New methodologies in leak detection

No matter how much attention is given to accident prevention, systems need to be in place to alert pipeline operators in the event of an incident. The in-line Integrated Leak Detection System can provide this safety net.

Leaks in liquid and gas pipelines always imply material losses. In some cases, an incident can turn into a critical event, particularly when the transported fluid is dangerous. Worldwide, pipeline operators are continuously increasing their efforts and investments towards integrity programmes, with the goal of preventing these undesirable events and consequently decreasing direct and indirect costs arising from areas such as remediation, penalties, reparations, damaged public image and stock devaluation.

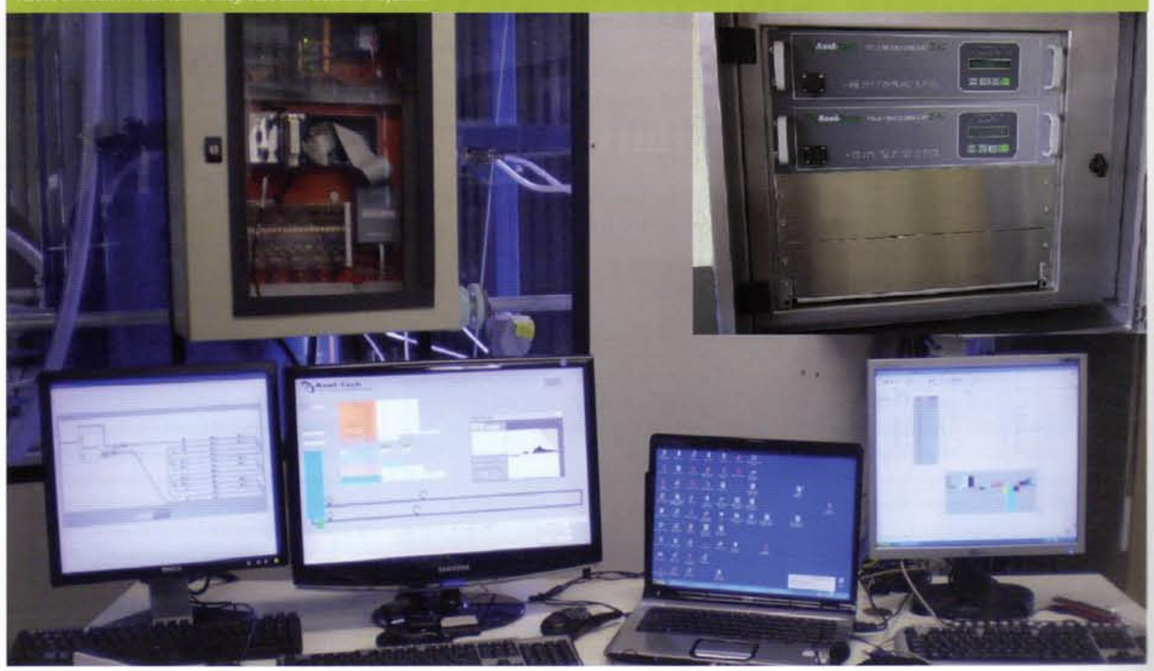
However, there's always a chance that an accident will occur, no matter how much attention is given to its prevention. For this reason, leak detection systems (LDSs) play an important role within integrity programmes. An LDS is a specially designed tool that helps operators to identify and react to a leak. The in-line systems continuously monitor the pipeline, and alert the operator to deviations that occur in particular operational conditions associated with leaks. Speed of response, sensitivity, reliability, accuracy, and robustness are the common parameters used to differentiate and assess systems, as is the highly desirable characteristic of their applicability to a wide range of scenarios.

Asel-Tech's new Integrated Leak Detection System (ILDS) has been designed around these characteristics, and features two different methodologies for detecting leaks:

- Negative pressure wave
- Mass imbalance.

These methodologies are designed to work together in the ILDS, in contrast to other LDSs where two or more techniques are bundled into a single package but run as isolated subsystems. In addition, a bi-directional collaborative implementation

Above and below: Asel-Tech's Integrated Leak Detection System.



produces a synergistic improvement in overall performance.

Negative Pressure Wave

The negative pressure wave subsystem, also known as sonic or acoustic, identifies the characteristic fluid dynamic transient wave that propagates through the fluid following a leak, and travelling long distances in both directions. Transducers installed at both ends of the monitored section of a pipeline can detect and transform pressure into an electrical signal, which is then read and analysed by dedicated field processing units (FPUs). The arrival time of the wave front at each sensor is registered and, since the wave propagation velocity is a known constant for each fluid in a pipeline, the precise position of the leak can be easily calculated.

The presence of background noise and operational events, such as those originated by a pump start or stop, or valve opening and closing, require several different filtering techniques to extract the characteristic leak signature. An important aspect of this subsystem is an artificial neural network (ANN) used for leak standards recognition, which significantly reduces the probability of false alarms.

Mass imbalance

Highly recommended in API 1130, the mass imbalance subsystem analyses the behaviour of line-pack variation compared to the difference between the inlet and outlet flows. The model uses measurements of flow, temperature, pressure and density taken at both ends of the monitored section; the pipe and fluid specifications; and, pressure and temperature measurements at intermediate points. Computational fluid dynamics' algorithms based on real-time transient models run cyclically at the system's central monitoring station, producing a curve representative of the behaviour of the line-pack variation relative to in-out mass variation. Again, techniques based on ANN qualify this behaviour, as being typical of a leak or not.

Working together

In order to validate an alarm, Asel-Tech's validation module crosschecks the corresponding signals received from both subsystems, as well as qualitative and quantitative analyses of other variables, such as the tendency of mass variation. Once recognised and declared as a leak alarm, the event is displayed to the operator with details of the moment it started, its exact location, the instantaneous leak rate and total spilled volume.

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Recently, a 2 km test loop has been scheduled for construction in the United States, and this will be used as a demonstration platform to train operators with real leak detections simulations. A fully automated control system and special tools will allow for leak behaviour emulation under various operational conditions.