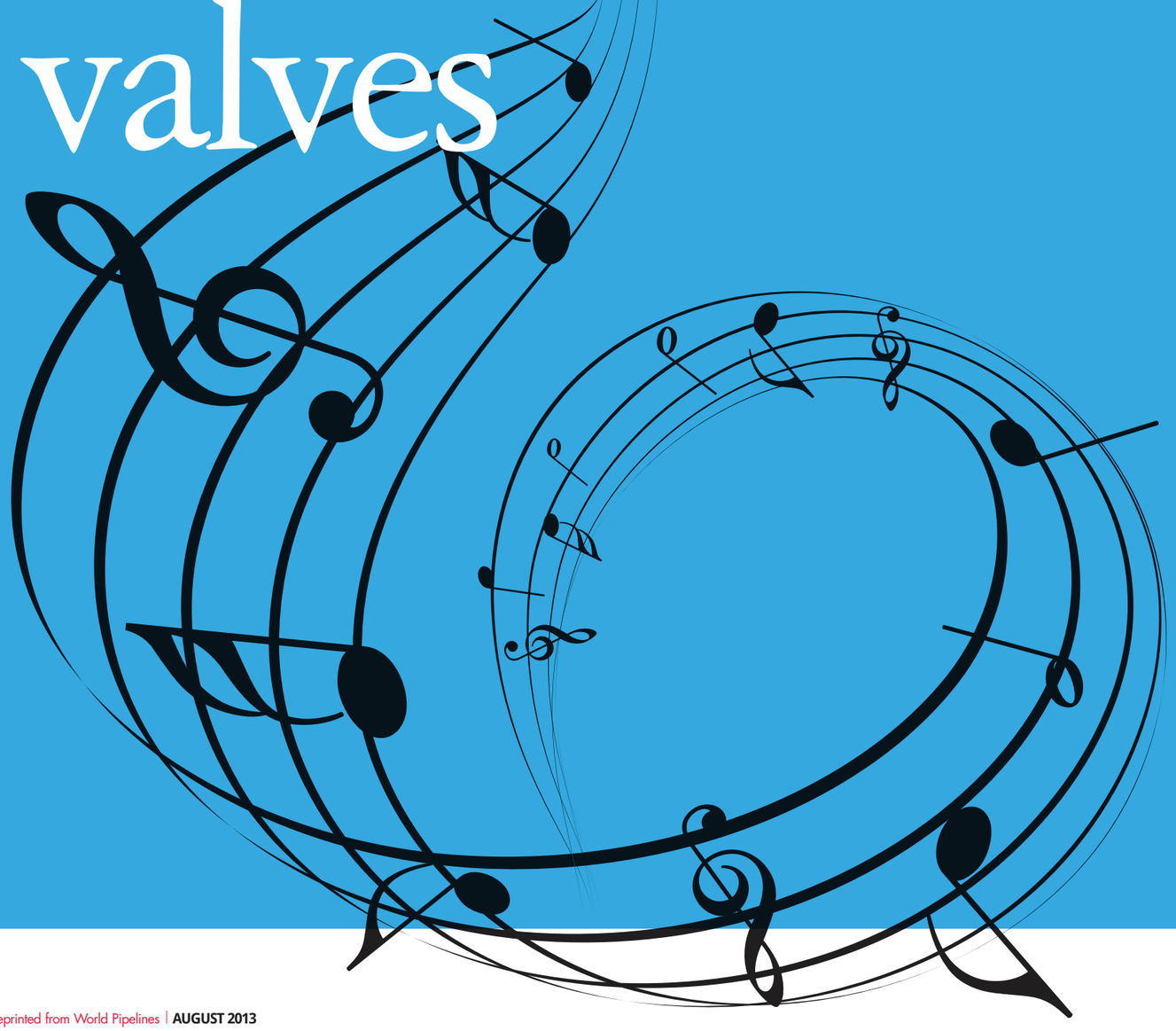
Silencing singing valves



Philip T. Cole, Group Vice President for MISTRAS United Kingdom Operations, shows how leak detection software can help find and stop those singing valves.

A leaking valve sings – not to human ears of course, but in the acoustic emission spectrum. It is a soloist that stands out from tight valves thanks to the emission of inaudible 'noise' caused by the turbulent flow of liquid or gas through a leak or orifice in pressurised piping or pipelines.

However, MISTRAS Group's VPAC™ technology is the oil and gas industry's toughest critic on singing valves. In fact, not only can the technology detect valve leakage, but it can also locate, quantify and estimate a valve leak's future cost in loss of both product and money. In pipelines and process systems the rapid identification of a leaking valve, together with knowledge of its leakage rate, has enormous safety benefits. Leaking valves can also lead to product contamination and losses as product

Figure 1. A technician performs a valve test using the handheld MISTRAS VPAC™II. With preloaded valve routes and properties, the leak detection system is able to provide on-board leak rate estimates during a test.

leaks through a 'closed' valve into another system operating at a different pressure.

History

Back in the 1990s, British Petroleum (BP) decided US$ 1 - 4 million/yr was too much to lose on flare losses. It teamed with Physical Acoustics Corporation – a MISTRAS subsidiary – to engineer an instrument to detect and quantify leaks in a measurement that takes a matter of seconds.

MISTRAS' partnership with BP helped compile a comprehensive database during a 10 year span, which helped illustrate just how the acoustic signal behaved on different valves under widely varying conditions, for both liquids and gases.

This empirical data was used to create the proprietary algorithms VPAC software uses to estimate leakage rate and subsequently trend product and monetary losses.

Consequently, the company's technology has been an in-service leak detection standard in the oil and gas industry since the mid 1990s. Acoustic emission (AE) leak detection identifies the 'noise' of the turbulent gas/liquid flow by using high frequency AE sensors with ranges above the vibration and background noise level of an industrial setting.

Site experience has shown that 5 - 10% of valves leak, and 1 - 2% of valves account for 70% of total losses on a typical refinery or offshore platform flare system. With VPAC technology, savings in excess of US$ 1 million per site per year can be readily achieved, and many times even greater.

With more than 1400 MISTRAS acoustic emission leak detection systems currently in use worldwide by major oil and gas organisations, VPAC technology has proven to be a popular instrument of choice for in-service leak detection on any valve (pipeline or other) that is supposed to be tight.

After detecting a leak, sometimes the fix is a simple stop adjustment. Sometimes 'popping' a RV clears debris from the seat. It is not always necessary to replace the valve. Whatever the size or solution, the VPAC technology can find the valve leak and estimate its volume and cost.

Most operators focus on the C2s and C3s, in addition to other high value items such as hydrogen, which can also compound the loss if it is a production bottleneck.

Flares with large gas flows often have gas recovery systems to capture product that is leaked to flare. While it is recovered, that once valuable product is just burned as fuel gas with the consequential financial loss – an occurrence knows as 'downgrading.'

Although developed initially for the identification of through-valve leakage on flare systems, MISTRAS VPAC technology was subsequently developed further through a two year programme together with Shell and BP exploration divisions for use on emergency shutdown valves (ESDV) on oil and gas production pipelines. This program extended the scope of the VPAC application to much larger valves than are common on flare systems, with both soft and hard seats, and in both gas and liquid service. Subsequently an online version of the system, the VPAC-1278, was developed, primarily for SDV applications. More than 1000 VPAC-1278 systems are now installed, permanently giving operators instant notification of leakage and quantification of the rate of leakage through any valve that is supposed to be tight. The online system is typically wired direct to the valve controller or plant DCS via an industry standard 4 - 20 ma current loop, the system resulting in enormous operational safety benefits.

Test procedures

The presence of a valve leak and its estimated rate can usually be determined in 20 secs. Measurements are taken on the valve with an AE sensor that is attached to a MISTRAS VPAC or handheld VPAC II. If there is any indication of a leak, then upstream and downstream measurements are also taken just outside the valve flange. If the highest signal measured is on the valve body, a turbulent flow is being produced and the valve is leaking.

If a leak is present, the readings collected in those upstream, downstream, and on-valve measurements will be the data from which a leak rate is calculated. It should be noted that as a valve opens and the flow orifice expands beyond a certain point, some of the flow would become laminar. The percentage open at which this occurs depends upon many factors, but for best estimation of leak rate the valve should be closed at the time of measurement. The sensitivity of MISTRAS VPAC technology depends upon many factors such as differential pressure, product, valve size and type. On small, high pressure valves it is possible to identify gas leakage of as little as 0.1 l/min measured at STP.

Thanks to a wireless Bluetooth connection, or data transfer cable, the readings can be sent to MISTRAS' companion software – VPACwin™ – on a laptop or PC, which loads and formats all test data from VPAC II into a user-friendly spreadsheet. The software then uses a proprietary algorithm to calculate leak rates and projected product and monetary losses onto the same type of spreadsheet.

This level of data analysis also permits operators to focus on the valves with the greatest malevolent effects (greatest leak rates or money wasters), and target them for priority attention.

This seamless test-to-results process is aided by preloaded test routes and valve information (ID numbers, valve type, inlet size, test medium, differential pressure, etc.) prior to beginning testing routes. If valve routes and properties were loaded into the MISTRAS VPAC II prior to testing, it can use that information to provide leak rate estimates right on the unit during a test.

The ability of the VPAC system (and its intrinsically safe model) to work in high noise, dangerous environments also makes them useful for operational troubleshooting.

MISTRAS even provides VPAC Services teams to run plant- or site-wide inspections. Armed with VPAC II's preloaded with valve routes and properties, the test data is transferred to a PC and generates fixed and custom report documentation.

Figure 2. The MISTRAS VPAC™II has been an in-service leak detection standard in the oil and gas industry since the mid 1990s.

Case studies

Savings of US$ 400 000 were achieved on one application alone by using the VPAC method to satisfy a safety case for pipeline emergency shutdown valves, confirming their leak tightness non-invasively. The alternative would have required complete production shutdown; instead of which, sufficient differential pressure was allowed to develop across the valve to confirm its leak tightness and allow downstream operations to continue.

Two subsea pipelines were connected via a 'crossover' link where the valves between the two systems were supposed to be closed and leak tight. The operator wanted to change the operating pressure of one of the lines, and had concerns about whether the valves might leak as a result of the resulting increase in differential pressure. Monitoring was installed on the valves and the period before during and after the change in operating pressure was continuously monitored. There was no evidence of leakage occurring at any time, giving the operator confidence that the change to operating conditions would not result in flow from one system to the other.

An onshore plant installed VPAC-1278 leak monitoring systems on 40 shutdown valves, connected via the DCS direct to the control desk. In the event of a shutdown being required the operator knows immediately if any of the valves that should be closed have either not fully closed, or are leaking, together with an estimation of the leakage rate. In an emergency situation it is not practical to send an operator with a portable VPAC out into the plant to walk around and check all the valves, so instead online systems are installed.

Music to 'new ears'

MISTRAS' portable VPAC II is ideal for global use in pipeline valves, refineries, offshore platforms, gas plants and petrochemical plants for detection and quantification of leakage in addition to operational troubleshooting. The VPAC-1278 online system is the perfect companion for pipeline and other isolation valves where it is inconvenient to take out a portable system.

It is so versatile, its diagnostic functions even stretch into other industries such as steam power generation, and while the MISTRAS VPAC II's versatility should not be undervalued; the value of its principal function – the detecting, locating, quantifying and estimating of leaking valves all throughout the oil and gas industry – cannot be overstated.

Around the world, there is an orchestra of singing valves. They are humming with the potential for savings, but only to those who can hear it.

MISTRAS' VPAC II allows one to hear the money flowing out of leaky valves and the opportunity to stop it. That is music to anyone's ears.