Leak Detection - Application Note

Fiber optic leak detection sensing cable installation on ammonia pipelines

DiView Graphical User Interface

FIBER OPTIC LEAK DETECTION IN PROCESS AND CHEMICALS PLANTS PROCESS SAFETY MONITORING

THE SUREST WAY TO DETECT THE PRECISE LOCATION OF ANY LEAK IN HAZARDOUS SUBSTANCES PIPELINES AND PROVIDE TOTAL INTEGRITY THROUGHOUT YOUR PIPELINE NETWORK, ENSURING EFFICIENT, SAFE AND SECURE OPERATION

- Distributed Fiber Optic Sensors
- Leak Detection on the Continuous Length of the Pipeline
- Ethylene, Hydrogen (H2), Liquid Natural Gas (LNG), Liquid Petroleum Gas (LPG), Ammonia (NH3), Oxygen and other refrigerated gases
- Establishes a Clear Indication of the Leak and Location
- Suitable for Hazardous Zones (ATEX)
- Intrinsically Explosion Safe
- Immune to Electromagnetic Interferences
- Suitable for long pipeline lengths - jetty and export line - or dense areas - production -
- Outdoor, buried - trench, horizontal drilling - pipelines
- Suitable for retrofit on existing pipelines, any diameter
- Maintenance without operation shutdown
- Operation during transient phases
- High spatial resolution 1m and detection capabilities
- High Reliability and Confidence Level SIL 2

Fiber optic leak detection is part of modern Safety Instrumented Systems (SIS), integrated in plant DCS / SCADA, enabling to meet requirements set by hazard and operability (HAZOP) analysis.

Pipeline leakages may have different origins, such as **corrosion, fatigue, material flaws, shocks, abnormal temperatures, extreme pressures, or excessive deformations** caused by ground movement. In the case of ammonia, leakages can be detected by the rapid drop of temperature due to the evaporation of the released liquid ammonia and its evaporation gases.

These local thermal anomalies can be reliably detected by a fiber-optic distributed temperature sensing system able to detect temperature changes with resolution down to 0.1°C, with 1m spatial resolution and 10s response time. A fiber optic cable is installed under the refrigerated pipeline along its whole length and is connected to a measurement system that can automatically detect temperature anomalies which are telltale of a leakage and **generate an alert** to initiate appropriate response actions on the affected pipeline section.

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EXISTING TECHNOLOGY LIMITATIONS

Often leaks are not detected until the amount of leakage is large. By this time significant environmental damage may already have occurred.

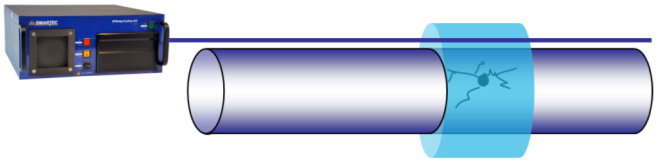
Even when conventional systems detect a leak, they are not able to pinpoint the location, leading to further delays and further expenses due to loss of product.

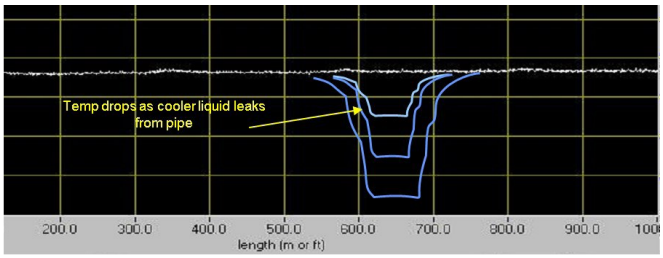
Sniffers and thermal cameras typically have high maintenance costs and require the installation of a large number of units to achieve a good level of coverage and small leakage detection performance.

Certain leak detection and inspection systems are used on a intermittent basis. If a leak occurs in between inspections, this will not be detected and critical safety levels may have been reached.

FIBER OPTIC LEAK DETECTION

The basic principle of pipeline leakage detection through the use of distributed fiber optic sensing relies on a simple concept: when a leakage occurs at a specific location along the pipeline, the temperature distribution around the pipeline changes. This change in temperature is localized both in space (a few meters around the leakage location) and in time (the onset of the leak). The origin of the temperature disturbance around the pipeline depends on the type of pipeline and its surroundings.

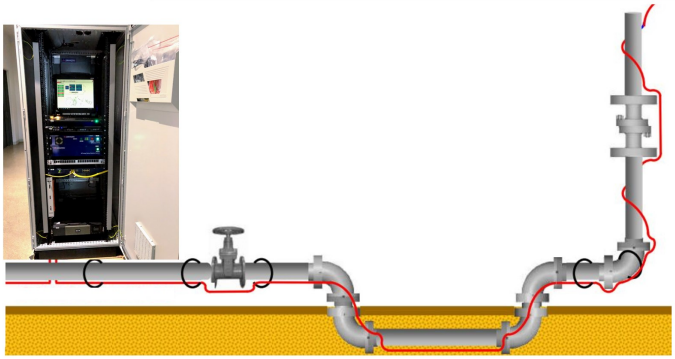




As product leaks from a pipe it can cause temperature differentials due to differences with ambient conditions or Joules Thompson effect.

In a **gas-carrying or liquefied gas-carrying pipeline**, when a leak occurs at a location along the sensing line the Distributed Temperature System (DTS) system will detect a localized temperature drop or “cold spot”. The gaseous substance flowing through the pipeline is cooled down by the pressure release through the leaking pipe section and cools the pipe section and the surrounding area. It is also possible to observe a hot-spot when a leak occurs in a gas-carrying pipeline, for example, in a pipeline carrying water vapor.

In a **liquid-carrying pipeline**, when a leak occurs at a location along the sensing line the DTS system will detect a localized temperature rise or “hot spot”. The liquid substance flowing through the pipeline is typically warmer than the structures adjacent the sensing line such that when the liquid escapes from the pipeline it tends to warm such structures. It is also possible to observe a cold-spot in the case of leaks from a liquid-carrying pipeline, for example, if the transported liquid is colder than the environment.



Fiber optic leak detection system installed along pipeline route

BENEFITS

Benefits to the Health, Safety & Environment Manager:

- Improved safety of infrastructure and to personnel
- Enhanced system reliability through reduced downtime
- Lower risk of environmental damage
- Improved productivity

Benefits at Operational Level:

- Leaks will be detected quickly thus minimizing risk to operations personnel, neighbors and the environment.
- The optic signals used for the leak detection are extremely low power and incapable of igniting flammable gases making then suitable for use in hazardous zones.
- The sensing element is a passive fiber optic cable with a design life of over 30 years with minimal maintenance costs .
- Micro leaks can be detected, allowing action to be taken early before leaks grow larger and cause potentially major catastrophes.
- System is fully automated lowering operating costs with less risk of human error. It can interface with existing SCADA and industrial control system using standard protocols (electrical relays, OPC, Modbus).

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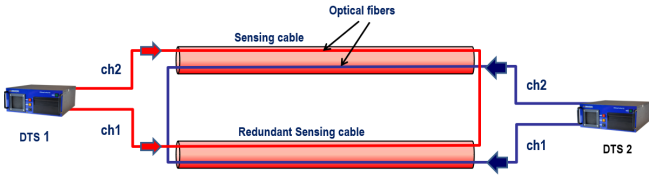
RELIABILITY AND AVAILABILITY

For mission-critical applications such as poisonous gas leak detection, several strategies can be used in order to ensure the reliability and high availability of such a system.

Optical fibers are always installed inside a cable to protect them mechanically, while ensuring the minimum possible thermal isolation. Additional strategies for increasing reliability and availability include the following:

- Using a looped cable, where both ends of the sensing cable are connected to separate channels of the interrogator
- Using cables containing multiple optical fibers
- Using multiple cables along the same pipeline
- Using two interrogators connected to different fibers in the same cable or to different cables enables a 2oo2 voting

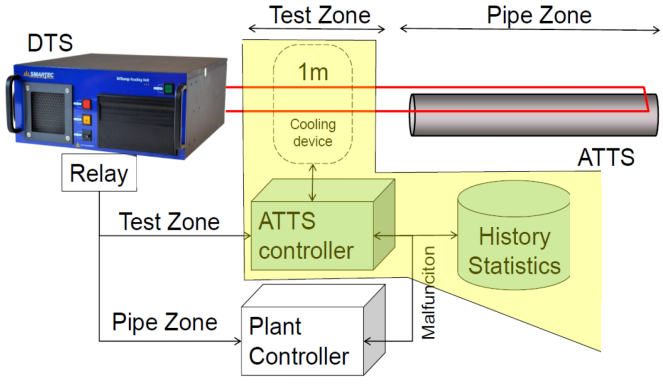


Redundant setup with two interrogators and looped fibers.

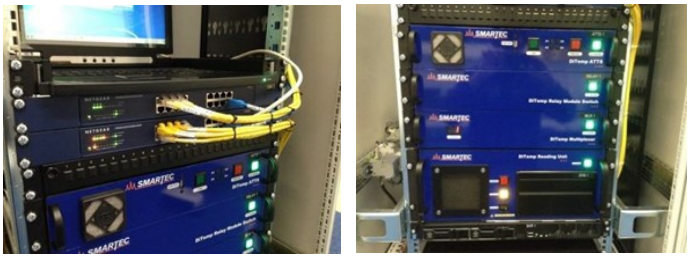
CONFIDENCE LEVEL

The SIL Leak Detection System is a fully integrated solution that delivers market leading performance.

The patented ATTS (Automated Trip Testing System), fully independent of the data acquisition system, monitors the performance achieving SIL 2 availability. Full alarm capability and allows easy connection to main distributed control systems. Site Integrity Leak Detection Systems are used in safety critical applications.



ATTS block diagram (ATTS in the shaded zone).



Modular assembly in rack cabinet- Multiple channels: 4, 8 and 16 channel multiplexer modules available to increase system flexibility

SYSTEM COMPONENTS

The fiber optic leak detection is based on a combination of sensing cables, measurement instruments and data processing software.

Different cables are available for temperature sensing (cryogenic, normal and high temperatures); the cables are designed to be installed on the pipeline surface or in its vicinity.

The Distributed Temperature (DiTemp) measurement instruments can measure sensors with a length of up to 2 x 30 km (upstream and downstream), the fastest measurement speeds and achieving temperature resolution of 0.1°C in field applications.

Software packages are available for detecting leakages of gas, fluids and multiphase pipelines, to display and publish the measurement results in a user-friendly interface, and to generate warnings when abnormal conditions are detected. GIS maps available to highlight precise locations of events.

The system delivers an intelligent and robust leak detection warning insensitive to external perturbations (electro magnetic fields, lightning, humidity, rain etc...).

Versatile installation procedures; thermal mapping of vessel, leak detection on any pipeline arrangements

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ACCESSORIES AND READOUTS

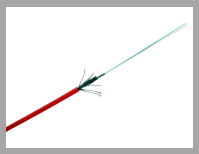
DiTemp DTS XR Reading Unit

DiTemp External Optical Switch 4 / 8 / 16 channels

DiTemp Harsh Reading Unit

DiTemp ATTS (Autotest)

Junction box (Atex)



Fiber Optic Temperature Sensing Cable

Fully redondant cabinet

DiView software interface on remote display

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They trust us

YARA, AtkinsRéalis, Grupa Azoty, OQ, sener, LAT Nitrogen, MAXAM, KEM ONE, SAIPEM, QAFCO Qatar Fertiliser Company

Services

- System Design
- Support on Installation
- Commissioning
- Data Management
- Data Analysis
- Cybersecurity

Other available Application Notes

- FO Leak Detection for Dams and Dikes
- Dam & Dike Instrumentation and Safety Monitoring
- Tunnel Instrumentation & Structural Health Monitoring
- Bridge Instrumentation & Structural Health Monitoring
- Building Instrumentation & Structural Health Monitoring
- Historical Monument Instrumentation
- Geotechnical and Structural Monitoring
- Nuclear Power Plant Instrumentation
- FO Movement Detection in Tunnels
- FO Leak Detection for Chemical Plants
- FO Leak Detection for Pipelines
- Storage Facility Instrumentation
- LNG Pipelines Monitoring

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