



Repairing pipeline holes is enormously cost-intensive, but no business can afford to ignore them. PAS Process Automation Systems Ltd. developed a monitoring system for pipeline leakages in 1997 (Leakage Detective System – LDS) to meet the demands of Čepro, a Czech company that operates oil, gas, and diesel pipelines as well as large tank storage facilities. The main demands were for a system that can report the detection of a leak within five minutes to a dispatcher and specify the position of the leakage with the highest possible accuracy.

The system detects very small amounts (a few liters) of missing oil, fuel, water or also gas, if the operating pressure in the pipeline is >4 bar. Holes with a diameter of a few millimeters (ratio of 1:100 to the pipeline-inner diameter) are identified. The position of the leakage is localized to within a range of 20 meters for pipeline systems of several 100 km in length. LDS is running currently on more than a thousand kilometers of pipeline in the Czech Republic, Russia and in the Ukraine with the companies Čepro, PDMN and Gazprom.

System design

The solution that has been developed – the so-called Sherlog Security Pipelines – is based on B&R automation devices. The individual measurement stations in the central station and along the pipeline are equipped with B&R controllers from the 2010 and 2005 series. The B&R process control system APROL is also part of the Sherlog System. APROL's reporting, alarm, trend and visualization options are optimal tools for controlling the distributed measurement stations or for using remote access (WAN, Internet, etc.) from the control room. The precision, provided by 16-bit analog input modules, real-time and arithmetic operations, makes the high sensitivity and accuracy of Sherlog possible.

In addition to LDS, applications such as control and monitoring of gas/oil stations, compressor stations, flow computing and controllers are required almost on every pipeline. This large range of additional functions can be implemented in Sherlog using the many functions of APROL.

Monitored Pipelines

Nonrenewable energy sources such as oil and gas and their refined products are of enormous importance to the world economy. The efficient production and safe transport of these raw resources is both vital for efficiency reasons, but also for protecting the environment. Therefore, holes appearing in a pipeline are a problem that should not to be underestimated. They are caused either by corrosion or intentionally by theft, when holes are illegally drilled in pipelines to siphon off oil or refined products. To avoid soil contamination and theft of raw resources, such leakages must be located as quickly as possible.

Method

Sherlog Security Pipelines rely on the precise measurement of pressure changes and statistical process analysis of pressure trends on several locations of the pipeline. Therefore, only a pressure measurement is necessary. No physical measurements of temperature, flow and density are required. The statistical process considers the following factors: The homogeneity and status (liquid/gas) of the medium, unnatural pressure fluctuations, higher hydraulic noise inside the pipeline and any transitional effects. All of these parameters reduce the sensitivity and the accuracy of the measurement methods. The sensitivity of the system is expressed as the ratio of the inner pipe diameter to the diameter of the detected leakage. Currently, a ratio of 1:100 is achieved. This means with normal operating pressure and without pressure fluctuations, the system can find holes with

a diameter of 8 mm within 5 minutes in a pipeline with an inner diameter of 800 mm.

Adaptability

Measurement sensitivity during pressure fluctuation is dynamically adapted to the current status in the pipeline so that false alarms can be avoided. During large pressure fluctuations, sensitivity drops. When conditions are back to normal, sensitivity increases again.

The highly developed algorithm recognizes natural variations inside the pipeline, such as a decrease in the outside temperature, interface diesel – petrol or changes in the topology structure of the pipeline. For this purpose, the system uses pressure transmitters from Fisher Rosemount 3081 SMART, HART communicator and B&R controller systems 2010 or 2005 with high resolution (16-bit) analog input modules (AI730, AI780).

Accurate leakage localization

The operator is informed of the position of the leakage as a distance between the beginning of the pipeline \pm absolute tolerance. The position of the leakage can be localized to within an area of 20 meters, for pipeline systems of several 100 km in length. The tolerance takes into consideration all disturbances that are evaluated by the system. Leakage identification requires two different reference points. The first value comes from one of the many measurement stations that are erected along the pipeline. The second value comes from the central station. The measurement station detects the leak within a few seconds depending on how far the leak is from the measurement station. The central station evaluates the situation along the whole pipeline and displays the result within five minutes.

This time period is required to read and evaluate the information from the stations. In the case of incorrect pressure measurement or an error in one of the measurement stations, the ability of the system to detect a leak remains unchanged. The accuracy of leakage localization decreases and the system reports a corresponding wider tolerance band for the calculated location of the leak.

Avoiding false alarms

The pressure measurement is processed by several methods that are not dependent on each other. This eliminates the influence of operating modes, inner temperature and measurement errors.

Alarms triggered by the operation of control valves, the closing of valves or branching can be suppressed using the configuration or by position condition scanning.

The PAS pipeline monitoring system currently monitors more than a thousand kilometers of pipeline for crude oil, fuel and gas in the Czech Republic, Russia and in the Ukraine. In the near future, transmission pipelines in Kazakhstan, Egypt, Rumania, Saudi Arabia, Brazil and India could be monitored with the PAS system, as PAS is currently engaged in talks with companies from these countries. 



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Process Automation Systems Ltd.

The Czech company founded in 1991 has essentially three main pillars: Industrial automation, monitoring systems for detecting pipeline leakages (Leakage Detecting System - LDS) and building control systems. With a total of 20 employees, the company makes an annual turnover of 1 million US dollars. Among its customers are the largest Czech refinery Česká Rafinérská, the Czech petrochemical market leader Chemopetrol Litvinov, the large Czech mining company Appian Group as well as Prague Airport (airline fuel supply system) and customers from the sewage treatment sector.

LDS developed in 1997, is used mainly by companies from the Czech Republic and the Russian Federation at the moment (Čepro, Transgas a.s. and Gazprom). However, companies from India, Brazil and the Persian Gulf have recently signaled an interest in the unique system.

Since its start-up phase, PAS has been working with B&R, and both companies share a longstanding history of cooperation. Customer applications are exclusively based on B&R hardware, and the LDS is also equipped with B&R hardware and standard software.

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System configuration with the distributed measurement stations

