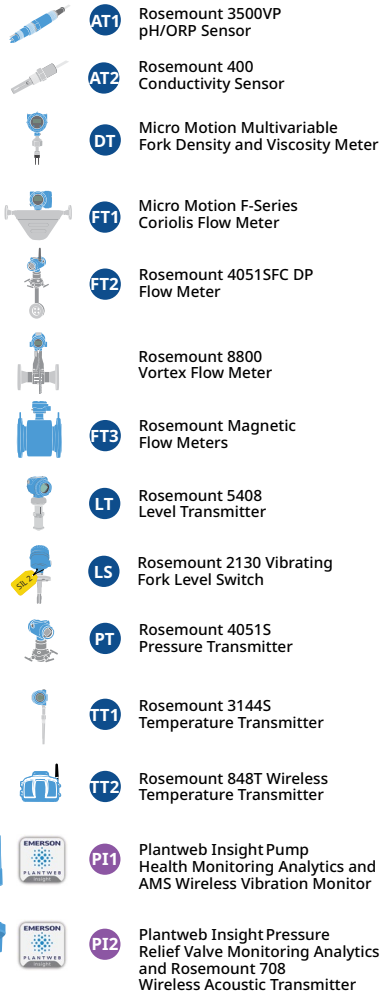
- Minimize batch transition time and off-spec product with improved measurements
- Troubleshoot batches in real-time to eliminate rework time and cost
- Optimize reactor heating and cooling performance to reduce cycle times

Optimize Energy Usage and Reduce Waste

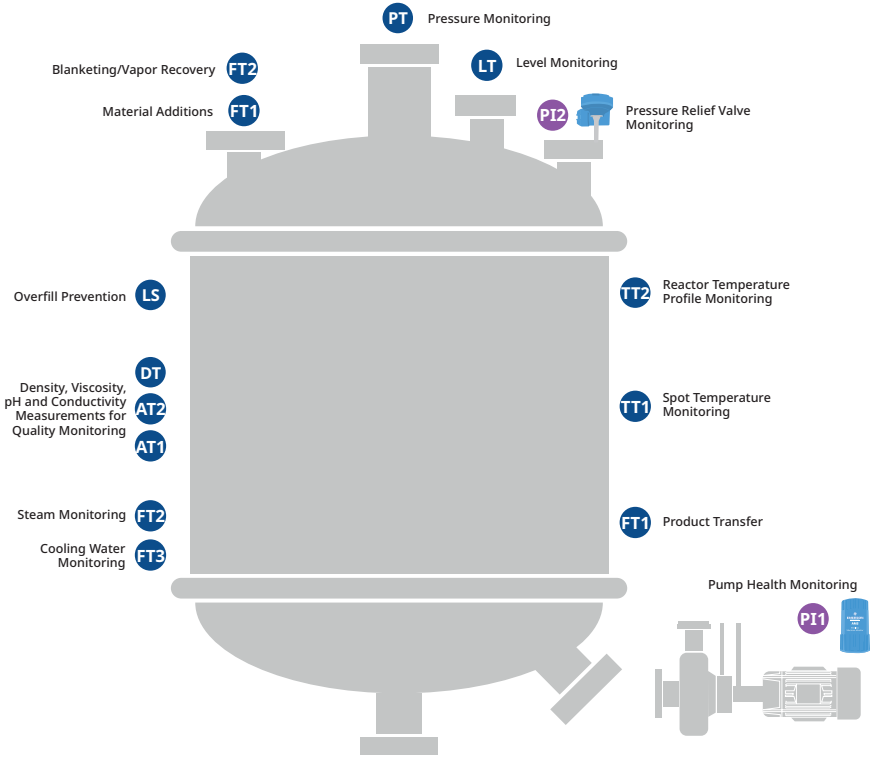
- Minimize manual operations with automated, reliable measurements to eliminate waste and rework
- Improve control of batch heating and cooling systems to increase energy efficiency
- Use energy-efficient equipment and heat recovery systems to reduce operational costs

AGILE OPERATIONS

Maintaining operational flexibility enables faster time to market and rapid response to demand shifts. Advanced process control and automation are the strategic levers to achieve production agility, allowing manufacturers to accommodate changes in formulations and manage a diverse product portfolio, while ensuring greater efficiency and product quality.



- AT1 Rosemount 3500VP pH/ORP Sensor
- AT2 Rosemount 400 Conductivity Sensor
- DT Micro Motion Multivariable Fork Density and Viscosity Meter
- FT1 Micro Motion F-Series Coriolis Flow Meter
- FT2 Rosemount 4051SFC DP Flow Meter
- Rosemount 8800 Vortex Flow Meter
- FT3 Rosemount Magnetic Flow Meters
- LT Rosemount 5408 Level Transmitter
- LS Rosemount 2130 Vibrating Fork Level Switch
- PT Rosemount 4051S Pressure Transmitter
- TT1 Rosemount 3144S Temperature Transmitter
- TT2 Rosemount 848T Wireless Temperature Transmitter
- PI1 Plantweb Insight Pump Health Monitoring Analytics and AMS Wireless Vibration Monitor
- PI2 Plantweb Insight Pressure Relief Valve Monitoring Analytics and Rosemount 708 Wireless Acoustic Transmitter



Advanced process control and instrumentation enable improved monitoring of reactor performance and extend catalyst life.

Optimize for flexibility and speed using intelligent instrumentation

- Batch and catalytic reactor optimization solutions
- Separation monitoring solutions
- Distillation control
- Heat and mass balance
- Dryers, mixers, crystallizers, evaporators
- Predictive analysis of assets:
  - Compressors
  - Heat exchangers
  - Fired heaters
  - Boilers
  - Pumps
  - Cooling towers
  - Blowers/fans

Digital technologies and automation lead to 10-30% increase in production efficiency and throughput

Source: McKinsey & Company (2020)

SUPPLY CHAIN & LOGISTICS

CHALLENGES

The production of specialty chemicals requires just-in-time manufacturing but it is challenged by complex supply chains and logistics. Lack of visibility into materials sourcing and asset tracking adds complexity to inventory planning, pricing, procurement, and quality control. Maintaining end-to-end visibility into supply chain and ensuring accurate product transfer in and out of the plant is key to reducing financial risk, making faster decisions and improving resource planning.

Supply & Logistical Hurdles

Supply Chain Management

- Inventory pressures requiring just-in-time delivery
- Lack of end-to-end supply chain transparency complicates material tracking

Logistics and Tank Management

- Inability to track product movement
- Insufficient visibility to tank inventory
- Product loading and unloading bottlenecks reducing throughput

Plant Mass Balance

- Inaccurate accounting of product quantity and quality affecting mass balance calculations and profitability
- High unaccounted-for product losses and uncertainty of product transfer and billing

SOLUTIONS

Close the gap between supply chain planning and operations execution using smart automation solutions designed to help you gain production visibility and agility. Maximize profitability with accurate and repeatable inventory as well as custody transfer measurements that comply with industry standards and support your accounting operations.

Improve Visibility Between Manufacturing and Supply Chain

- Improve inventory management and increase on-time order fulfillment with Aspen Plant Scheduler
- Optimize schedules for both production sites and stock transfer orders

Ensure Seamless Container Loading and Logistics Integration

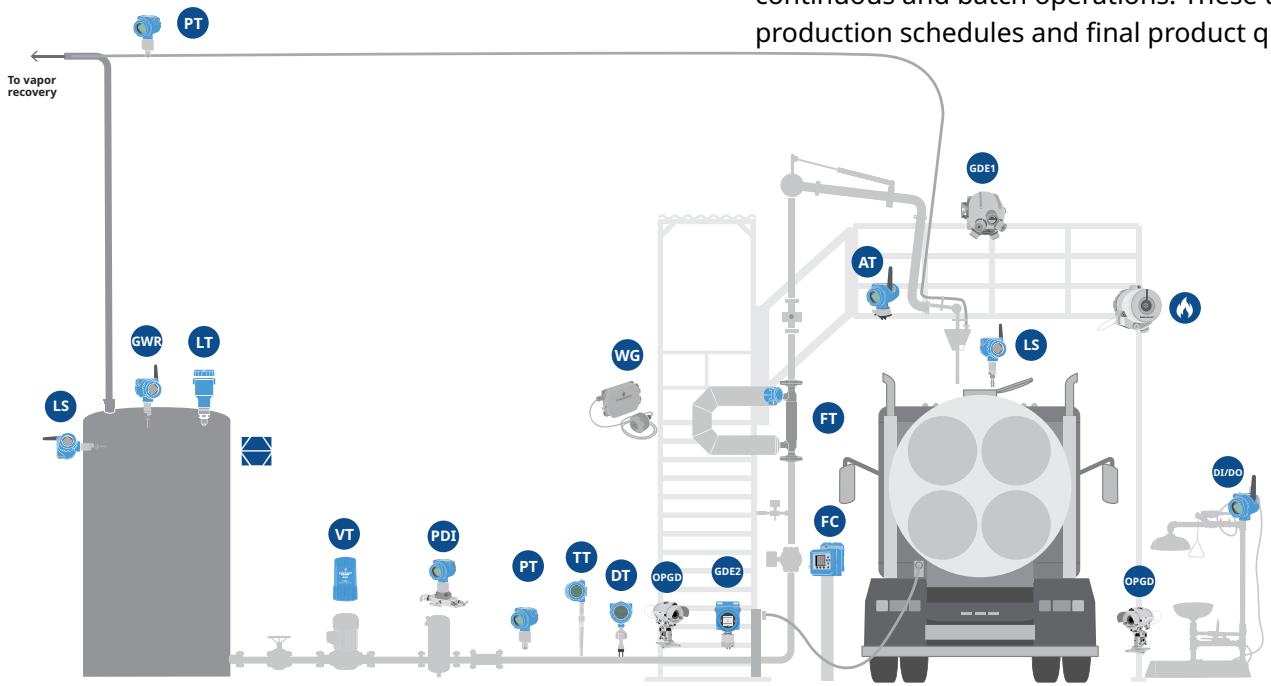
- Vertically integrate container loading with logistics
- Streamline and reduce terminal loading and unloading
- Automate and control tank inventory and product movement to confidently utilize capacity

Ensure accurate and repeatable product transfers

- Implement advanced measurement and monitoring to minimize custody transfer errors, ensure product quality and maximize throughput
- Reduce unaccounted-for losses and billing disputes
- Improve plant mass balance with enhanced measurement integrity

EFFICIENT OPERATIONS

Quickly adapt to evolving supply chain complexities and ensure accurate product transfer using digital planning, scheduling and metering solutions for continuous, semi-continuous and batch operations. These tools provide better visibility into inventory, production schedules and final product quantity and quality to maximize your margins.



Enhance visibility and agility with automation solutions embedded with domain expertise

- Tank management and terminal automation
- Logistics management
- Tote management
- Automated loading and unloading systems
- Custody transfer measurement
- Measurement of raw material variability
- Model predictive control
- Data lake management

PT Rosemount 4051S In-Line Pressure Transmitter

GWR Rosemount 3308 Wireless Guided Wave Radar Level Transmitter

LT Rosemount 3408 Level Transmitter

PDI Rosemount 4051S Coplanar Pressure Transmitter

TT Rosemount 3144S Temperature Transmitter

LS Rosemount 2160 Wireless Vibrating Fork Level Switch

VT AMS Wireless Vibration Monitor

FC Micro Motion Series 3000 Transmitter/Batch Controller

DT Micro Motion Multivariable Fork Density and Viscosity Meter

OPGD Rosemount 935/936 Open Path Gas Detector

GDE2 Rosemount 925 Fixed Gas Detector

Rosemount TankMaster™ (and TankMaster Mobile) Inventory Management Software

FT Micro Motion ELITE Coriolis Flow Meter

WG Wireless Gateway

GDE1 Rosemount Incus Ultrasonic Gas Leak Detector

AT Rosemount 928 Wireless Gas Monitor

Rosemount 975 Flame Detector

DI/DO Rosemount 702 Wireless Discrete Dual Input/Output Transmitter

65% of chemical players expect digitalization to impact their operational competitiveness

Source: EY DigiChem SurvEY (2022)

CHALLENGES

The risk of processing, storing, and transferring toxic, hazardous, and flammable materials is undeniable in the production of specialty chemicals. In addition to putting personnel, the environment and nearby communities at risk, safety incidents can also have an impact on a company's financial health and reputation.

According to the American Fuel & Petrochemical Manufacturers (AFPM), the top three leading causes of Tier 1 safety incidents are due to issues with piping, tanks, and pumps.

Top tier 1 & 2 safety incidents

Piping Systems	Tanks	Pumps	Heat Exchangers	Pressure Vessels	Fired Heaters
49%	11%	8%	6%	4%	4%

Source: American Fuel & Petrochemical Manufacturers (2017)

SOLUTIONS

Chemical producers that adopt new safety strategies and technologies to minimize their personnel's exposure to hazardous materials, while ensuring the integration of more accurate, reliable, and regulatory-compliant process equipment, significantly enhance safety for both personnel and the site.

Automated online sensing solutions protect your personnel and plant

Piping Systems	Tanks	Pumps	Heat Exchangers	Pressure Vessels	Fired Heaters
Real-time corrosion monitoring	Complete tank safety systems including tank overfill prevention	Leak detection and condition monitoring	Condition monitoring to detect problems	Fire and leak monitoring and over pressure protection	Burner Management System (BMS) compliant with new API standards and ambient toxic gas detection and alarming

SAFER OPERATIONS

Partnering with a trusted safety and automation solutions expert can help chemical producers develop strategies to mitigate and reduce safety risks in four primary areas: **containment safety, occupational safety, process safety, and functional safety.**

LT Rosemount 3408 Non-Contacting Radar Level Transmitter

LS Rosemount 2130 Vibrating Fork Level Switch

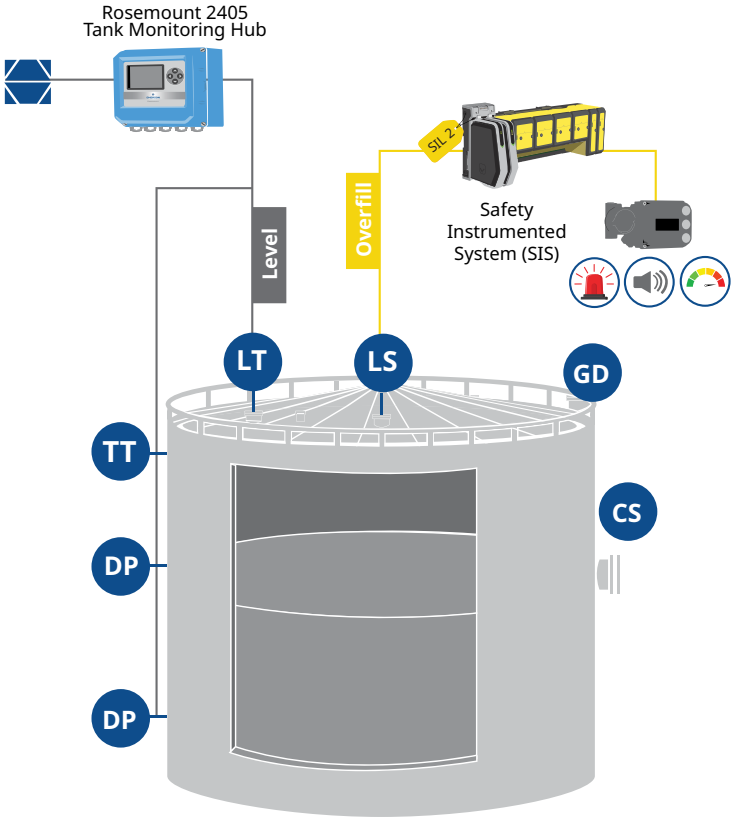
TT Rosemount 248 Head Mount Temperature Transmitter

DP Rosemount 4051SLT Level Transmitter

CS Rosemount Wireless ET310 Corrosion and Erosion Monitoring System

GD Rosemount Incus Ultrasonic Gas Leak Detector

Rosemount TankMaster™ WinView (and TankMaster Mobile) Tank Management Software



Containment incidents can be prevented by effective safety instrumentation and automation.

Containment Safety

- Corrosion and erosion monitoring sensors
- Complete tank safety systems
- Flame and gas detection sensors

Occupational Safety

- Wireless monitoring solutions for safety showers and eyewash stations
- Wireless monitoring solutions to automate operator rounds
- Continuous, long range ambient toxic gas detection solutions
- Bluetooth® wireless technology enabled instrumentation to minimize unnecessary operator exposure to hazards

Process Safety

- Safety certified instruments with advanced diagnostics

Functional Safety

- Automated or self guided proof testing solutions
- Smart instrumentation for the entire safety loop

One overfill statistically occurs every 3300 filling operations

Source: Marsh and McLennan (2015)

SUSTAINABILITY

CHALLENGES

The global push to reduce greenhouse gas emissions to net zero by 2050 is challenging chemical producers to explore ways to minimize energy use and emissions. With stringent environmental regulations and increased consumer demand for reducing pollution and utilizing more recyclable products, it is becoming critical for the industry to develop strategies for a circular business model, waste reduction, and use of renewable feedstocks and energy sources.

The challenges of a net-zero future

Process Decarbonization

- Reducing energy intensity and emissions
- Meeting regulatory requirements
- Sourcing and/or generating renewable fuels
- Managing carbon capture, use and storage

Alternative Feedstocks

- Converting to bio-based feedstocks
- Producing synthetic feedstock from captured carbon
- Producing feedstock from waste

Resource Stewardship

- Circular recovery to new feedstocks
- Product recovery to alternative uses
- Product recycling
- Product waste-to-energy
- Water reduction and re-use

SOLUTIONS

Smart process instrumentation and effective automation are essential components of any comprehensive strategy to decarbonize chemical operations and sustainably manage resources and end-of-life considerations.

Energy Efficiency Opportunities

- Energy and asset optimization to operate at best setpoints even under changing conditions
- Site-wide energy monitoring to track actual and expected energy use
- Mass and energy balance to pinpoint losses

Feedstock Flexibility

- Monitor feedstock compositional changes to ensure quality
- Utilize In-line sensors for pH, and viscosity to ensure consistent reaction conditions
- Enable precise dosing and material tracking using smart flow and mass measurement devices

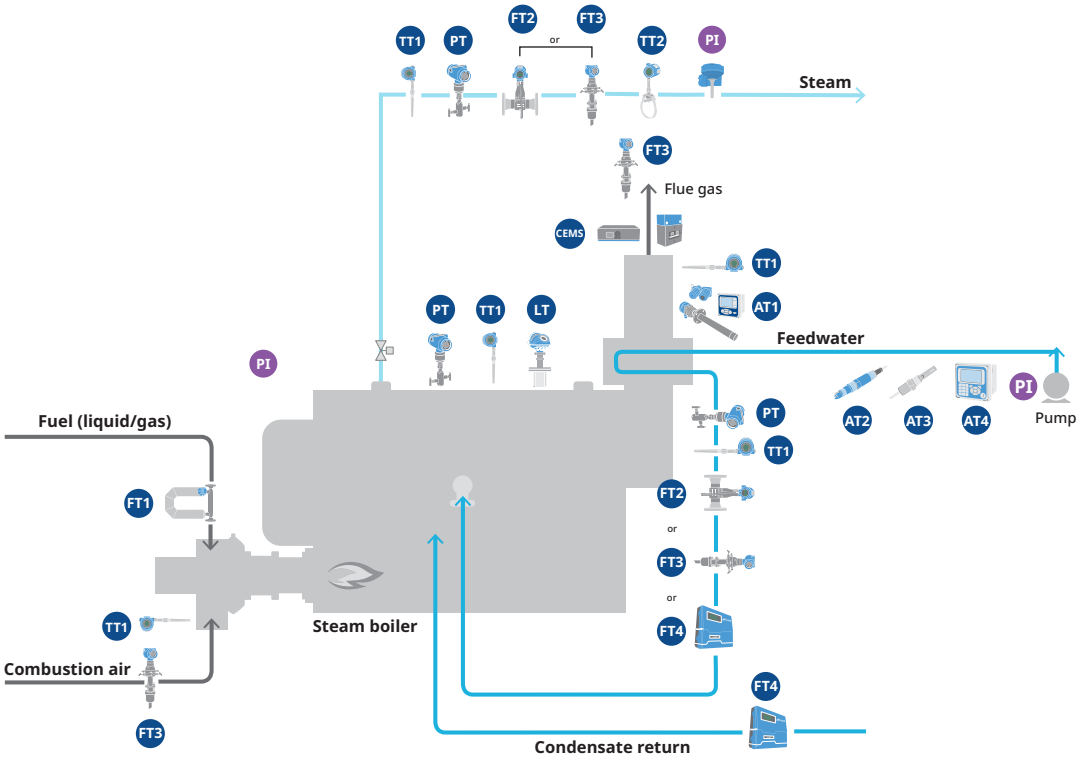
Process Efficiency

- Use data-driven monitoring solutions of water feeds and wastewater treatment to ensure effective reuse
- Improve combustion efficiency to lower energy intensity and emissions
- Get better quality control of recyclate process using advanced sensing solutions

SUSTAINABLE OPERATIONS

Renewable manufacturing starts with a solid foundation of intelligent instrumentation. Emerson's measurement devices with predictive field analytics are built to provide the real-time visibility into process performance that you need to meet sustainability goals.

- PI Plantweb Insight Analytics Software
- TT1 Rosemount 3144S Temperature Transmitter
- TT2 Rosemount X-well Temperature Transmitter
- FT1 Rosemount 4051S Series Pressure Transmitter
- PT Micro Motion ELITE Coriolis Flow Meter
- FT2 Rosemount 8800 MultiVariable Flow Meter
- FT3 Rosemount 4051SFA Annubar Flow Meter with 485/585 Averaging Pitot Tube
- FT4 Flexim FLUXUS F731 Non-Intrusive Ultrasonic Liquid Flow Measurement
- LT Rosemount 5300 Guided Wave Radar
- CEMS Rosemount X-STREAM Enhanced Continuous Gas Analyzer
- Rosemount CT5100 Continuous Gas Analyzer
- AT1 Rosemount 6888A In Situ Oxygen Analyzer and Rosemount OCX 8800 Oxygen and Combustibles Transmitter
- AT2 Rosemount 3900 General Purpose pH/ORP Sensor
- AT3 Rosemount 400 Conductivity Sensor
- AT4 Rosemount 56 Dual-Channel Transmitter



Optimizing boiler operations starts with a good base of intelligent instrumentation.

A greener tomorrow starts with reliable sensing solutions

- Fired heater and combustion control
- Heat exchanger and boiler efficiency
- Steam trap monitoring
- Steam system and distribution optimization
- Mass and energy balance
- Flare composition analysis
- Fugitive emissions prevention and monitoring
- Pressure relief valve monitoring
- Energy management information systems
- Hydrocarbon leak detection

Between 30% to 50% of an operating budget is spent on energy

Source: Energy Star Guide for Energy and Plant Managers (2015)

RELIABILITY

CHALLENGES

Suboptimal reliability impairs asset productivity, which weighs against operating margins. Reliability can be the difference between chemical companies that thrive and those that don't survive. In a market environment where response times are critical, improved equipment reliability can be a timely and cost-effective way to capture opportunities.

Most common reliability problem indicators

Unplanned Downtime

- Largest cause of lost production is unplanned downtime *
- Limited insight into process, equipment and device health

Lost Productivity

- Manual operator rounds
- "Run-to-failure" scenarios and reactive response to malfunctioning

Stranded and Insufficient Data

- Dis-integrated data and systems
- 50% higher costs due to reactive maintenance *

* Source: McKinsey & Company (2020)

* Source: ARC Advisory (2014)

SOLUTIONS

Data-driven reliability programs are key to digital transformation for the chemical operations of the future. They can help surface the causes of unexpected failures and identify ways to mitigate the resulting unplanned downtime, paving the way to operational excellence.

Diagnostic Alerts Powered by Smart Field Instrumentation

- Real-time diagnostics increase visibility and enable faster corrective actions
- Data-driven failure prediction using advanced analytics reduces unplanned outages

Complete Asset Health Monitoring

- Shift from reactive to predictive maintenance with continuous, condition-based monitoring of assets
- Automate manual rounds with real-time information from wireless sensors

Remote Cloud Access to Stranded Plant Data

- Bring valuable diagnostic data within reach with secure, on-demand wireless access for improved decision-making
- Add new measurement points to identify performance problems with easy to integrate, non-intrusive wireless sensing instruments

AVAILABLE OPERATIONS

Leveraging reliability as a core competitive strategy can help chemical producers know where to strategically optimize costs, mitigate risk, and increase availability. Turn to Emerson's domain expertise and smart measurement technologies to improve operational performance through maximum production availability and throughput.

TT1 Rosemount 848T Wireless Temperature Transmitter

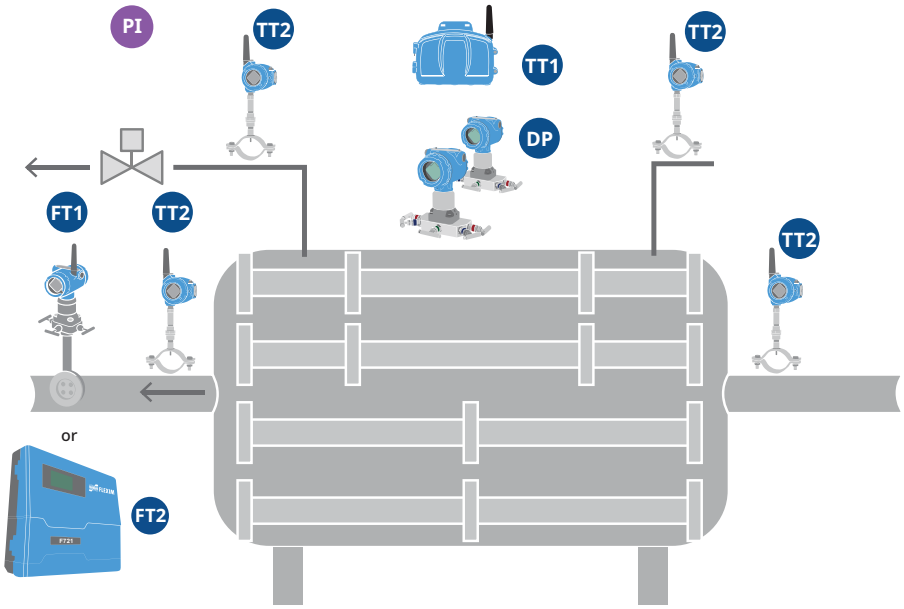
TT2 Rosemount X-well Technology with 3144S Wired Temperature Transmitter or Rosemount 648 Wireless Temperature Transmitter

FT1 Rosemount 4051SFC Wireless Compact Conditioning Orifice Plate Flow Meter

FT2 Flexim 731TE Ultrasonic Clamp-on Flow Meter

DP Rosemount Wireless 4051S Differential Pressure Flow Meter

PI Plantweb Insight Analytics Software



Fully instrumented heat exchanger provides valuable insights into performance.

Domain Expertise

Emerson reliability consultants have found that chemical companies that depend on **condition-based, planned maintenance** have fewer equipment emergencies, **resulting in 14% less downtime and 71% lower maintenance costs. ***

Asset Monitoring Solutions

- Heat exchanger monitoring
- Steam trap monitoring
- Pump health monitoring
- Corrosion and erosion monitoring
- Vibration monitoring
- Wireless sensing
- Mobility tools to bring control room data to the field

* Source: IndustryWeek (2018)

90% of all heat exchangers experience fouling

Source: MDPI - A Review of Crystallization Fouling in Heat Exchangers (2021)

NEW FIT-FOR-PURPOSE MEASUREMENT INNOVATIONS

OPENING UP NEW POSSIBILITIES FOR YOUR OPERATION

MICRO MOTION™ G SERIES CORIOLIS FLOW & DENSITY SENSORS

Full performance and enhanced connectivity in a low cost, compact design.

ROSEMOUNT™ 3408 LEVEL TRANSMITTER

Non-contacting radar level measurement and overfill prevention.

ROSEMOUNT™ X-WELL TECHNOLOGY

Non-intrusive temperature measurement without the complexities of thermowell.

ROSEMOUNT™ 3144S TEMPERATURE TRANSMITTER

Plug-and-play sensor with industry-leading accuracy, stability and reliability.

PLANTWEB INSIGHT™

Scalable pre-built analytics for increased visibility into key asset health condition.

ROSEMOUNT™ 4051S PRESSURE TRANSMITTER

Combines ease of use with smarter, faster and more reliable measurement.

ROSEMOUNT™ WIRELESS ET310 CORROSION AND EROSION SENSOR

Non-intrusive, continuous monitoring of metal loss without the cost of wiring.

BLUETOOTH® TECHNOLOGY ENABLED MEASUREMENT DEVICES

Rosemount Pressure, Temperature and Level Transmitters, plus Micro Motion 4700 Coriolis.

MICRO MOTION™ 4200 AND 4700 CORIOLIS TRANSMITTERS

Backwards compatible to upgrade your Coriolis without replacing the entire meter.

ROSEMOUNT™ 9195 WEDGE FLOW METER

Accurate measurement for dirty, highly viscous or abrasive fluids.

ROSEMOUNT™ 1058 LIQUID ANALYSIS TRANSMITTER

Displays input from liquid sensors and communicates to the control room.

ROSEMOUNT™ 470XA GAS CHROMATOGRAPH

Reliable gas composition analysis for natural gas, biomethane and hydrogen.

COMPREHENSIVE SENSING SOLUTIONS

DRIVING VALUE CREATION EVERYDAY

PRESSURE

The broadest portfolio to meet virtually every application need.

TEMPERATURE

Maintain your ideal process temperature to maximize control.

LEVEL

Solve liquid and bulk solid challenges across multiple applications.

CORROSION & EROSION

Non-intrusive monitoring of pipework metal loss in extreme environments.

LIQUID ANALYSIS

Continuous, inline analysis and monitoring of process liquids.

GAS ANALYSIS

Real-time detection and analysis of more than 60 gases.

FLAME & GAS DETECTION

Reliably safeguard your people, facilities and the environment.

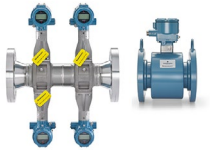
PERVASIVE SENSING

Flexible, scalable and robust wireless sensing to advance your IIoT strategy.

CORIOLIS FLOW, DENSITY & VISCOSITY

Accurate measurement of mass flow, volume flow and density.

MAGNETIC & VORTEX



Reliable measurement of conductive fluids, gas, liquid and steam flows.

DIFFERENTIAL PRESSURE FLOW

Primary elements, transmitters and fully configured solutions.

INLINE ULTRASONIC

Fiscal metering and validation of oil and gas flows.

NON-INTRUSIVE ULTRASONIC

Low-maintenance, clamp-on flow measurement of liquids and gases.

TANK GAUGING SYSTEMS

Bulk liquid measurement for inventory control and overfill prevention.

INTEGRATED MEASUREMENT SOLUTIONS

Turnkey measurement and analytical solutions for liquids and gases.

LIFECYCLE & TRAINING SERVICES

Global support and training capabilities to operate safely and reliably.

130+ Years

Emerson has been delivering value creation for industrial manufacturing for over 130 years.

For more information, visit **Emerson.com**

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