Case Study

Raychem

Canadian Oil Sands Mining and Upgrading Plant Heated Sulphur Pipelines



PROJECT DETAILS

Applications:
One 6", 3.3 km, and one 4", 1.7 km, Molten Sulphur Transfer Pipelines

Technology:
Skin-effect Trace-Heating System (STS), Fiber Optic Distributed Temperature Sensing (DTS), Finite Element Analysis (FEA), Thermally Isolated Pipe Supports/Anchors, Pre-insulated Pipe and Mineral Insulated and/or Power Limiting Heat Tracing Cables on Long Road Crossing, Vents, Drains and Pressure Relief Piping.

Location:
Fort McMurray & Fort Saskatchewan, AB Canada

Date:
April 2009 & February 2013

Contract Scope:
Design, Engineering, Procurement, Construction QA & Commissioning

Client:
Multinational Oil & Gas Exploration, Development & Production Companies

DESIGN & INSTALLATION CHALLENGES

The Heat Management System for these Sulphur pipelines presented the following challenges:

- Implementation of the World's first Fiber Optic Distributed Temperature Sensing (DTS) system on a Sulphur pipeline with the challenges and learning curve that is inherent to any new technology application.
- Extremely low ambient temperatures during installation, commissioning and start-up of the STS and Fiber Optic DTS systems.
- Welding attachment of the heat tubes and fiber optic encasement tube and alignment of pre-insulated pipe spools on a small service pipe size (4").
- A tight range of allowable temperature from 125°C to 145°C for molten Sulphur with set points of 135°C and 138°C along the entire length of pipelines.
- Requirement to re-melt and heat-up solidified Sulphur without causing overheating or over-expansion, considering both pipelines had elevation changes that resulted in entrapped air or "empty" sections in the lines and in high and low localized temperature regions during re-melt.

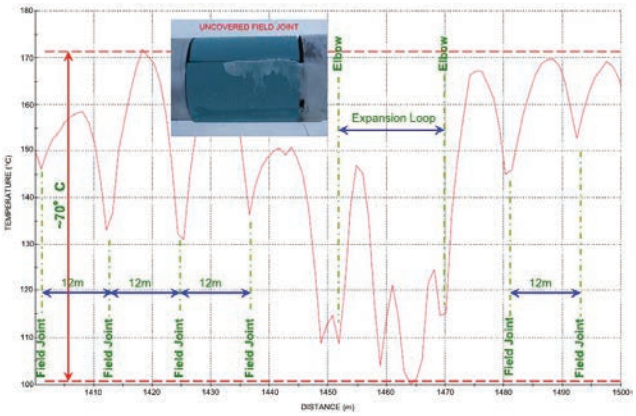
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DESIGN HIGHLIGHTS

Chemelex designed and commissioned the World's first Sulphur pipeline with fiber optic Distributed Temperature Sensing (DTS). Although this system was installed with the purpose of assisting Operations during both normal and re-melt operating conditions, it was invaluable when it came to trouble-shooting the insulation system prior to Sulphur introduction to the pipeline. Multiple insulation deficiencies were precisely found and corrected using this fiber optic temperature monitoring system.

The secondary Sulphur pipeline was subjected to two programmed re-melt tests during commissioning in order to ensure the safety and reliability of the design. One re-melt test was conducted with a single heater at full power and another was performed with both heaters at reduced power. Both tests were successful and served to validate the system's performance.

To meet the needs of these challenging applications, Chemelex employed the following heat management system:



FO Temperature Profile used for Insulation Troubleshooting

- An inherently safe Raychem Skin-effect Trace-Heating System (STS) which has high exposure temperatures and an efficient heat transfer to the pipe. The Raychem STS technology resulted in better heat transfer and a lower temperature differential between the pipe and cable sheath, thus leading to a safer design.
- A state-of-the-art Raychem temperature control and monitoring system with vacuum contactors, electrical fault protection, metering, and a multi-power heat delivery mechanism; reducing the total operating costs of the system.
- A Fiber-optic based Distributed Temperature Sensing (DTS) system that provides a dynamic pipeline temperature profile at each meter with 1°C accuracy, providing continuous monitoring of the temperature along the entire length of the pipeline.
- Finite Element Analysis (FEA) 3D modeling to determine the anticipated temperature profile of Sulphur across the cross-section of the pipe and during re-melt.

The following additional features were included in the design of the heating systems for these Sulphur pipelines:

- 100% redundancy of electrical equipment including the heat tube, STS wire, pull/splice and connection boxes, STS panels, STS transformers and RTD sensors. While both heat tubes were utilized under normal operation, each tube was designed to have sufficient output power to independently re-melt the entire Sulphur line under typical anticipated winter conditions. With this level of redundancy, maintenance activities could also be performed on the upstream electrical distribution system without affecting the operation of the line.
- Optimized composite thermal insulation with an inner layer of expanded perlite and an outer layer of load-bearing polyurethane foam.

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