Discovering remote monitoring for nitrogen sleeves

Many older pipelines on the UK gas network have sleeves, mainly at sensitive locations where additional protection is required. Some sleeves contain pressurised nitrogen to provide protection against corrosion but these also necessitate manual checks and refills at high cost. Northern Gas Networks (NGN) is the first gas utility to install remote monitoring on all its nitrogen sleeves, resulting in greater efficiency, safety gains and improved compliance. Kevin Young, NGN's integrity manager, describes how the technology has worked for them.

Gas pipelines passing under arterial roads, rivers, railways, other pipelines or densely populated areas require additional protection against damage and corrosion.

One method used during pipeline construction in the 1960s and 70s was to encapsulate the pipeline with a metal "sleeve" at sensitive points (*see Figures 1A and 1B*). The sleeve provided additional physical protection and, through pressure containment in the event of a pipeline failure, protected the public.

Modern design uses heavy-walled pipes to achieve the same objectives. So sleeves are not an issue for the future – but they remain an important maintenance issue within the gas industry.

Figures 1A and 1B: Nitrogen sleeves in various shapes and sizes.

Impressed current cathodic protection (CP) is used on high and intermediate pressure steel pipelines to protect them at areas of coating damage or imperfection.

Transformer rectifiers provide a high direct current (DC) output that is capable of protecting long lengths of pipeline.

With CP systems, the use of protective sleeves has a disadvantage. At the forged end, where the sleeve is in contact with the pipeline, the CP transfers from the pipeline to the sleeve. The pipeline is at greater risk of corrosion, even if it is at less risk of damage from impact, compaction and vibration. This is an issue for all pipeline operators and some serious incidents have resulted from the failure of a sleeved pipeline due to corrosion effects.

In the UK, one solution was to fill the annulus between the pipeline and its sleeve with nitrogen gas. Nitrogen provides an inert atmosphere, but its pressure must be maintained to avoid ingress of water and oxygen and to prevent corrosion taking place.

Older sleeves often proved vulnerable to leakage at the epoxy ends and at the gas fill points as hoses and fittings perish over time. To maintain adequate protection the pressure within the sleeve, 1 bar when filled, should not typically fall below 0.6 bar.

Operators check the sleeve pressure manually, typically every three, six or 12 months. A sleeve might measure 150 metres by 900mm in diameter so refilling it from a nitrogen gas bottle is labour-intensive and the access point may be in an inaccessible area or at the side of a dangerous road.

Figures 2A & 2B: Merlin nitrogen sleeve monitors

Northern Gas Networks and remote monitoring

Remote monitoring fits well with NGN's strategy, including the RIIO formula review, to the make best use of innovation and technology and to help reduce its carbon footprint.

NGN was the first gas utility in the UK to deploy the Merlin remote CP monitoring system. With over 100 nitrogen-filled sleeves throughout its network, NGN approached Abriox Ltd, supplier of the Merlin system, to discuss whether it could also monitor nitrogen sleeves.

This resulted in two developments for nitrogen sleeve monitoring:

1. A single enclosure containing all electronics and an internal pressure sensor (*see Figure 2A*), designed for GRP enclosures
2. A communications module with an external pressure sensor (see Figure 2B), designed for slim posts.

The Merlin measures the sleeve pressure, checks that it is within the permitted limits and emits an alarm immediately if a certain threshold is exceeded.

Data is reported automatically to Abriox's iCPSM web-based software where NGN can configure the Merlin monitors and view or export the data.

Pilot project

In an initial pilot project, NGN installed Merlin monitors on five nitrogen sleeves with the aims of:

1. Minimising the requirement for labour-intensive visits to sites to take manual readings
2. Allowing a more proactive approach to the management of such assets
3. Limiting damage to the environment

The data collected from most of the sleeves showed no visible loss of pressure over a five month period.

Where the nitrogen sleeve was holding its charge it could be presumed that no corrosion was taking place within it and the requirement for a routine site visit was reduced.

However, where the sleeve pressure had fallen from a fill level of 1 bar to 0 bar within two weeks, NGN was able to ascertain that the sleeve required immediate inspection as it was clearly not maintaining pressure.

Previously, this issue might have gone undetected until the sleeve was next checked, during which time the pipeline would be unprotected against corrosion.

Figure 3: Repair of sleeve

Project implementation

NGN is now extending the Merlin project to monitor all its nitrogen sleeves. The frequency of maintenance no longer has to be at fixed intervals. Knowing how long each nitrogen sleeve will hold its charge allows NGN to plan exactly when it needs to be topped up, based on the pressure decay rate, and to react promptly to exception alarms.

The Merlin sensor is far more accurate and stable (+/–0.25 per cent full scale over a temperature range –20 to 85°C) than it needs to be, so calibration is not onerous.

The system should be totally suitable for the application for at least five years. However, NGN will check a small, random sample of the sensors annually as good practice.

The sleeve pressure data is an asset health indicator. NGN has reviewed the whole status of its nitrogen sleeves and is creating management plans to deal with the remedial workload, including:

3. On-line inspection data (where available) including the gas pressure in the pipeline, its diameter and rural or urban classification
4. Records, both recent and from construction including the coating specification of the parent pipe and information on its construction
5. Maintenance history and inspection including CP and any known coating defects

NGN is also able to carry out repair work on the end seals. The example in *Figure 3* shows epoxy shell technology. It involves large, deep excavations that are expensive but reasonably practicable.

In conclusion, the benefits of remote nitrogen sleeve pressure monitoring to NGN include: improved compliance with regulation, policy and procedures; improved protection against corrosion of the pipeline within the sleeve; a reduced risk to NGN's workforce and real-time analysis of data which is easily accessible without having to search through records.

The system also allows the automatic identification of units that are signaling an alarm on a "need to know" basis, without requiring site visit paperwork and efficient risk-based management and monitoring of the nitrogen sleeve readings.

Other benefits include reduced direct labour operational costs for manual pressure readings and additional cost saving through the elimination of unnecessary site visits while skilled labour can be diverted onto fault-finding and tackling key maintenance issues. ■