

Non-Intrusive Pipeline Diagnostics by Pressure Wave Analysis

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Pipeline Operators Objectives and Challenges

- Achieving balance for peak returns
 - Maximise asset performance
 - Minimise maintenance costs
 - Minimise risks
- Debris can build up over time
 - Bore restrictions can impact business performance
 - Full blockage can occur if not managed properly
- Integrity considerations
 - Corrosion, metal loss, leak
 - Environmental and reputational harm
- Significant effort and resources spent by operators to determine pipeline conditions and maintain and inspect their assets
- Accurate upfront diagnostic information is necessary for better planning and to help reduce remediation time, costs, and risks



Pipeline Diagnostics Solution by Pressure Wave Analysis

DEPOSIT PROFILING

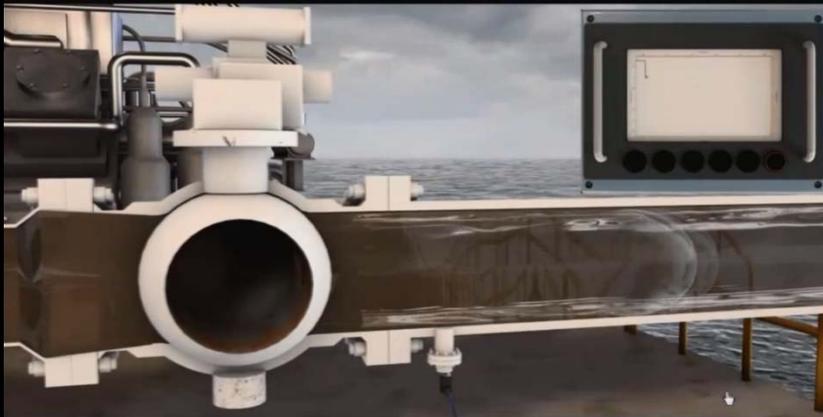
Pressure Wave Analysis Overview



- A pressure wave (the pulse) is created at one end of the pipe.
- This wave travels in the pipe at the speed of sound while returning a reflected signature wave corresponding to features in the pipe:
 - Barriers to flow, partial or complete
 - Changes in medium (phase, density)
 - Leaks
- Blockage positions, deposit profile, and leak characteristics are then estimated by analysis of the signal response

Data Collection

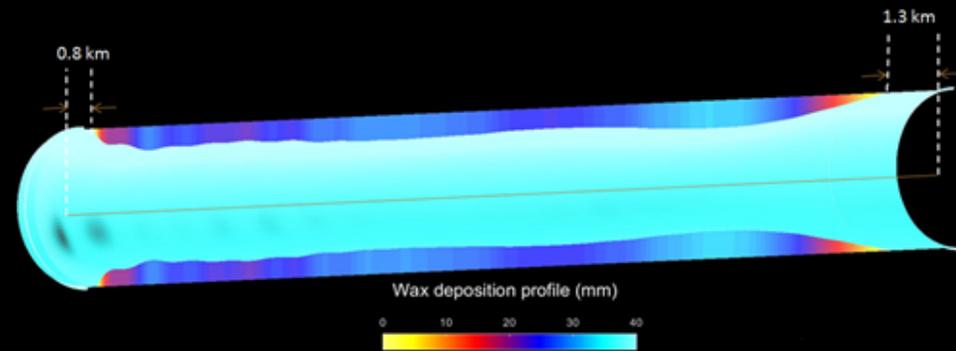
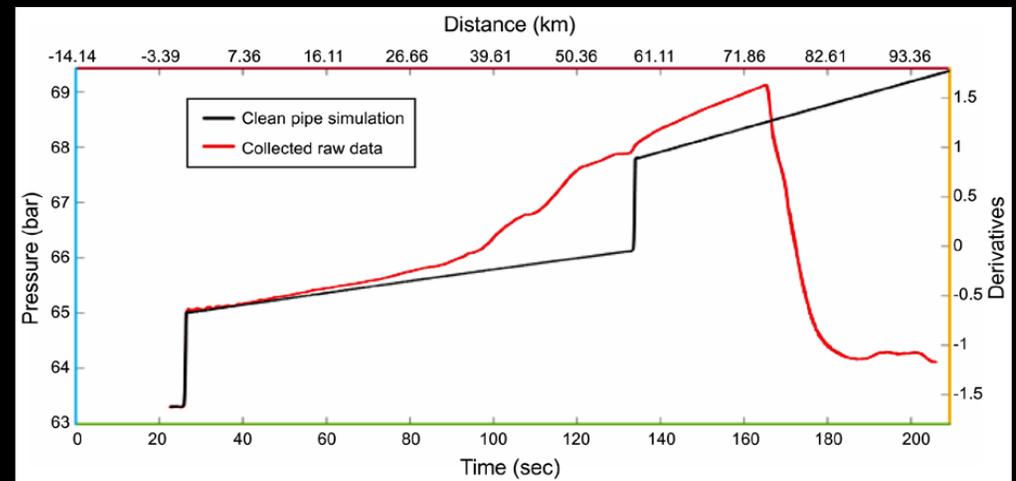
- Single-person operation
- Minimal equipment
- Simple setup
- Non-intrusive
- Fast execution



- Engineer / model
- Induce pulse
- Record reflections
- Repeatable survey
- Transmit data
- Perform analysis
- Report findings

Analysis and Results

- Determine fluid properties and pulse velocity profiles
- Apply pressure and temperature gradients
- Normalise datasets
- Simulate clean pipeline
- Apply proprietary algorithms
- Extrapolate deposit profile, blockage position, or leak rate and position
- Issue detailed results



Application During Planning

- Significant effort necessary to plan pipeline intervention
- Planning performed for worst-case scenario:
 - Theoretical understanding of pipeline condition
 - Risk / fear of blockage
 - Unnecessary resources
 - Large number of pig types and quantity
- Clear information about the pipeline condition allows
 - Assessing piggability
 - Better planning of pigging program
 - Determining chemical treatment requirements
 - Identifying debris handling needs



Application During Pipeline Maintenance

- Conservative approach often considered
 - Reduce flow rate to adjust pig speed
 - Operation team fully focused on pigging

- Traditional monitoring methods are flawed
 - Reliance on subject matter expert
 - Pig condition assessment is subjective
 - Volume of debris measured not reliable

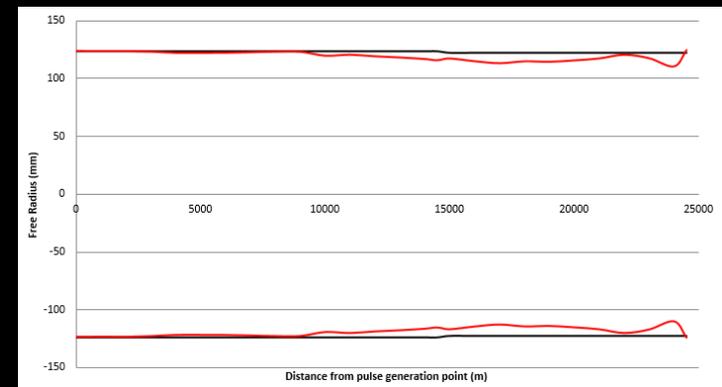
- Pressure wave analysis allows
 - Non-subjective decision criteria
 - Measurement of remaining debris
 - Optimising the pigging program
 - Clear and fast decisions on the effectiveness of the pigging program



Pig Type	Pig Description
1	Gel pig
2	80% inner diameter (ID) medium-density foam pig
3	80% ID high-density foam pig
4	100% ID medium-density foam pig
5	Foam caliper tool
6	95% ID bi-directional cleaning pig
7	100% ID bi-directional cleaning pig
8	100% ID bi-directional cleaning pig c/w wire brush
9	100% ID bi-directional gauge pig
10	Inline inspection tool

Application During Pipeline Inspection

- Pipeline inspection is usually performed through internal inspection using complex and costly intelligent pigs
- Inline inspection requires a clean internal bore to obtain conclusive data and help avoid the tool becoming stuck
- Pressure wave analysis helps
 - Ensure cleaning has progressed to the level necessary to obtain conclusive data
 - Minimise the risk of a stuck pig



Conclusions

Pressure wave analysis provides the following benefits:

- Surveys pipeline debris quickly and safely with a repeatable and verified high level of accuracy
- Allows detailed knowledge of pipeline conditions for planning purposes
- Helps reduce the risk of blockage or loss of integrity
- Tracks and optimises the pipeline intervention campaign as it progresses and confirms efficiency of the cleaning methodology
- Saves time and resources and helps lower costs throughout inspection and maintenance programs

Non-Intrusive Pipeline and Wellbore Diagnostic Service Provides Decisive Insight to Help Optimize Asset Integrity and Performance Management

THANK YOU

QUESTIONS Q&A ANSWERS THANK YOU HALLIBURTON