



CONNECT AND PROTECT

SULFUR Transport Pipelines

Safe, Reliable and Cost-Effective Skin-effect Tracing System (STS) Solution


nvent

RAYCHEM



Industrial Solutions

As the world's largest provider of complete electrical heat management systems, primarily for the general process, oil and gas, chemical, and power generation industries, nVent provides innovative products and turnkey solutions under market-leading brands nVent RAYCHEM and nVent TRACER. Our premiere turnkey solutions include full life cycle support—ranging from front-end engineering and installation to maintenance and operation services. Our global experience and office presence in 48 countries uniquely position us to manage the heat needed for projects of any size and scope.

The Heart of the Solution

nVent RAYCHEM STS Skin-effect Tracing System technology is a unique and effective heat-tracing solution for heated sulfur pipelines. nVent has successfully integrated multiple state-of-the-art technologies to offer safe, reliable and cost effective sulfur transport. Our Heat Management System (HMS) for sulfur transfer pipelines includes nVent RAYCHEM Skin-effect Tracing System (STS) cables, Pre-Insulated Piping, thermally isolated Anchors & Supports, Fiber-Optic Distributed Temperature Sensing (DTS) and nVent RAYCHEM Pipeline Supervisor (RPS) predictive analytical software combined with Finite Elemental Analysis (FEA) and Computational Fluid Dynamics (CFD) analysis.

Our proprietary sulfur pipeline re-melt program is specifically designed to address the criticality of re-melting temperamental sulfur pipelines. The introduction of "Bundled Technologies" for sulfur pipeline re-melt applications has improved the availability and awareness of pipeline operational insights to minimize the potential for failures during this critical sulfur re-melt process.

Safe Sulfur Transport

With the increasing use of heavy sour crude oils, safe sulfur transportation is becoming increasingly important for the refining industry. Similarly, the discovery of new sour natural gas reserves has increased the amount of gas processing worldwide to strip out sulfur impurities. Sulfur transport via heated pipelines is proven to be a preferred alternative to transporting liquid sulfur versus trucks or rail lines crossing public infrastructure. This transfer pipeline application has unique requirements due to the limited operating temperature range for liquid sulfur, pipe expansion movements and overheating concerns during re-melting of sulfur in the pipeline.



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Heat Management System

A Heat Management System (HMS) is an engineered system designed to maintain or protect process piping, equipment, vessels and instrumentation at pre-determined temperatures and within the defined design criteria. Our HMS for sulfur transport pipelines includes: Engineering & Design, Procurement & Fabrication, and Construction Services.

With the implementation of the nVent HMS, customers have realized more reliable, safe and cost effective solutions for sulfur transport pipelines as compared to other technologies. A list of existing project references is available upon request.



ENGINEERING & DESIGN

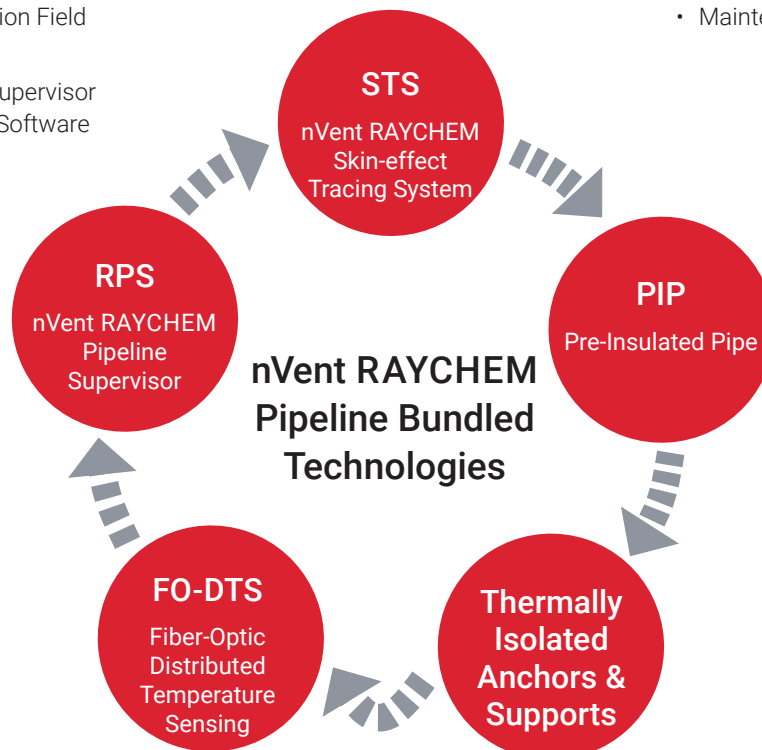
- nVent RAYCHEM Skin-effect Tracing System (STS) Technology
- 3D Finite Element Analysis
- CFD Analysis
- Transient Analysis
- Fiber-Optic Distributed Temperature Sensing (DTS)
- Detailed System Optimization
- Proprietary Thermal Insulation Field Joint Design
- nVent RAYCHEM Pipeline Supervisor (RPS) Predictive Analytical Software

PROCUREMENT & FABRICATION

- Multi-Power Output Heat Delivery Mechanism
- Control and Monitoring System
- Prefabricated and Pre-insulated Piping System
- Customized Power Distribution
- Thermal Insulation
- Fiber-Optic DTS Cable Sensing System

CONSTRUCTION SERVICES

- Installation
- Materials Management
- Project Controls (Budget and Schedule Compliance)
- Field Technical Support and Coordination
- Quality Assurance/Quality Control (QA/QC)
- Commissioning and Start-up
- Maintenance/Audits

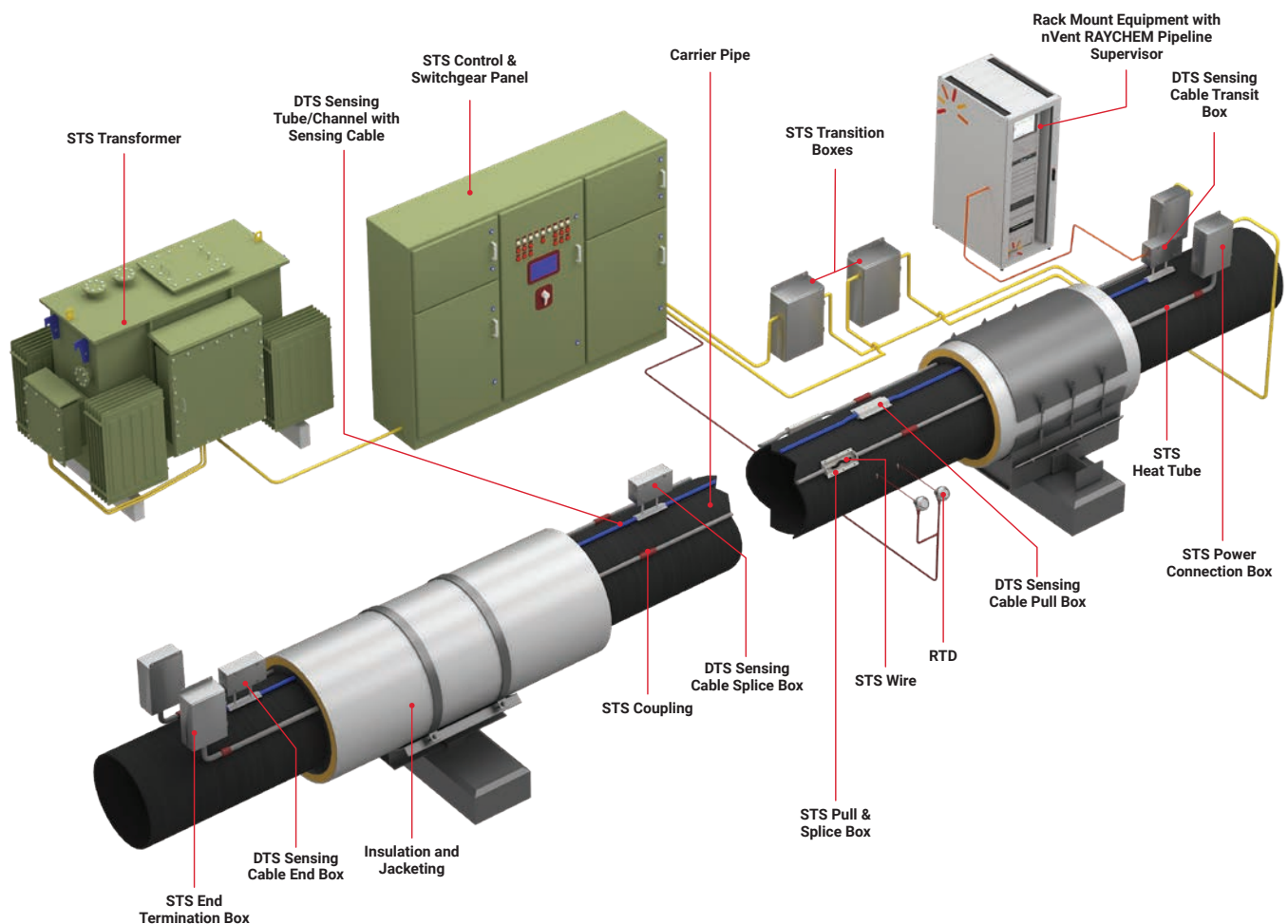


Skin-effect Tracing System (STS)



STS SYSTEM

nVent RAYCHEM Skin-effect Tracing System (STS) is a versatile engineered heat management system configured to deliver heat for long transfer pipeline applications. The system is typically designed for temperature-sensitive pipeline heating circuits in excess of 1 km and up to 50 km in length and can generate significantly higher wattages compared to conventional heating system solutions.



Skin-effect Tracing System (STS)

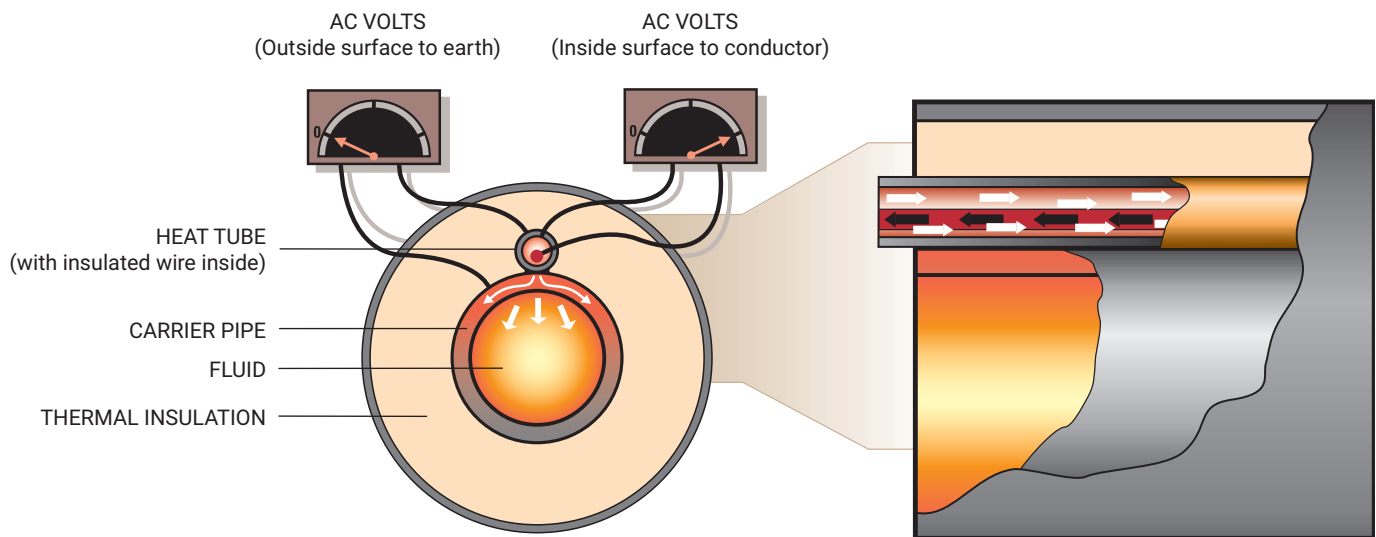
CAPABILITIES

- Circuit lengths up to 12.5 km (7.8 miles) from a single power source
- Maximum operating temperatures up to 260°C (500°F)
- Power outputs up to 150 W/m (45.7 W/ft)
- Inherently safe design—the exterior of the heat tube and carrier pipe is at ground potential
- Efficient heat transfer from the heat tube to the pipe
- Can be provided as a pre-fabricated and pre-insulated piping system

BENEFITS

- Minimizes power distribution costs, especially for long sulfur transfer lines
- Results in a predictable, safe and reliable heat management system
- Reduces the risk of hot spots throughout the re-melt or solidification process during normal operation
- Reduces on-site total installation costs
- Requires extremely low maintenance

STS TECHNOLOGY



STS CABLE DESIGN PARAMETERS

STS-HT

Maximum Voltage Rating

2400 VAC

Maximum Circuit Length

12.5 km (7.8 miles)

Power Output Rating

(application dependent)

150 W/m (45.7 W/ft)

Maximum Operating Temperature

260°C (500°F)

Cable Construction

Nickel plated copper wire with
Fluoropolymer insulation

PTB 21 ATEX 1005 X

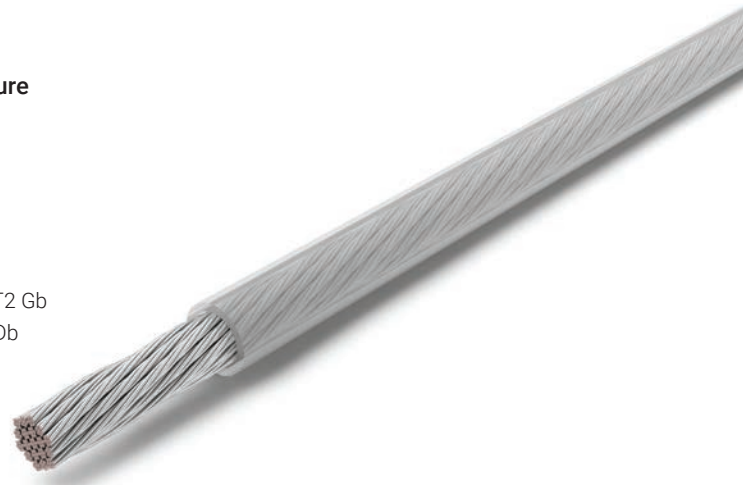
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Customized Insulation & Thermally Isolated Pipe Supports

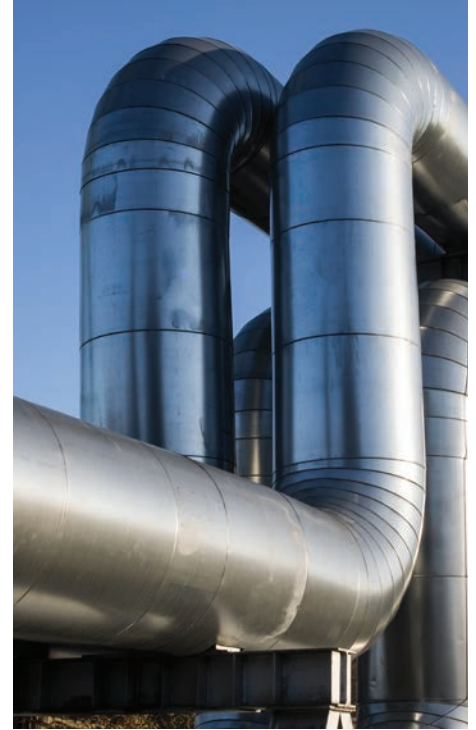
nVent has proven expertise in designing customized insulation systems, which are optimized to meet the challenging requirements of sulfur transport pipelines.

CAPABILITIES

- Multi-layer thermal insulation system with high temperature rated inner layer, rigid thermally efficient outer layer, and UV resistant outer jacket
- Fabricated off-site and delivered per the contractors installation construction requirements
- Engineered pipe supports, guide plates and anchors to support the pipe loads/ displacements and also minimize heat loss

BENEFITS

- Optimizes heat loss, protects against water ingress and natural elements, and able to handle large loads
- Off-site fabrication helps to compress project schedules and improve quality control for enhanced reliability and performance
- Reduces field labor requirements by addressing many critical work elements in a controlled factory setting
- The combination of properly designed insulation and supports creates a uniform thermal profile along the pipeline for optimal heat conservation



Advanced Control and Monitoring & Power Distribution Systems

nVent designs each STS control panel and transformer to meet the specific requirements of temperature-critical sulfur transport pipelines.

CAPABILITIES

- Multi-power heat delivery mechanism provides additional power level options for heat-up/re-melt conditions, to maintain the tight-temperature window needed for the temperamental sulfur re-melt process
- Custom solution STS transformers designed to meet specific project requirements

BENEFITS

- Minimizes operating costs, with capacity to handle heat-up/re-melt power when needed.
- Delivers a flexible operating voltage which is required for re-melt conditions



3D Finite Element Analysis

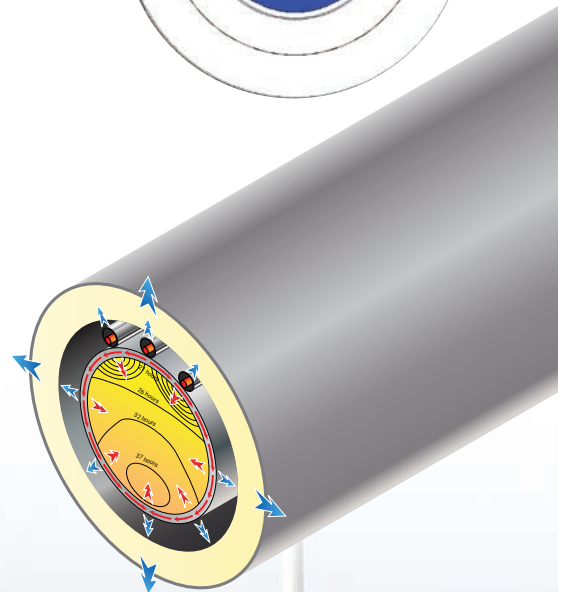
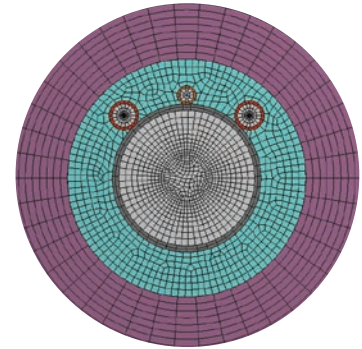
3D Finite Element Analysis is an integral part of the nVent sulfur transport pipeline heat management system. FEA is an important tool used to verify key elements of the pipeline design via thermal modeling and simulation.

CAPABILITIES

- Simulate the temperature profile of sulfur throughout the cross section of the pipe
- Determine the heat-up or cool-down characteristics (and times) of the sulfur line through transient analysis
- Simulate the temperature profile along the length of pipe

BENEFITS

- Ensures that the sulfur temperature does not fall below the solidification temperature across the cross section of the pipe and at other key locations along the pipeline
- Determines the time available before the sulfur solidifies due to power failure under varying operating and ambient conditions
- Analyzes hot spots and voids throughout the sulfur re-melt process



Fiber-Optic Distributed Temperature Sensing (DTS)

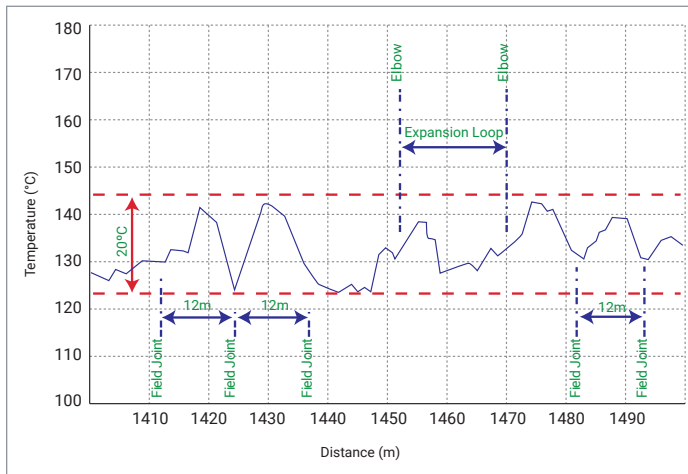
nVent has a proven track record of implementing distributed fiber-optic temperature sensing solutions on heated pipelines. Most recently, we have pioneered the introduction of predictive analytics to maximize the value of DTS. These systems provide critical insight into the temperature profile along the entire length of pipe.

CAPABILITIES

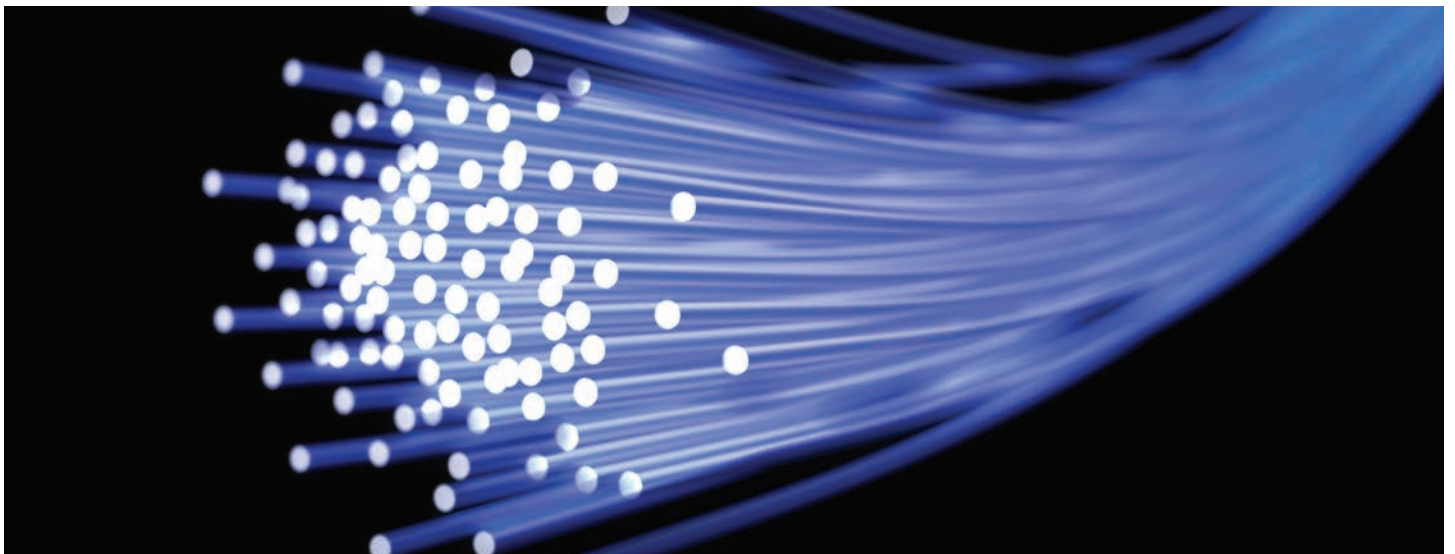
- Temperature profile with 1°C accuracy and 1 m resolution along the length of the pipeline
- Capable of sensing temperatures for sulfur pipelines from each DTS station or at end of line

BENEFITS FOR SULFUR TRANSPORT PIPELINES

- Verifies the thermal “as-built” condition of constructed pipeline, which creates a baseline for operations and identifies any potential areas of concern
- Facilitates pipeline operators and maintenance personnel in identifying day-to-day anomalies
- Facilitates the commissioning process by pinpointing the locations of inadequate, absent, or damaged insulation along the entire length of the pipeline
- Minimizes the risk of pipe damage during re-melting of solidified sulfur by precisely locating hotspots, plugs or voids along the entire length of the pipeline



Temperature Profile

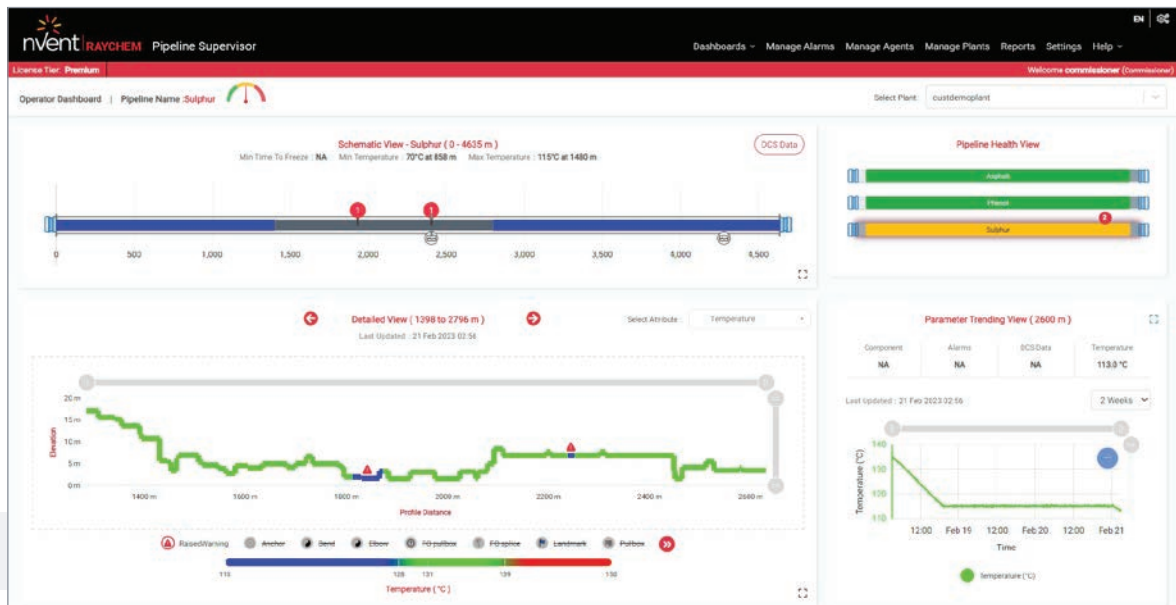


nVent RAYCHEM Pipeline Supervisor

DTS Pipeline temperature monitoring on an operating pipeline is very helpful, but often severely underutilized due to operator inattention or lack of data interpretation skills. This is why customized algorithms and machine learning, when combined with fiber-optic Distributed Temperature Sensing (DTS), can bridge the gap between “data” and actionable “information”.

WHY ARE PIPELINE MONITORING ANALYTICS NECESSARY?

- **Enhanced Risk Avoidance** – Operators need to easily visualize all the risks to keep the pipeline in a safe operating zone. Catastrophic pipeline ruptures lead to significant financial, environmental, and reputational damage to any company. The implementation of pipeline predictive analytics provides your organization with an additional level of protection to help lower the risk profile of critical pipeline assets.
- **Critical Situational Response** – When you lose power or need to ensure a uniform re-melt, critical monitoring and analytics minimize the risk state. Real-time data combined with targeted algorithms can help in significantly reducing hazards that are associated with unwanted operational situations or outcomes.
- **Operational Optimization** – Advanced alarm notifications of concerning trends or events are provided when an abnormality is detected by nVent’s algorithms, minimizing full-time operator engagement. A real time Health Gauge at the top of the dashboard provides a high level status indicator of your pipeline.
- **Flow Assurance** – Ensuring that the fluid in your pipeline is flowing (or ready to flow) by monitoring for a Uniform Thermal Profile is key. Remove the guesswork to verifying this critical prerequisite to starting your pumps.



RPS
Dashboard

NVENT RAYCHEM PIPELINE SUPERVISOR (RPS)

nVent RAYCHEM Pipeline Supervisor (RPS) is a culmination of nVent’s many years of experience troubleshooting, optimizing and maintaining our clientele’s temperature-critical Sulfur pipeline applications. We combine the power of distributed temperature data from DTS with specially customized algorithms that create a wealth of useful analytics, on a real-time basis. These analytics are configured to your specific pipeline geometry! They use time trending to create warnings/alarms of conditions along your pipeline, while also providing the time and location where problems are occurring (or may be about to occur).

Additionally, our proprietary sulfur pipeline re-melt program is designed to increase the safety and reliability of re-melting solidified sulfur in the pipeline. This invaluable assistance can dramatically reduce the risk of pipeline failures during sulfur re-melt.

- nVent RAYCHEM Pipeline Supervisor takes the Distributed Temperature Sensing (DTS) data from a fiber-optic sensor on a pipeline and continually analyzes it using complex algorithms. Essentially, it creates a “stethoscope” on the pipeline to understand what is happening in real-time, (e.g., temperature, phase change status, re-melted zones, rupture detection).
- Creates “actionable” tasks and “alerts” for operations & maintenance personnel that are data driven.
- Provides advance warning of heater performance degradation, or pipeline operations outside of normal parameters.
- Allows access to critical pipeline heating and temperature status remotely via Tablet, iPad, Smartphone, remote PC, etc.
- Configured for your specific pipeline service and operational design parameters.

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