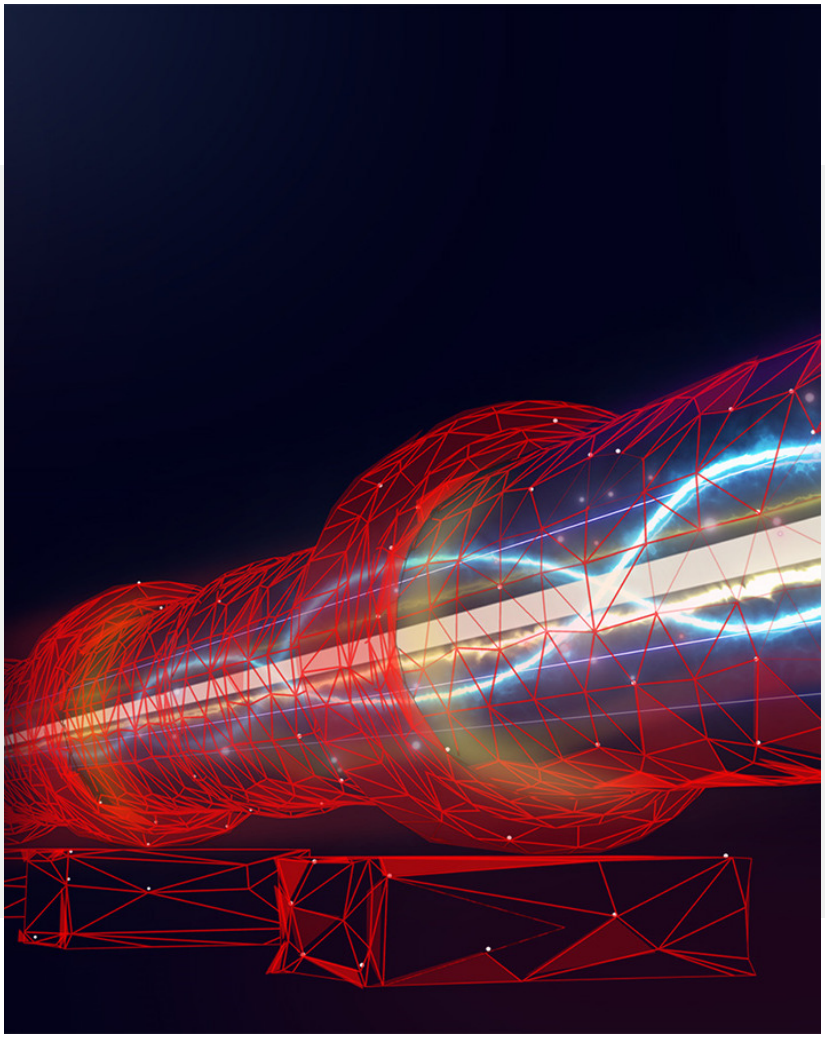

InnerVue™ non-intrusive pipeline diagnostics

Removing uncertainty

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The Pipeliners Association of Houston

March 4, 2024

Pipeline diagnostics challenges

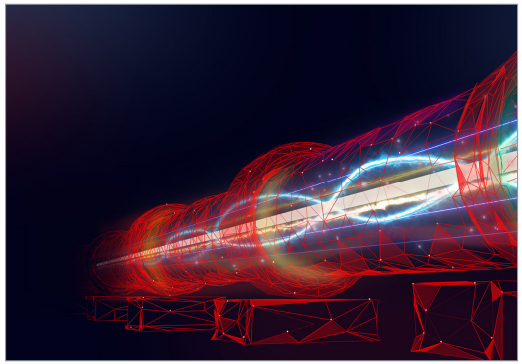
Current market issues and solutions:

- **Flow Restriction**
- **Maintenance Costs**
- **Deposit Identification**
- **Pigging and Inspection**
- **Third-Party Interference**
- **Leak Detection**

The standard current market solutions are intrusive pig mounted technologies.

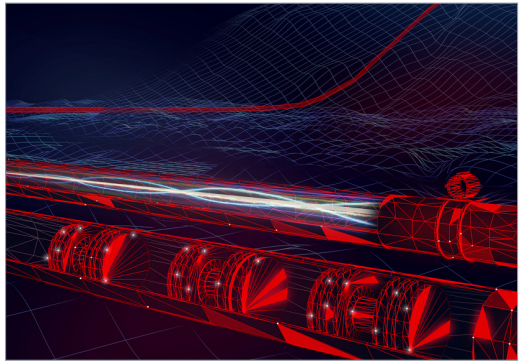
There are some non-intrusive solutions but they either very localized and inaccurate.

InnerVue™ non-intrusive pipeline diagnostics



What is it?

Non-intrusive pressure wave analysis in pipelines giving unique insight to manage the efficiency and integrity of your production assets.



How does it work?

An induced pressure wave transits the system at the equivalent speed of sound and the reflected signature wave corresponds to features in the system, such as:

- Barriers to flow – complete/partial
- Restrictions to flow – depositions of solids such wax, sand, etc.
- Loss of energy – leaks and product theft
- Physical changes – tees, manifolds, reducers, etc.

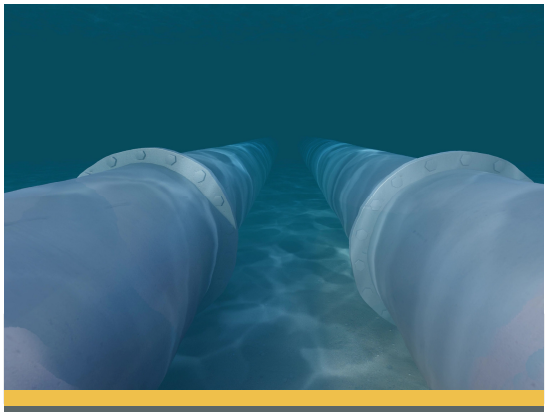
So what? What sort of decisions does it influence?

Every client has a different expectation and issues, so you need to tailor the story to answer their challenge.
Using the consultative selling approach, focus on understanding the issue and the exact need of the client.
Only then propose the right InnerVue method being mindful of the operating parameters (limitations).
The slides in this deck are here to pick and choose, it is going to be very rare occurrence that you would need them all.

InnerVue™ non-intrusive pipeline diagnostics

APPLICATIONS

- Location of blockages, features, or lost objects
- Mapping of deposit thickness and distribution
- Pig Tracking in near real-time
- Leak location and quantification



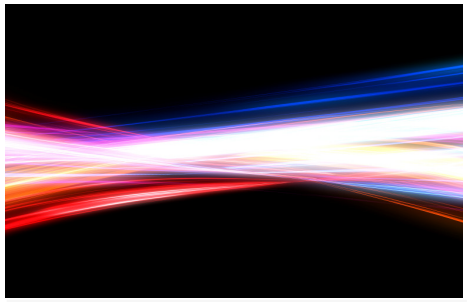
FEATURES

- Collect data rapidly, with minimal equipment and personnel
- High resolution data capture
- Ultrafine pressure sensitivity
- Interactive 3D rendering of the results

BENEFITS

- Call-out at short notice
- Fast turnaround of survey results
- Enhances maintenance and monitoring programs
- Optimizes preparation and execution of remedial works

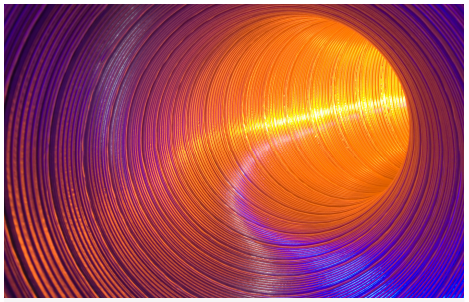
InnerVue™ pipeline diagnostics capabilities



Blockage Location

What is your first step to address an unplanned blockage?

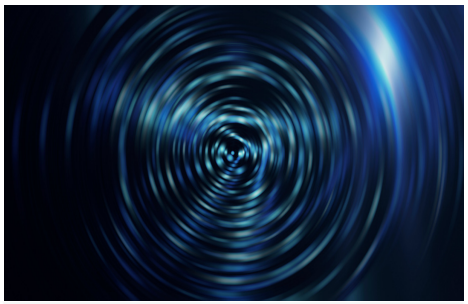
Every second counts when production stops. Stuck pigs, wax or sand plugs and hydrates can happen. Knowing exactly where the blockage is enables fast recovery.



Deposit Profiling

Is your pipeline ready for increased production or inspection?

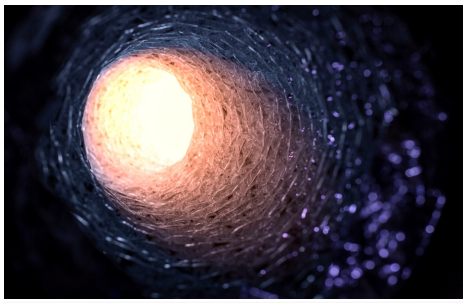
An InnerVue™ survey will map the restrictions and deposits giving you confidence in the actual condition of your line to plan for maintenance and reliable in-line inspection.



Pig Tracking

Do you know where your pig is in the pipeline at all times?

Live pig tracking, using pressure wave analysis, can inform you about the location and behavior of your pig while traveling through the line.



Leak Identification

How prepared are you to react in the event of a hydrocarbon leak?

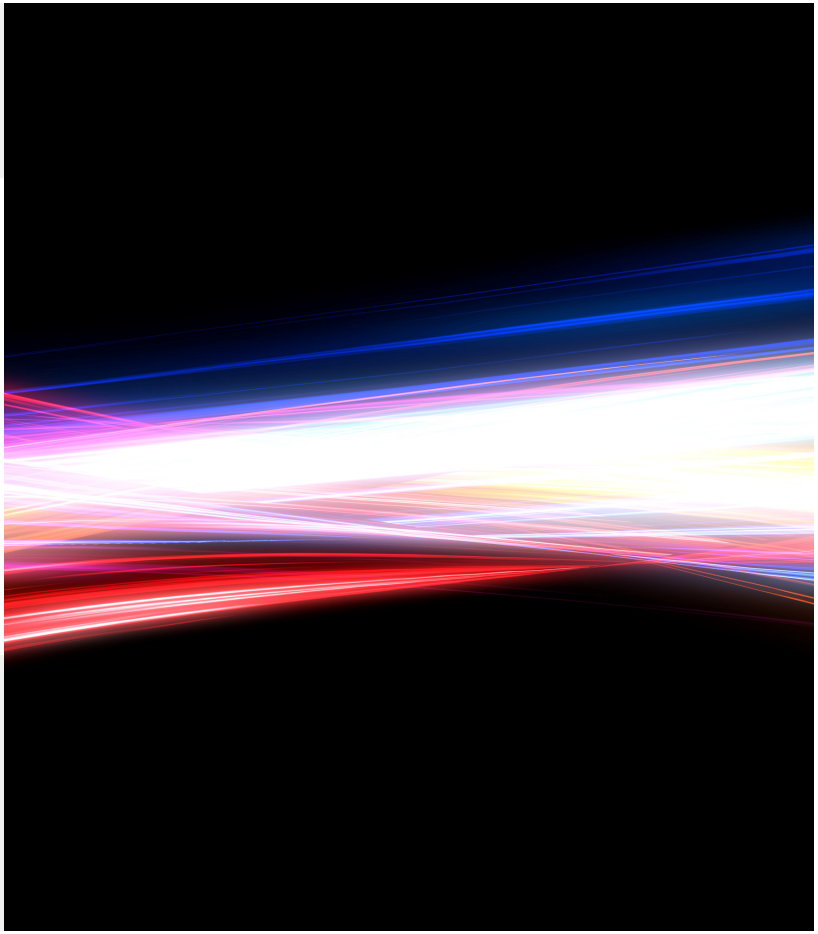
Reaction time is the primary factor in limiting environmental impact. The ability to know the location and quantify the leak severity assures accurate, rapid-response decision making and remedial actions.

InnerVue™ execution flow chart

InnerVue™ execution stages
Technical Sales App – feasibility assessment
Commercial proposal
PO
Procedure preparation
Execution
Analysis using the Data Center
Final report

Blockage location

Removing uncertainty



Blockage location

APPLICATIONS

- Stuck pig
- Hydrates
- Wax, scale and sand blockages
- Umbilical blockages

FEATURES

- Can be performed in liquids or gas at low pressures
- Location accuracy to within 0.4% of distance to blockage
- Hand-carry equipment package
- Only one technician required

BENEFITS

- Call-out at short notice
- Fast turnaround of survey results
- Can measure the full length of blockage
- Pin-point location for pipeline cutting

Ideal operating parameters

InnerVue™ non-intrusive pipeline diagnostics

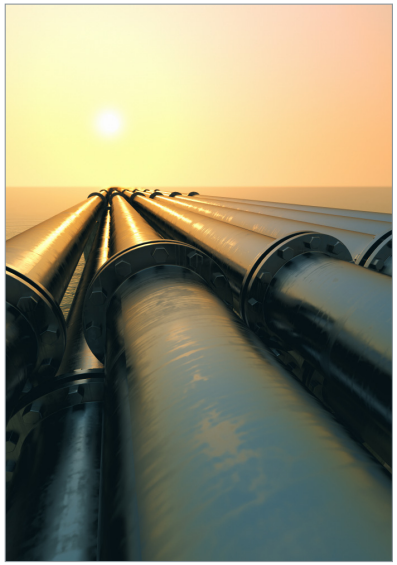
Blockage location

- Suitable for gas and liquid: stabilized oil, water, condensate, lab analyzed gas composition
- Single Newtonian Fluid and known fluid properties
- Ideal length for both liquid and gas >1km to <100km
- Minimum pressure required : 5bar for liquid , 20bar for Gas
- Minimal temperature change in the line or accurate temperature profile
- Pipeline materials – steel/alloys
- No tees, wyes, manifolds, offtakes, non-return valves
- Bleed valve available on the system which can be rapidly opened and closed
- Small bore connection available system side of the pulse generation point

Oil export line back in production after InnerVue™ lead remediation campaign

Blockage location

Europe



Challenge

- Operator had stuck pig during routine pigging operations
- Determined to have been caused by wax build-up
- Operator required to return pipeline to clean state

Solutions

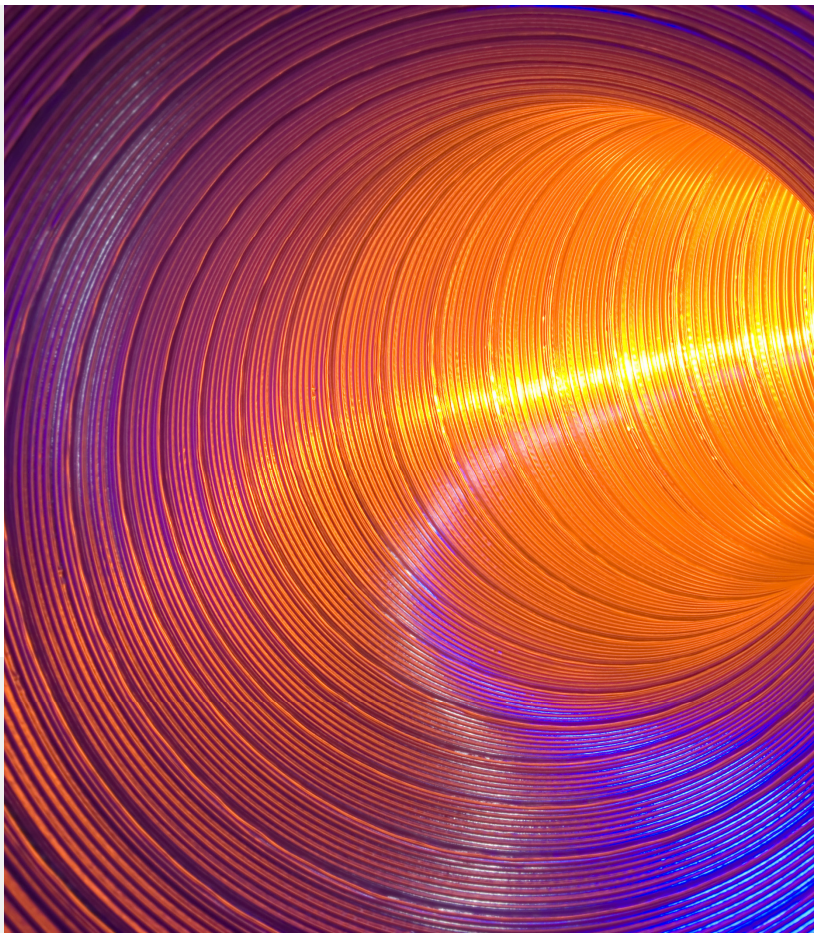
- InnerVue™ survey performed to assess wax build up
- Pigging & Chemical Treatment campaign planned
- Repeat surveys taken throughout cleaning campaign
- Cleaning campaign adjusted based on survey results

Results

- 5 months of engineering including deposit assessment, laboratory analysis, FEED study and detailed engineering
- PPS personnel mobilised for 2 months to both locations to assist the Client for the cleaning operation
- 14 highly efficient pig runs and retrievals in accordance with procedures
- Successful cleaning of the pipeline and restoration to full production of 9 KBD. Equivalent to an EVC of 450 KUS$ per day

Deposit profiling

Removing uncertainty



Deposit profiling

APPLICATIONS

- Wax, sand, salt, hydrates, asphaltenes or scale build-up
- Liquid pooling
- Lost object location
- Can be used in fluid or gas systems

FEATURES

- Collect data rapidly with minimal equipment and personnel
- Proven to over 127 km pipe length in liquid and 25 km in gas
- Location accuracy of pipeline length within 0.4% distance and sensitivity to 1mm of diameter variation

BENEFITS

- Validate and calibrate theoretical models
- Optimization of cleaning campaigns and shutdowns
- Periodic surveys for monitoring during production
- Confirm effectiveness of pigging and chemical treatments

Ideal operating parameters

InnerVue™ non-intrusive pipeline diagnostics

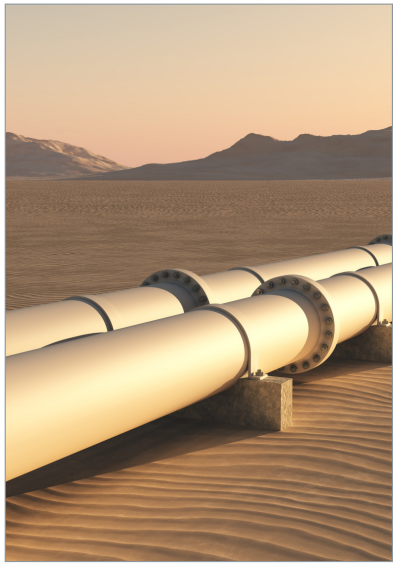
Deposit profiling

- Suitable for gas and liquid
- Single Newtonian Fluid
- Ideal length for liquid >1km to <100km and gas >1km to <25km
- Stable flow
- Minimum temperature change in the line
- Pipeline materials – steel/alloys
- Sampling possible to measure density and viscosity or bulk modulus at the time of the survey or system available for calibration
- Small bore connection available system side of the pulse generation point (e.g. instrument connection)
- The size of the tie-in point can be from ¼" and bigger, however the tie-in point should not be more be than 20m from the pulse generation valve

Deposit profiling to optimize the cleaning campaign

Deposit profiling

West Africa



Challenge

- Our Client had previously un-pigged a 16inch oil pipeline 20.5 km long.
- The quantity of deposits in the line was unknown but expected to be significant.
- The client required cleaning of the line to enable an ILI inspection.

Solutions

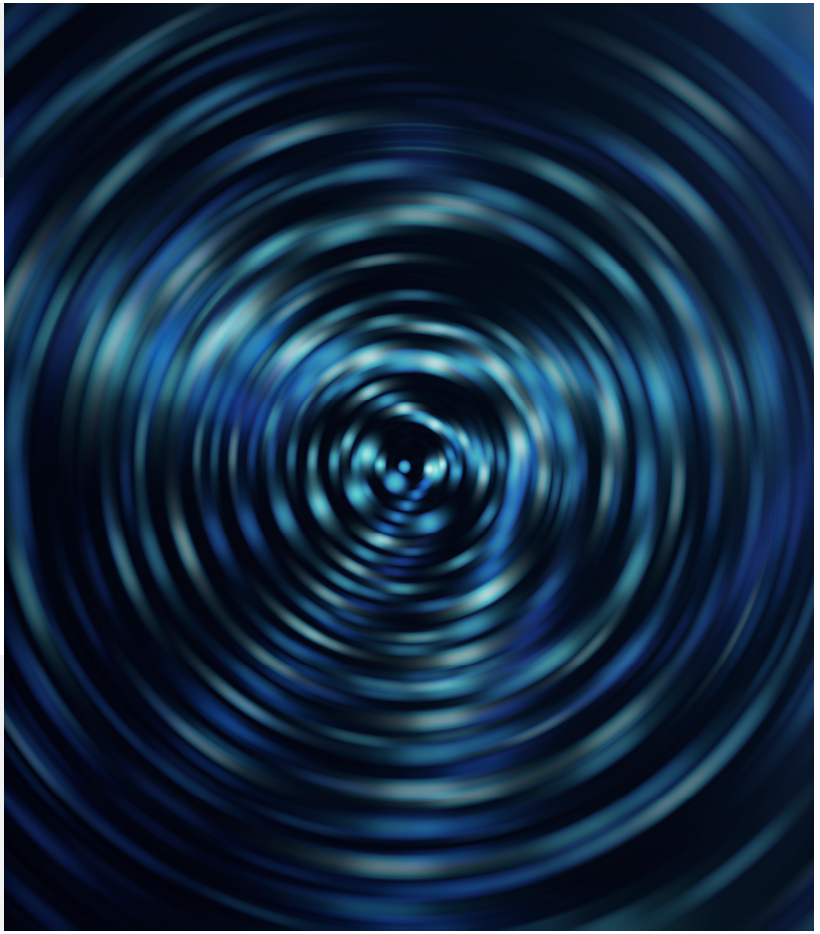
- Using InnerVue™ we preformed deposit surveys to determine the initial condition of the pipeline.
- We then used the deposit information to design and successfully perform a progressive pigging and gel cleaning program
- InnerVue™ surveys were used during the cleaning process and upon completion to give our client the confidence that the line was ready for an ILI inspection.

Results

- 577 tons of wax laden sand was removed from the pipeline.
- Assisted the client to perform successful ILI run.
- The Customer resumed production increased through-put performance.

Pig tracking

Removing uncertainty



Pig tracking

APPLICATIONS

- In-line Inspection
- Precommissioning
- Maintenance pigging
- Remediation
- Stuck pig contingency

FEATURES

- Continuous near real-time pig location
- Outputs include pig speed and time of arrival
- Proven in gas systems up to 120 km
- Can track the pig from both ends of the line
- Results readily available onsite and online

BENEFITS

- Resource management for launch and receipt
- Confirmation of pig speed adjustments
- No impact on operations or production
- No modification to plant or pig required

Ideal operating parameters

InnerVue™ non-intrusive pipeline diagnostics

Pig tracking

- Suitable liquid and gas
- Single Newtonian Fluid
- Length for liquid between 2km and 10 km and for gas between 2km and 100km
- Stable flow
- Minimum temperature change or documented temperature in the line
- Pipeline materials – steel/alloys
- Sampling possible to measure density & viscosity or bulk modulus at the time of the survey or system available for calibration
- Pressure ranges:
  - for liquid >5 barg, <90% MAOP
  - for gas >24 barg, <90% MAOP
- No tees / wyes / offtakes producing into the pipeline, no non-return valves or unmanaged pressure relief valves
- Actuated valve with maximum closure time <2.5 sec
- Small bore connection available system side of the pulse generation point:

Major lessons learned in real-time pig tracking trials

Pig tracking

Europe

Challenge

- Customer wanted to perform base line inspection on new gas transmission pipeline from Albania to Italy with complex shore to deepwater to shore topography
- ILI-tool operating speed range was limited to 2-3 m/s
- Requirement to track the speed of the ILI-tool in real-time, so the Customer could adjust the gas flowrate

Solutions

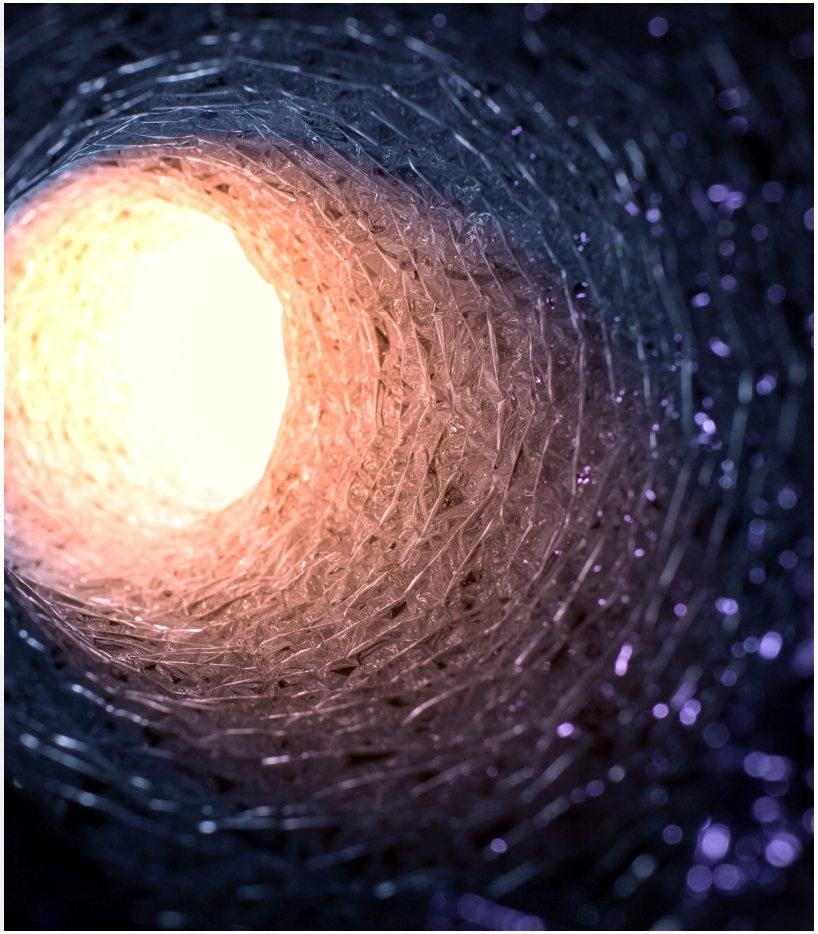
- Mobilize the personnel a day early to record pipeline behaviour with no pig in the line
- Perform InnerVue™ surveys from both ends of the pipeline in 15 minutes intervals
- Analysts were on-line 24 hours within 3 days

Results

- Managed to track the ILI pig for 17km, but could not locate the pig for the rest of the length
- Customer get the data about the pig location within 45 minutes after each survey taking
- Learn the significant amount of real-world information regarding turnaround efficiency and pipeline reaction and behaviour during the pigging operations in gas

Leak identification

Removing uncertainty



Leak identification

APPLICATIONS

- Buried and remote pipelines
- Subsea and deepwater
- Integrity and emissions monitoring
- Product theft surveillance

FEATURES

- Single instrument tie-in point
- Suitable for use when the leak is occurring, not only the rupture event
- Collect data rapidly with minimal equipment and personnel

BENEFITS

- Call-out at short notice
- Validate theoretical models
- Responding quickly to the leak in order to limit environmental damage
- Effective planning of remedial actions

Ideal operating parameters

InnerVue™ non-intrusive pipeline diagnostics

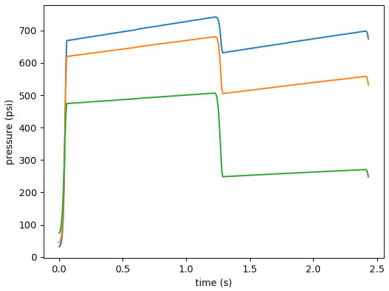
Leak Identification

- Suitable liquid
- Single Newtonian Fluid
- Length between 2 and 30 km
- Stable flow
- Minimum temperature change or documented temperature in the line
- Pipeline materials – steel/alloys
- Sampling possible to measure density, viscosity, bulk modulus and acoustic velocity at the time of the survey or system available for calibration
- Pressure between 10 bar and 90% of MAOP
- Single leak, >10% flow rate, preferably known quantity and location for field testing. Could also be a known Wye or Tee junction with known flow rate
- No non-return Valves
- Small bore connection available system side of the pulse generation point (e.g. instrument connection)
- Actuated in-line valve with closure time <2.5 seconds per inch ID

Leak Identification a unique application ready for field trials

Leak identification

North America



Challenge

- Pin point leak location
- Help to plan remediation method
- Minimize environmental and reputational impact

Solutions

- Testing accomplished with both water and air in a controlled flow loop
- More than 360 tests were done
- Combined Leak identification and gas-liquid pooling testing program

Results

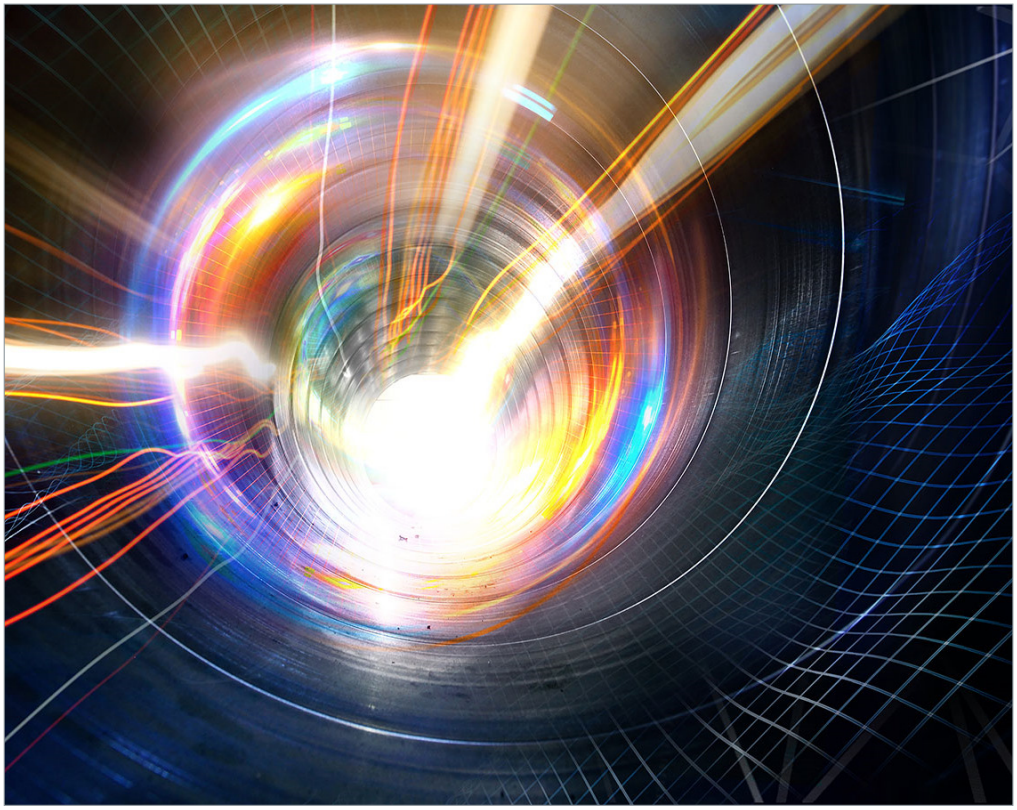
- Leak tests with both air and water were successful
- Clear separation of the curves of different leak sizes and rates
- High confidence of applying this method in full scale scenario
- Currently we are actively seeking test trial opportunities

Track record

Up to 2023 we have successfully executed more than150 projects

Key highlights:

- Longest pipeline surveyed 140 km
- Diameters ranging from ½” umbilical cores to 36” gas transmission lines
- Fluid: water, oil, dry gas, gas condensate, LNG & NGLs, methanol, ethanol, ethylene, propylene, diesel, winter diesel, aviation fuel (Jet A-1)



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THANK YOU