GAIN INSIGHT, ELIMINATE RISK AND PIG WITH CONFIDENCE

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Oil and Gas pipeline operators clearly understand the benefits of periodically pigging their pipelines, in terms of cleaning, flow assurance and retrieving information regarding the internal condition of the pipeline. By doing so, the operator gains confidence that there is no risk of imminent failure. In practise, however, many operators are reluctant to risk pipeline pigging operations in circumstances where the pipeline contents are not fully understood and can be resistant to pigging for fear of blocking the line and shutting down production. There are also the concerns around the cost of the campaign and the additional expense to facilitate recovery should the pig become stuck.

Frequently, the operator may have significant data on the flow rate, product composition and damage, but will not have information regarding deposits within the pipeline. This data would ideally include, volume of deposit, location of deposit and any significant pipeline bore restrictions as a result of the deposit build up.

How can a pipeline operator gain confidence in their pipeline prior to pigging?

One method is to determine the pipeline's contents by accurately measuring the flow between reference points along the line. This then presents a problem; how do we introduce flow measuring equipment subsea, without first shutting down production, emptying the pipeline's contents and breaking into the pipeline?

A highly effective solution would be to introduce a low activity radiotracer into the pipeline and, using highly sensitive radiation detectors, track the flow regime at specific reference points along the length of pipeline. This is especially the case if the pipeline is known to have many different depth regimes and the temperature profile of the oil in the pipeline is close to wax formation. This arrangement is detailed in Figure 1.

Using details of the diameter and length of the pipeline we can calculate the volume (V_{empty}) of the empty pipe as installed. If the flow rate (Q) of the pipeline is known, then the volume of deposit (V_D) in the line is calculated as thus:

$V_D = V_{empty} – (Q \times t)$

Where t is the time taken for the pulse to pass two detectors, where the distance between the detectors is known.

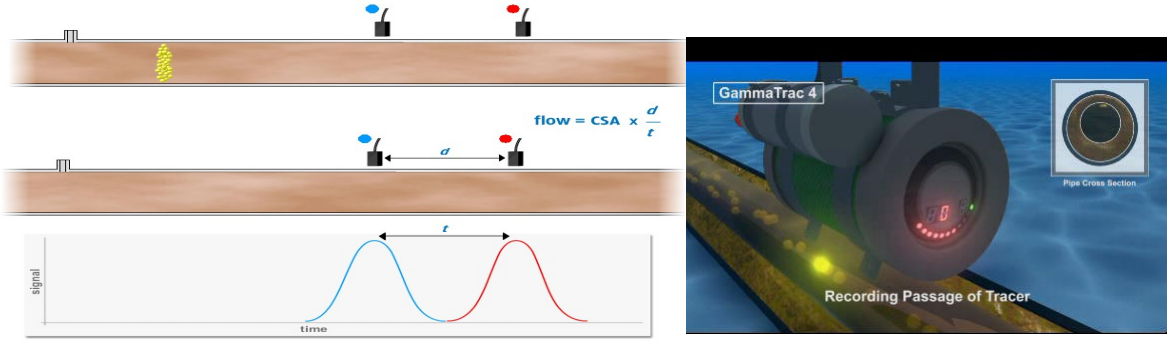

Figure 1

The mean linear velocity can be calculated by measuring the time interval between detector responses and knowing the distance between them. If full bore turbulent flow can be assumed, and the pipe internal diameter is known, then the velocity can be converted to volumetric flow. Accuracy will depend on the precise circumstances but the mean velocity can usually be measured to better than ± 0.5%.

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The basic principle of tracer investigation is to label a substance or phase and then follow it through a system. Looking at tracer studies from a problem solving point of view, if problems of fluid transport can be described in terms of 'When? 'Where to?' and 'How Much?' then they can be solved by means of tracer techniques.

The basic requirements of a tracer are as follows:

- It should behave in the same way as the material under investigation
- It should be easily detectable at low concentrations
- Detection should be unambiguous
- Injection and detection should be performed without disturbing the studied system
- The residual tracer concentration in the product should be minimal.

The criteria can be met by the use of radioisotope tracers and by selection of the most appropriate tracer for a particular application. More than one radioisotope can be selected and the factors that are important in the selection of the tracer are the:

- Half life
- Specific activity
- Type of radiation
- Energy of radiation
- Physical and chemical form

In this application, the flow rate through the system must be known and remain relatively constant. Detectors are positioned at known distances apart along the pipeline. A pulse of tracer is added to the pipeline and its velocity past the detector positions measured. Using the velocity and flow rate, the average bore size can be calculated between detector locations. This measurement provides critical information for the operator prior to any proposed pigging operations. Operators have the confidence to successfully run pigging campaigns, safe in the knowledge that a pig will not get stuck and in turn, cause significant production losses.

Operator advantage

By employing multiple detectors, individual segments of the pipeline can be evaluated in one tracer pass. If the flow velocity is higher within the pipeline then this is indicative that there is more solid build up. Such knowledge allows better decisions to be made on remedial action.

Following the analysis of the data, if any segment of the pipeline represents a particular cause for concern, due to the volume of deposit there in a simple relocation of the subsea data collection units can further evaluate deposit profiles within smaller areas. Subsequent localised evaluation of the deposit distribution could be obtained by utilising a non-intrusive ROV or Diver deployable technique. This allows for the depth of deposit to be determined at any section. See Figure 2.

The scanning technique utilises field proven technology, of which is most commonly used in determining the structural status of platform support members; thus providing immediate data as to whether members are dry, flooded, partially flooded, or even have wall-thickness anomalies.

The scanning technique is non-intrusive, requires no prior pipeline cleaning in order to obtain results and furthermore, is not affected by pipeline coatings, including concrete weight coating.

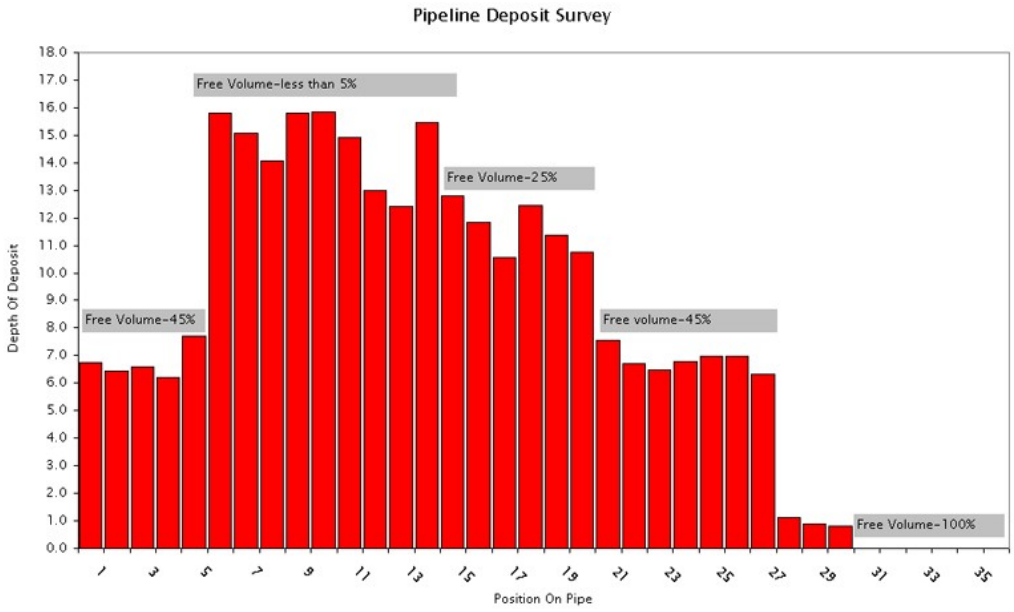

Figure 2

Risk aversion

Having used techniques for flow assessment using a tracer and a detailed survey of any problem areas, the operator has valuable data regarding the contents of their pipeline. A detailed risk assessment can be undertaken to confirm whether to proceed with pigging the pipeline. Putting any solid object into a pipeline carries risks, from losing track of the pig within the pipeline, to not knowing exactly when the pig has arrived or its exact location within the pig receiver upon arrival. This is where a reliable method of pig tracking is paramount to provide the operator with confidence.

Radioisotope pig tracking

This method of pig tracking is undertaken by using a safe, low activity radioisotope, which is integrated into the pig module. The radioisotope is detected by very sensitive monitoring equipment, the GammaTrac™, which can be placed on top, or alongside the pipeline. The GammaTrac™ unit can be used on partially buried and shallow buried pipelines. The sensitivity of the unit allows optimisation of the isotope source strength for the particular pipe diameter and ensures safety of the operators whilst in use.

Source sizes are calculated in accordance with the Beer-Lambert equation:

$I = I_o \cdot \exp^{(-\rho\, d\, \mu)}$

Where:

I	is the radiation dose rate at the surface of the pipe
I_o	is the radiation from the source
ρ	is the density of material through which the radiation is transmitted
d	is the distance from the source to the outside wall of the pipe
μ	is the material absorption coefficient.

Application of this equation allows for correct sizing of the source to ensure the radiation dose rate on the surface of the pipe is no more than 7.5 micro Sieverts per hour; which is the legal limit not to be exceeded by non-classified radiation workers. This means that whilst the pig is in the pipeline or pig receiver, the area is safe for operators to perform their duties.

The features of this technology are:

- Confirmation of pig launch from the launcher
- Easy application and retrieval to and from the pipeline
- Pigs can be tracked wirelessly by several Subsea units (up to 3000m from each tracking unit) and a velocity can be determined, making it more accurate to predict arrival time
- Pig tracking units can be placed in up to 3000m of water depth
- Pig can be located to within 5cm
- No batteries to run flat should the pig become stuck or flow is suspended
- Pig can be detected even through thick walled receivers or pipes
- Pigs can be detected through “Pipe in Pipe”, flexible and umbilical systems
- Number of pigs can be determined to ensure all pigs in a train have arrived
- System can be used in conjunction with standard methods of pig detection and will not cause interference
- ATEX approved topside tracking units available.

Advantages to the operator are:

- Complete confidence in closing isolation valves to pig receiver
- Knowing when a pig will arrive, allowing for preparation of process
- Pigs are located within minutes of arrival; thereby reducing process downtime
- Pigs can be left unattended for long periods of time and can still be accurately tracked
- System can be left in a safe state without the need for an engineer to be present until pig extraction is required
- No ‘cooling off’ period required after pig arrival before pig extraction
- No requirement to raise hot work permits.

Summary

Taking time and effort to understand the inside of your pipeline will significantly reduce the risk and help avoid overly conservative views toward carrying out the pigging operation.

For further information about flow assessment, pig tracking using isotopes and other Subsea applications of radiation visit www.tracerco.com