FROM ITS INCEPTION 60 YEARS AGO, PIG SIGNALLING HAS EVOLVED, MOVING FROM INTRUSIVE TO ADVANCED NON-INTRUSIVE METHODS. THIS WHITE PAPER DELVES INTO THE TECHNOLOGICAL SHIFT AND THE PRACTICAL APPLICATIONS OF THESE SIGNALLING METHODS, GUIDING STAKEHOLDERS TOWARDS INFORMED DECISIONS FOR OPTIMAL PIPELINE OPERATIONS

A POTTED HISTORY OF PIG SIGNALLERS

Wikipedia identifies Shell Development as running the first ‘intelligent pig’ in 1961 & Tuboscope as running the first commercially available intelligent pig in 1964. In the absence of other information for the purposes of this paper, this is the assumed first start of intrusive pig signalling.

This implies that intrusive pig signalling, is at least in the order of 60 years old. Intrusive pig signalling as defined by TDW is:

- Trigger inside the pipeline trips when a pig or sphere passes, activating a high-visibility signalling mechanism — a flag, electrical indicator or combination of the two.

- Accurately detecting pigs and other tools as they pass distinct points along the pipeline.
Non-intrusive pig signallers came later. The earliest reference found is Pigtek, 1979 – a unit relying on the detection of a change in magnetic field. Since the late 1990s non-intrusive pig signallers have steadily found their way into the pipeline industry – in particular from the mid 2000s onwards.

Since that date the OEMs have typically moved into two camps for non-intrusive signalling:

• Magnetic - relying on the pig containing a magnet and the signaller detecting the rise and fall of that magnetic field as the pig passes

• Acoustic – relying on the rise and fall of the acoustic noise created by the pig as it traverses the pipeline and passes the signaller.

One manufacturer alone has an ultrasonic unit targeting liquid pipeline systems – arguably the third camp.

The biggest ‘camp’ of course remains intrusive pig signallers. Indeed, there is some thinking that says intrusive at pig launcher & receiver stations and non-intrusive on the pipeline. As the pig trap is normally isolated, maintenance of intrusive pig signallers should be straightforward. However, this misses the point – the accurate data provided by non-intrusive signallers and the fact that they cannot leak is of fundamental importance (and by extension means pigging operations should never be impacted by a leaking pig signaller).

WHY SPECIFY NON-INTRUSIVE OVER INTRUSIVE

Pig signallers have been traditionally a mechanical item. In some markets they consist of a welded fitting and then a threaded pig signaller into that fitting. In other markets they are typically bolted to a counter flange and if on the pipeline fitted with a valve. If they are fitted within the isolation limits of the pig launcher or pig receiver they may or may not be fitted with a valve. The valve is present to allow maintenance under pressure.

Generally, pipelines are rarely, if ever ‘shut down’. The consequence of this is that intrusive pig signallers requiring maintenance have to be the subject of some type of intervention. Be that with a hot tap tool or with a proprietary jacking bracket. Either way this is an operation with risk to the operator and the environment.

The consequence of this, is that the maintenance on the pig signallers when considered on a global basis – generally does not occur, or certainly not in accordance with the original equipment manufacturer’s manual. The risk then becomes the ability of the pig signaller to function reliably and / or the possibility of hydrocarbon release to atmosphere.

Clearly non-intrusive signallers do not suffer this. If they do require maintenance or repair they can simply be removed and taken to an appropriate work shop. They can be replaced with an inventory unit as well to ensure there are no impacts to operations.

Non-Intrusive Pig Signallers can be easily strapped to the pipeline

So, no leak paths, no environmental impact, ease of maintenance and by extension reliability through pipeline operational life.

Some intrusive pig signallers are fitted with proximity switches, many are not. This means that an operator has to lower the flag. In the case of a non-intrusive signaller there are numerous settings that can be modified but in principle the control room will know what time the pig passed. The field personnel can either view the unit and
scroll through the events, communicate with the control room, communicate with the unit locally via Bluetooth or be told the pig has passed using LoRaWAN or GSM to text or email the notification.

Not only does this provide timely & accurate information, it provides it in a way that mitigates the need for operators to check pig signallers. The operators can then perform other tasks, thus saving money and increasing efficiency. Equally, if a pig arrives late or does not arrive at a pig signaler – the control room and the operator will know there is a problem. Of course, there are likely to be other system tell-tales – but having accurate pig passage times up to the point the pig appeared to stop or slow down can support any mitigation activities. Detailed & accurate information reduces operational costs.

The nett out is that Non-Intrusive signalling are safer, better for the environment, there is total lifecycle cost benefit when compared to intrusive signallers and they improve operations.

DATASHEETS AND REALITY

The application at hand should take precedence over datasheet review & standardisation. Meaningful understanding of the application and the types of pigs the operator will use and why should be considered.

A data sheet for a magnetic pig signaler will say ‘pigs require magnets’.

A data sheet for an ultrasonic pig signaler will say ‘can detect all types of pigs in a liquid system’.

A data sheet for an acoustic pig signaler will say ‘can detect all types of pigs in all pipelines’.

All the above is true, but equally all of the above does not provide the full ‘best solution’ picture. Typically, in an industry operating on an EPC model for CAPEX developments and in particular where standardisation & commonality where ‘possible’ is almost a pre-requisite the ‘acoustic’ solution appears to be the most robust.

Ultrasonic Pig Signallers can provide precise estimation of pig position as well as detect their passage

This may well be true on the pipeline away from background or intermittent noise. However, in the case of relatively ‘noisy’ areas it is theoretically possible that either the background noise or the foreground noise overcomes that instruments ability to pick out the noise of the pig passage or creates a noise that the instrument identifies to be a pig passage. This could be a helicopter in the case of background noise and foreground noise could be related to the operation of the pig receiver & proximity of the instrument (position necessary to be on the minor barrel close to the reducer) to the kicker line. The case of the helicopter is obvious – the arrival and departure of a significant noise emitter. The case of the pig receiver operating process is less obvious but is related to valve line up creating acoustic noise followed by the changing acoustic profile as the pig is received and the differential pressure across the pig then equalising.

The result is a variety of reasons that can attribute to either a false positive (i.e. a helicopter) or a missed pig (too much acoustic noise).

It is entirely sensible to apply the best solution to the application at hand and there are many factors & opportunities here:

- If the pigs used are metal bodied pigs they can be fitted with magnets – thus giving a more ‘direct’ response and minimising false positives and missed pigs.
• If the system is liquid then an ultrasonic sensor can be used for all types of pigs. Again a direct response and very limited false positives or missed pig scenarios.

• With ultrasonic, at the primary challenging locations – pig launch & pig receipt – particularly when flow rates are materially lower than at peak production there is the opportunity to move the sensor to locations where there is a higher probability of a stalled pig – i.e. between the mainline tee and pig trap valve at the receipt location. You can even inspect the launcher to ensure the pig has left without needing to open the quick opening closure.

• There are of course cases where foam pigs (which we generally would not recommend are fitted with magnets) are used in wet gas systems for liquid management and in those cases the acoustic type of pig signaller is the most suitable.

• If the above points are not considered and acoustic is the preferred technology, it is entirely feasible to screen out false positives when there is no pig in the pipeline by communicating with the instrument.

NON-INTRUSIVE - AN ADVANTAGE AT THE CAPEX STAGE?

A common objection (or reason to choose the acoustic systems) is that pigs do not have magnets.

Granted – however there is a lot of sense in CAPEX projects of working to ensure that the pigs eventually purchased for operations come with magnets – or even buying a number of startup pigs as part of the CAPEX hand over at commissioning.

In the case where operators are considering adding magnetic signallers to pipelines during their operational life, there could be a need to add magnets to existing pigs. This is rarely as straightforward as it sounds and generally magnets are best affixed to pigs during manufacture at properly competent manufacturing facility with a proven design.

Whilst this may add to the total cost – the likelihood is that the total savings & advantages of non-intrusive signallers still represent value. Equally, purchasing new pigs appropriately designed with the operators feedback being considered can be a valuable exercise.

A common objection against magnetic non intrusive pig signallers is they cannot detect foam pigs.

Firstly foam pigs, whilst having their place are not generally the most effective operational pigs. The soft (2lb/cu.ft) variety is typically used for soaking up residual hydrotest water after bulk dewatering. This leaves the medium & high-density types which can be used, but usually in the case of ‘rescue pig’ or progressive cleaning – in those circumstances there is often additional mitigations in place and it is perfectly feasible to fit an electro-magnetic tracking device to a pig and this is common in ‘non routine operations’.

At the CAPEX stage – intrusive pig signallers with valves are often more expensive than their non-intrusive counter parts, even before considering site fabrication, welding & NDT. Typically, contractors do not free issue valves and
ask the intrusive pig signaler supplier to provide them – a comparatively small number of highly specified small diameter valves in a busy industry. One could argue that there is also a much greater schedule risk given these are pressurised fittings.

The challenge with all of the above is that the nuances of pigging and the differing challenges facing operators through the life of a pipeline are often not captured or thought through in detail sufficiently during FEED & EPC. The ‘go to’ solution appears to be intrusive or even acoustic even though there are potentially better solutions.

FINAL THOUGHTS

Pig signalling has evolved significantly over its 60-year history, from intrusive to the introduction of non-intrusive technology. Non-Intrusive signalers, whether magnetic, ultrasonic or acoustic promise enhanced safety, environmental benefits and operational efficiency.

The successful application of these signalers requires consideration of pipeline specifics and the type of pigs used but in reality it is very simple. If it is a liquid system, use ultrasonic, if it is not use magnetic unless foam pigs are a part of your routine pigging operation (with a high frequency) and in that case use acoustic.