TraceTek

Acid Leak Detection

A White Paper from Tyco Thermal Controls

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Abstract

Environmental pressures are becoming a significant issue for a whole range of industries where strong mineral acids are either employed in manufacturing processes, created as a by-product, or as waste.

Leading companies already adopt a regime of good maintenance, training, spill and leak mitigation procedures. Increasingly, they are also seeking better ways of detecting acid weeps or leakage at the very earliest stage. They are fully cognisant of the damage that an environmental incident can have on their corporate reputation.

In this white paper we touch briefly on some of the strategies that have been employed in the past and we explore how innovative sensor cable technology can provide an efficient and cost effective means of detection.

Introduction

Environmental issues have a very strong resonance today with the general public and companies are now expected to account formally for their environmental, social and corporate governance within the Annual Report. The pressures from governments, regulators and environmental pressure groups are particularly strong for those involved in the production of phosphate fertilizers, pharmaceuticals, purification of petroleum, dyestuffs, smelting, electroplating or the reprocessing of spent nuclear fuel.

The challenge for companies participating in these processes is the need to store and transport highly corrosive acids in a potentially complex system of tanks and overhead or underground pipelines, with an associated range of potential leakage points such as threaded and flanged pipe joints, pumps, valves, manifolds, gaskets, elbows, tee-joints, nipples, etc.

Computational Pipeline Monitoring systems, or Supervisory Control And Data Acquisition (SCADA) techniques, while practical in detecting large leaks associated with major incidents and extended geography of oil and gas transmission pipelines, are not viable for most operations involved in the transportation and storage of acids over shorter distances and in batch flows.

Most companies deal with the risk of acid leak through a combination of containment and visual inspection. Several techniques are available to enhance the effectiveness of visual inspection, such as the use of florescent dyes together with suitable leak inspection lights, or color-changing leak detection paint. Clearly, these are useful only where pipelines are visible. Physical inspection can be time consuming and is subject to human fallibility.

Leak detection paint can be effective for use in in-line inspection

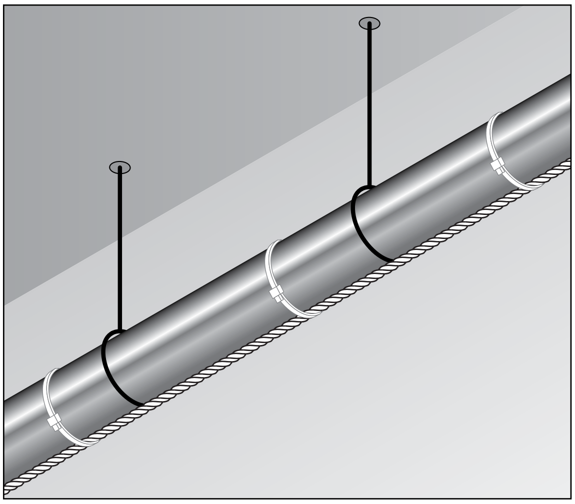
At least one company employs nylon tubing to extract vapor samples from concealed points along the line for analysis. We suspect that the time taken to revisit each sample point, and the amount of vapor that must be analyzed, makes for a rather slow overall response.

Helium testing is a special leak-locating technique sometimes used during commissioning but it does not present a practical solution for a working plant.

Leak detection cabling techniques are used very effectively for indoor water and aqueous chemical leak detection but have not so far been practical for the outdoor detection of strong mineral acid leaks. The older cables couldn't be used because they also detected and reacted to casual water sources like rain or snow melt.

Distributed acid leak detection cable

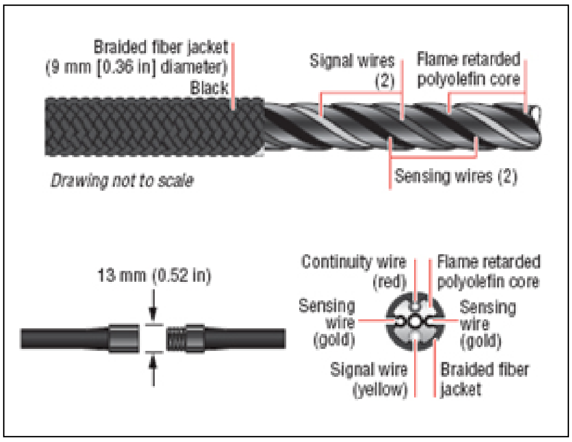
Earlier this year, the TraceTek product group of Tyco Thermal Controls LLC announced a new sensor cable that directly targets concentrated sulphuric and nitric acids.



TT7000-HUV sensing cables are primarily intended for use on overhead piping, vertical pipe, valves and manifolds and other fittings where concentrated sulfuric or nitric acid could leak. Sensing cables can also be used on floors, in drip pans, in sumps, trenches and underground in slotted conduit.They may be pulled into double wall containment pipes or tanks to monitor interstitial space.

The unique feature of this new TT700-HUV cable is its ability to ignore rain, snow melt, wind-blown sea spray or other sources of water that would have triggered previous generations of sensor cable.

When used with associated monitoring instrumentation, the cable senses the presence of acid, triggers an alarm and pinpoints the location of the acid contact to within +/- 1 m accuracy. It is designed to ignore casual water, whether from condensation, riser leaks, breaches in the containment pipe or similar sources.



TT7000-HUV TraceTek sensing cable for strong mineral acids

The cable consists of a four wire bundle spiraled around a central core. Two wires are insulated with a fluoropolymer insulation selected for its resistance to acid attack. They are designed to remain intact and insulated even after contact with acid.

The two remaining wires are jacketed with a varnish-like insulation material that will hold up in water from any source, organic solvents, fuels, dilute and weak acids and other nuisance liquids that might be encountered in a working plant environment.

If, however concentrated acids (sulfuric > 75% concentration or nitric > 50% concentration) make contact, the insulation material dissolves exposing the underlying conductors. The acid itself is then used as a conductive charge transfer electrolyte which permits ionic conduction from one electrode to the other, allowing the acid spill to be detected and located.

A small DC excitation voltage is applied in several combinations to the four conductors that make up the cable in order to assure that the cable has not been disconnected or damaged. The cable is fully supervised and the user is notified if any damage has occurred which would impeded the system's ability to detect and locate an acid leak.

The outer polyester fiber rope layer provides wicking action to assure close contact between any acid drips and the cable core. It also provides mechanical abrasion protection and pulling strength during

		Typical response time at 20°C (68°F)	Typical response time at -5°C (23°F)
Acid Response Time	96% sulphuric acid	Less than 90 seconds	Less than 7 minutes
	90% sulphuric acid	Less than 3 minutes	
	75% sulphuric acid	Less than 5 minutes	
	69% nitric acid	Less than 90 seconds	Less than 15 minutes
	37% nitric acid	Less than 5 minutes	

installation in double containment pipes. A key benefit of the Black polyester outer braid is that it supplies a UV resistant 'sun-shield' to provide extra UV protection for the cable core.

Operating environment

TT700-HUV sensor cable is designed for demanding indoor or outdoor environments and has been designed to be permanently resistant to water in normal use.

Qualification testing has been done in salt water, hot water & tap water for extended periods and no sensing cable degradation is observed.

In addition to UV radiation protection, the cable can be exposed to rain, snow, fog, condensation, dust, blowing dirt and other contaminants without causing a false alarm.

Instrumentation

The instrumentation (TTSIM-1) provides excitation voltage that attempts to drive current from one electrode wire to the other every few seconds. No current flow is possible until an acid leak occurs.

It is only after the selective insulation has been attacked and dissolved by acid that current can flow from one electrode to the other. The TTSIM-1 monitors the sudden increase in current flow, infers that a leak has been detected and alerts the operator to the event.

A further set of measurements managed by the TTSIM's on board microprocessor permit the calculation of the leak location.

Leak location

Calculation of the leak's location is made only after detection has been confirmed. The cable is manufactured to a tight ohms/meter tolerance such that the leak location can be calculated with precision. Typical location accuracy is +/- 1 m for a 1000 m circuit.

Installation

When used to monitor suspended or rack mounted pipe, TT7000-HUV sensing cables must be attached to the pipe system at the lowest point where any acid leak is most likely to drip from the pipe system. Usually this will be the 6 o'clock position on horizontal piping but other mounting locations and techniques may be necessary if site conditions are unusual.

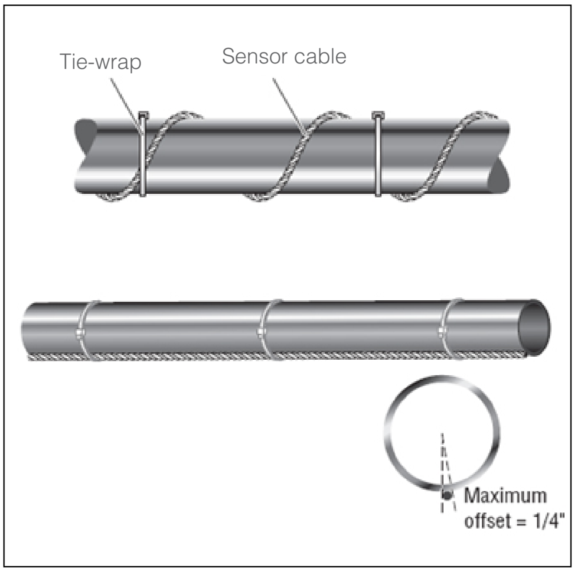
In particular, special consideration should be given to pipe supports, couplings, "T's", valves and other fittings. It is the responsibility of the installer to position the cable such that any leak will drip onto the cable.

In some installations, the materials or structures beneath the pipe system may be so critical or valuable, that a drip tray system should be considered in addition to the sensor.

For pipeline applications:

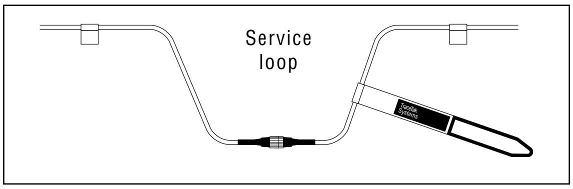
- The cable should be along the bottom of the pipe, using tie-wraps to secure the cable at the 6 o'clock position. Cable position should be maintained within 1/4 in (6 mm) of 6 o'clock position.
- One tie wrap should be used every 12 in to 18 in (300 to 450 mm) along the pipe, with extra tie wraps at fittings or bends as needed.

Important: It is the installer's responsibility to position the sensor cable correctly. The cable must trace the lowest point of the pipe or fittings such that any acid leaking from the pipe or fittings will drip onto the cable surface as it drips off the bottom of the pipe or fitting. The cable should not be used on the top or side surface of a pipe. It should not be used to spiral horizontal pipes.



Configurations for vertical and horizontal piping

Exception: If the cable is used to trace vertical pipe, the cable should be spiraled around the pipe and secured with tie-wraps. B.



For sumps, containment trenches, and subfloor applications, a service loop should be provided at each cable connector.

Care must be taken not to exceed the maximum pulling force of 100 kg (220 lb).

One-way, unambiguous detection process

When acid of sufficient concentration attacks the cable, the outer layer of the electrode insulation is dissolved. The resulting detection alarm and location calculation is complete and unambiguous, but the one-way detection process imposes certain testing and maintenance considerations.

The cable must not be tested with acid as the destruction of the acid specific insulation layer is a one-way process.

Once a particular section of cable has been exposed to acid it must be replaced to restore full intended operation. If the cable is not replaced, the portion of the cable where the acid-selective insulation has dissolved will act as a water sensing cable and could generate false alarms due to condensation or other sources of water in the containment.

If sufficient time passes between leak detection and clean-up operations are commenced, there is a high probability that the electrodes themselves will be destroyed and the instrumentation will show a loss of cable continuity as a *cable break or loop break.*

After clean up

If the extent of activated cable is limited, it may make sense to splice-in a short replacement length using connectors or butt splice (field installed connector kits and splices are available). However in many case it makes more economical sense to replace an entire section of cable after the leak area has been flushed and the source of the leak has been repaired. The choice will be based on local skill levels and time pressure to restore operations.

Conclusion

Until the development of strong acid-detecting cable, methods of sensing leaks have been limited and piecemeal. Visual inspection has been the most useful strategy for above ground and overhead transport pipelines and containment tanks, aided by colour-changing paints and dyes.

The advent of acid detecting cable, used in conjunction with real-time monitoring instrumentation, now provides an early warning system that works equally well in a whole range of environments. These include overhead piping, vertical pipes, valves, manifolds and other fittings where concentrated sulfuric or nitric acid could leak. Sensing cables can also be used on floors, in drip pans, in sumps, trenches and underground in slotted conduit.They may be pulled into double wall containment pipes or tanks to monitor interstitial space.

A system built around strong acid-detecting cable provides low cost, round-the-clock monitoring that aids a quick response, limiting exposure to environmental damage, interruption to service and expensive clean-up.

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