APSENSING.

Wet Oil Pipeline Monitoring

Barnstorf, Germany

Project Overview

AP Sensing is monitoring two buried wet oil pipelines utilizing our Distributed Temperature Sensing (DTS) and Distributed Acoustic Sensing (DAS) systems for leak detection. This complex project utilizes advanced leak detection techniques to provide a very low false alarm rate and high detection capabilities. AP Sensing was initially selected for the project based on previous experience that the customer, Wintershall Dea had with AP Sensing's systems through its partner GESO. In the end, Wintershall Dea was incredibly satisfied with the system capabilities.

The first pipeline, „Bockstedt", is a 6-inch pipeline nearly 9 km long, buried 100-120 cm below ground. It utilizes a 1-channel N4386B DTS instrument with a measuring range of 12 km, connected to a multi-mode fiber within the fiber optic sensing cable, which is installed at a distance of approximately 10 cm along the pipeline.

The second pipeline, „Dueste", is 13 km long and includes 6-inch and 4-inch sections. It is buried 100-120 cm below ground and monitored by a 1-channel N4426A DTS instrument with a measuring range of 20 km, connected to a single-mode fiber. The fiber is installed approximately 10 cm from the pipeline. In addition to the DTS system, a 1-channel N5000A DAS system was installed to track the Pipeline Inspection Gauges (PIG).

The DAS System is connected to a second single-mode fiber within the fiber optic cable (FOC) and configured to monitor the pipeline in real time, visualize acoustic energy over time/distance in waterfall plots, and store the measured data on an external storage unit.

Background

- Monitoring of two buried wet oil pipelinesnear Barnstorf, Germany, with different configurations and insulation types
- Unburied pipelines require advanced leak detection due to possible thermal fluctuations

Solution & Benefits

- DTS and DAS systems deployed with SmartVision for real-time monitoring and visualization
- Multiple detection methods used (gradient-based, machine learning) to ensure low false alarm rate and high sensitivity
- System successfully identified simulated leaks with precision, even at low volumes and temperatures

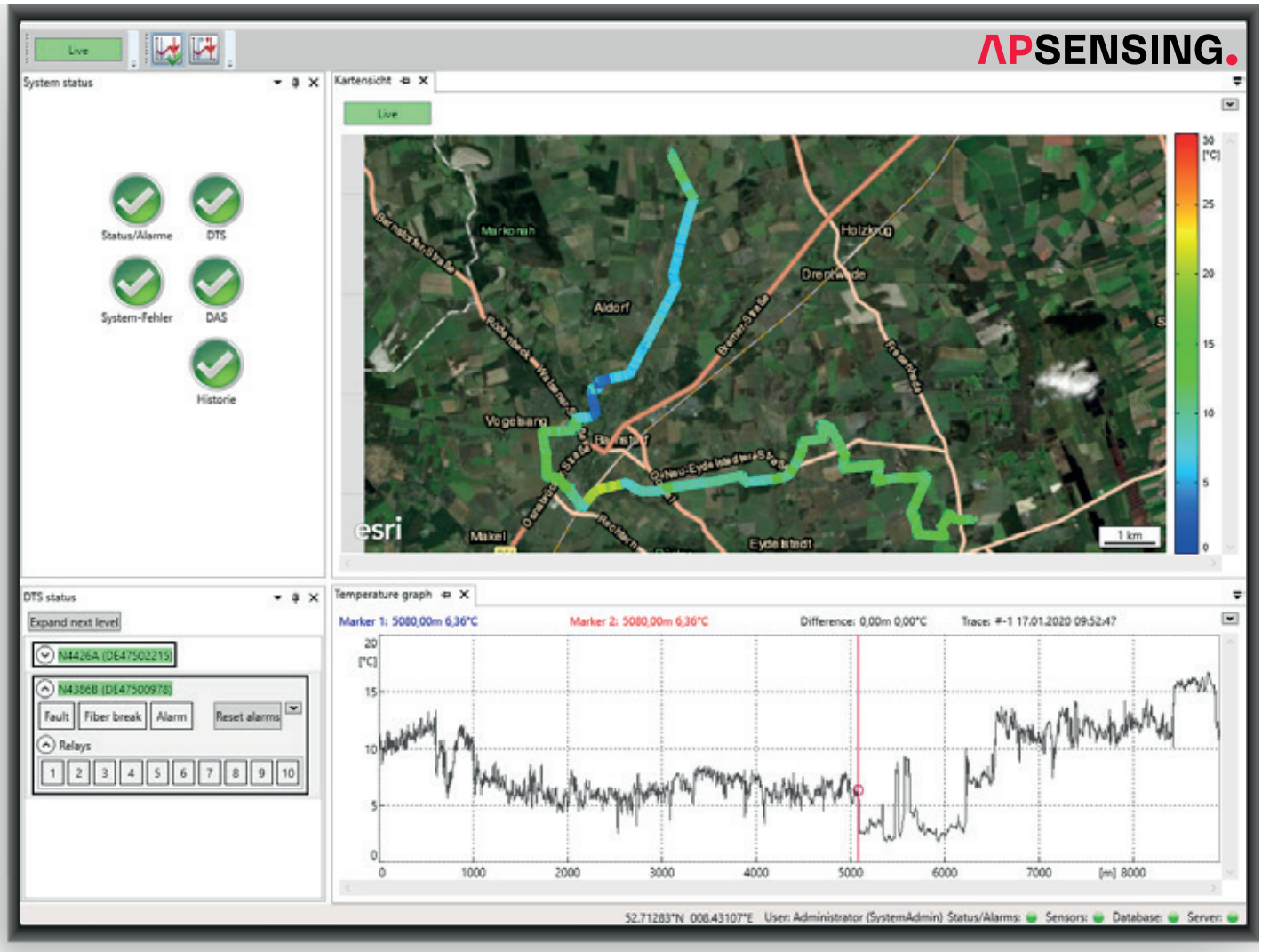

Figure 1: SmartVision operator interface

The main challenges of this project include the existence of different sensing fiber types along both pipelines, and particularly the different configuration of such pipelines. While the one pipeline is thermally insulated, the other is not and therefore the temperature fluctuations in the pipeline (including hot water treatments) would reach the sensing cable and influence the leak detection capabilities. Our advanced leak detection techniques eliminate these effects while retaining high detection capabilities and a low false alarm rate.

SmartVision

AP Sensing's monitoring software SmartVision is installed on the main server, which is mounted in the DTS/DAS cabinet. A SmartVision client version is also installed on another PC, which is used to visualize the asset, the temperature traces and the leak alarms in the control room. The MapView is implemented in SmartVision to visualize both pipelines and the corresponding temperature profiles in a single map based on the corresponding GPS coordinates. The benefit of the MapView is to make locating a leak event as simple as possible for an operator.

Leak Detection Technology

The oil leak detection in this project is based on the DTS measurement technology. The DTS measures the ambient temperature on the fiber optic cable and raises an alarm if the ambient temperature changes within the defined time period.

Because the oil temperature is higher than the soil temperature, a significant change in temperature

signifies wet oil leaking from the pipeline. Several parameters are included to take into account temperature changes caused by daily routine, oil production, hot water treatment of the pipeline, spatially varying FOC laying conditions and other effects, and to eliminate them as much as possible.

APSensing uses several methods to detect a leak:

- **Classic detection** utilizing maximum/minimum temperature thresholds, difference to average zone temperature, and positive/negative temperature gradients. This can be easily configured and operated, but can also have restrictions, especially during changing operating conditions.

- **Gradient based** detection utilizes analysis of the temperature history and an analysis of the ambient temperature for each position. The results are combined mathematically to determine a measure of unusual behavior and trigger alarms when a certain threshold is exceeded. This method achieves a higher sensitivity than classic detection, and smaller changes in temperature can be detected. This method is used for both pipelines in this project.

- **Machine learning transient leakage detection** eliminates faulty alarms during heating, for example, due to hot water treatment or during a temperature change in the pipeline that can be attributed to a sensor cable that is not installed at the same distance from the pipeline. Based on a few weeks of pipeline operation, a pipeline fingerprint can be generated and alarm thresholds can be defined. This method is also used for both pipelines in this project.

Results

After calibration of the DTS temperature traces and mapping of the sensor fibers to the pipelines, data was collected over several weeks to build the machine learning models and calculate the corresponding alarm parameters. A validation of the alarming concept took place by simulating a real leak using a dedicated setup, which injects water at a specific temperature and flow rate on the pipeline. All leak tests were successful and AP Sensing's monitoring system alarmed correctly at the exact location of the simulated leak.

The project was commissioned in November 2019; final leak tests occurred at the end of February 2020 and were assisted by TÜV Nord. The system was able to alarm a simulated leak where the injected water was only around 20°C and reached a total volume of 230 liters, corresponding to only 1.4 barrels. The customer was extremely satisfied with the alarming capabilities of the system.

www.apsensing.com
info@apsensing.com