

Advancements in Leak Source Identification Technology:

- Acoustic 'Noise' Logging
- Surface Vent Monitoring

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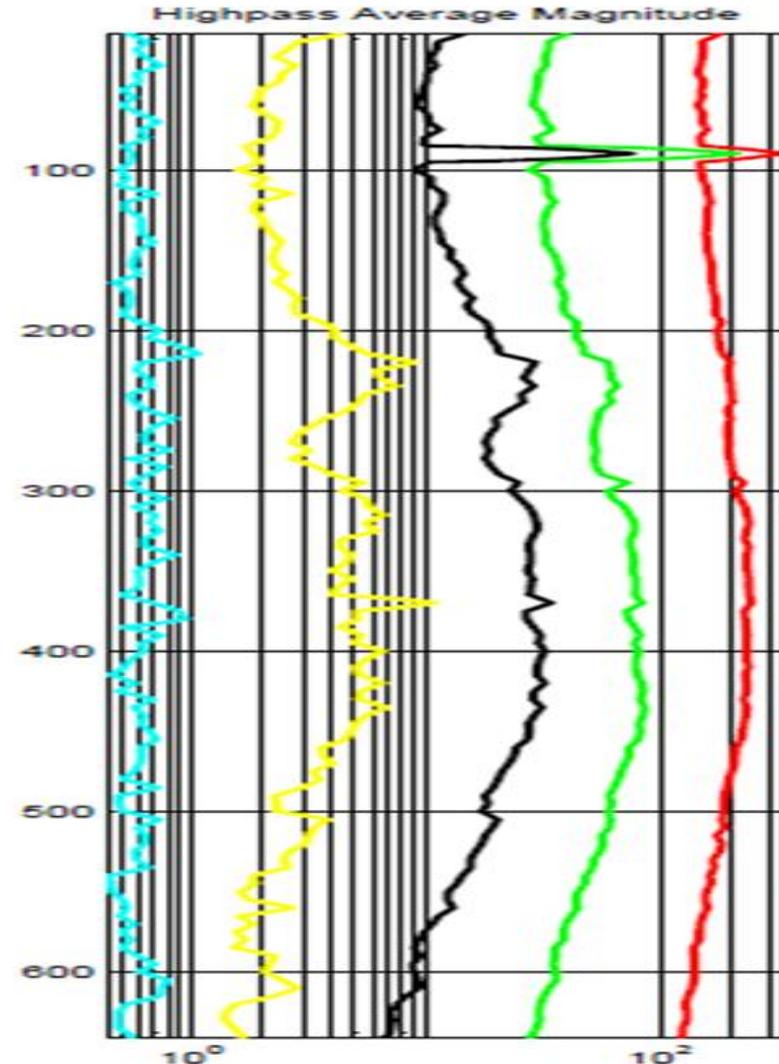
Outline

- Challenges Using Traditional Technology
 - Acoustic 'Noise' Log
 - Surface Vent Monitoring
- Advancements
 - MiQro™ Acoustic Log
 - VentMeter™
- Conclusions & Remarks
- Questions

Note: a case study well will be used throughout this presentation to compare technologies

Traditional Acoustic 'Noise' Log

- **Station stops recorded throughout well**
 - Filtered into frequency bands
 - Average magnitude 'power' at each depth
- **Low Signal Noise Ratio**
 - Piezo sensors are good, but noise floor is high due to truck noise coupling, electrical systems not designed for acoustic surveys
- **Averaging drowns out any resolution**
 - P1V1=P2V2 very few actual downhole leak related events at source
 - Averaging makes low flow rates difficult to pick out
 - Picking out source from overall profile is difficult
- **Sound propagation**
 - Wellbore is perfect waveguide
 - Surface activity, reflections, standing waves, cement changes / pinch points, tool motion, all convoluted together into a 'noise' profile
- **Case study: Client's well file conclusion from this data: "no clear indication of source"**



Typical Surface Vent Monitor

- **Not a consistent measurement**
 - Usually a home made device - hose in coffee cup, old pressure gauge, etc.
 - Changes in input hose size/angle, type of fluid, height water column can vary rate 1000%
 - Unit of 'bubbles' – not a quantified value
 - Too many to count?
- **Vent gives tremendous amount of data that won't be captured**
 - No long term, continuous recorded log
 - Won't see patterns emerge, such as frequency changes, stored supercharged gas
- **Case Study: Client's well file conclusion from this data: 'too many to count'**



Obvious Need For Advancement

- Success rate in Canada is low:
 - Can get up to Millions \$ being spent / well
 - Average 3 interventions per well
- Operators having difficulty keeping up with abandonments due to leaks
- Significant liability and risk
- Finding source is first step
 - Technology developed in 60's – not for leaks
 - 'No definitive source' 'too many to count' isn't sustainable

Advancement in Acoustic 'Noise' Logging - MiQro™

Fiber Optic Acoustics

- Fiber optics for both sensor and data communication
- Signal to noise ratio 1000's of times higher than conventional noise tools
- Distributed arrays of high fidelity, high bandwidth sensors

Data Not Averaged

- Each micro second analyzed to capture very small, sporadic events

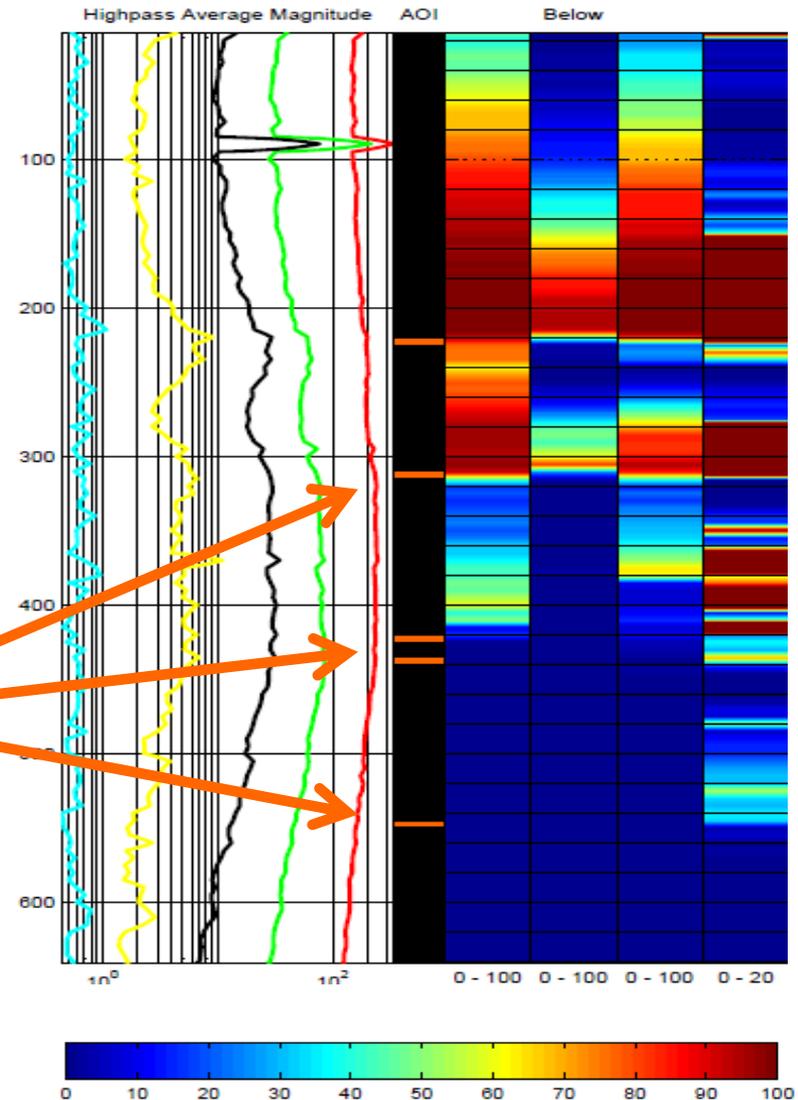
Overcomes sound propagation issues

- Because arrays high fidelity – sonar to determine direction of sound in order to de convolute
- Hifi Algorithm uses several methods to de-convolute amplitude profile
- Specifically designed for finding inflow/outflow points in tubulars



Presentation - Source Location

- Four frequency bands – similar to noise logs
- Algorithm determines direction of all acoustics
- Jet color map:
 - blue no activity, red lots of activity
- Acoustic areas of interest marked by orange tick
- Note - Magnitude does not give indications
- ***Client decided to address three acoustic areas of interest, starting at the bottom most.***



Interventions

#3 310-315m

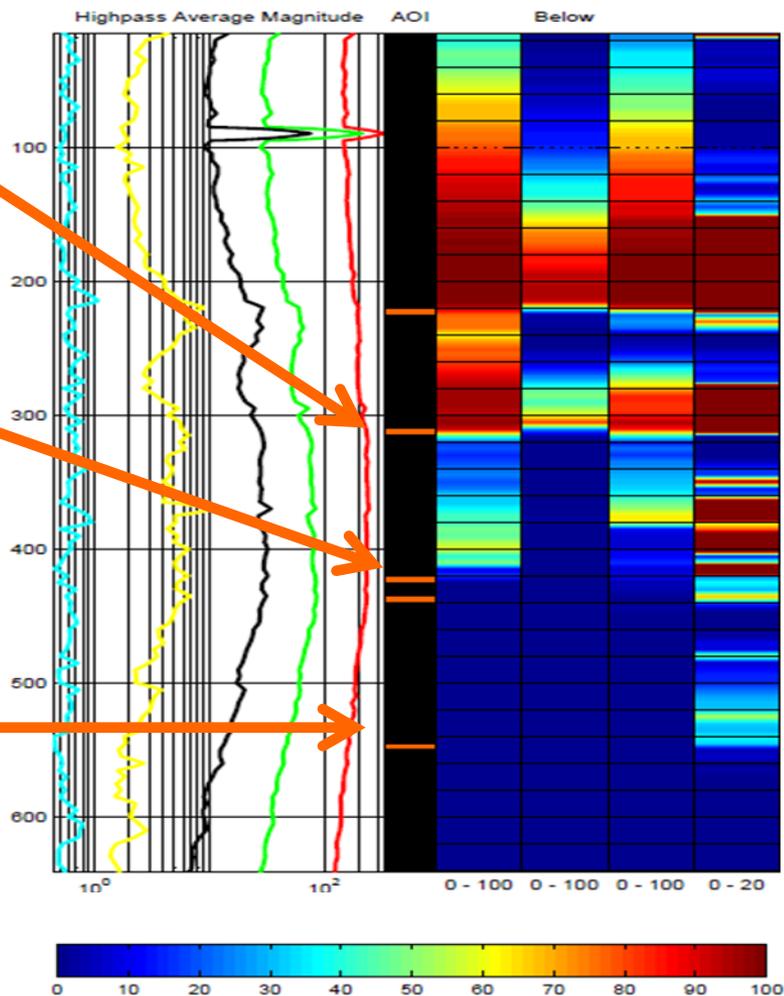
- April 2
- 6m³ @ 2.8MPa feedrate
- **Vent – 0 bubbles**

#2 440-445m

- March 27
- 6m³ @ 6.8MPa feedrate
- **Vent – too many to count**

#1 545-550m

- March 23
- 6m³ @ 6.8MPa feedrate
- **Vent – too many to count**



Despite a feedrate, were 1# and #2 unsuccessful?

Advancement in Surface Vent Monitoring - VentMeter™

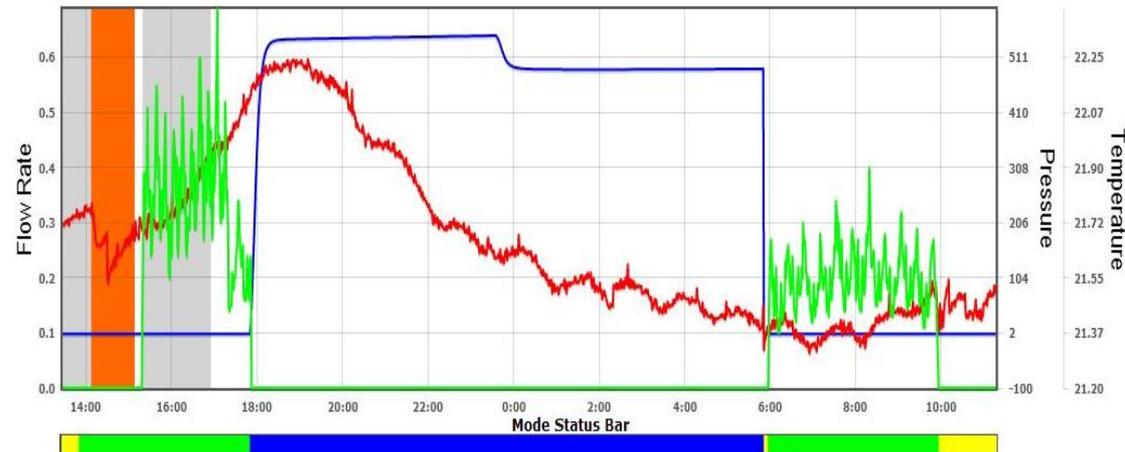


- **Proper Scientific Measurement**

- Accuracy to 1 'bubble' per day
- Consistent @ -40 to +40 degC ambient

- **Provides Long Term Record**

- Vent gives tremendous amount of clues
- Not always looking for immediate shut off – small clues
- Will help flag identify potential gas storage
- Will help identify secondary sources
- Conclusive data to avoid unnecessary squeeze attempts
- Well documented results
- Web based, real time, composite reporting



Start Time: 04/18/2013 13:27:25

[Zoom out to Previous](#)

End Time: 04/19/2013 11:16:36

Mode Status Legend	
Green	Flow Mode
Blue	Buildup Mode
Yellow	Bypass Mode
Orange	Perforation
Grey	Intervention

Chart Layer Legend			
<input checked="" type="checkbox"/>	Pressure (kPa)	<input checked="" type="checkbox"/>	Temperature (°C)
<input type="checkbox"/>	Total Flow (m³)	<input checked="" type="checkbox"/>	Flow Rate (m³/day)
<input type="checkbox"/>	Barometer (kPa *)	<input type="checkbox"/>	AUX

* Uncorrected

- [View Last 24 Hrs.](#)
- [View Complete Job](#)
- [Generate PDF](#)
- [Generate CSV](#)
- [Refresh Data](#)

Real Time Data Provided Useful Clues

#3 Intervention

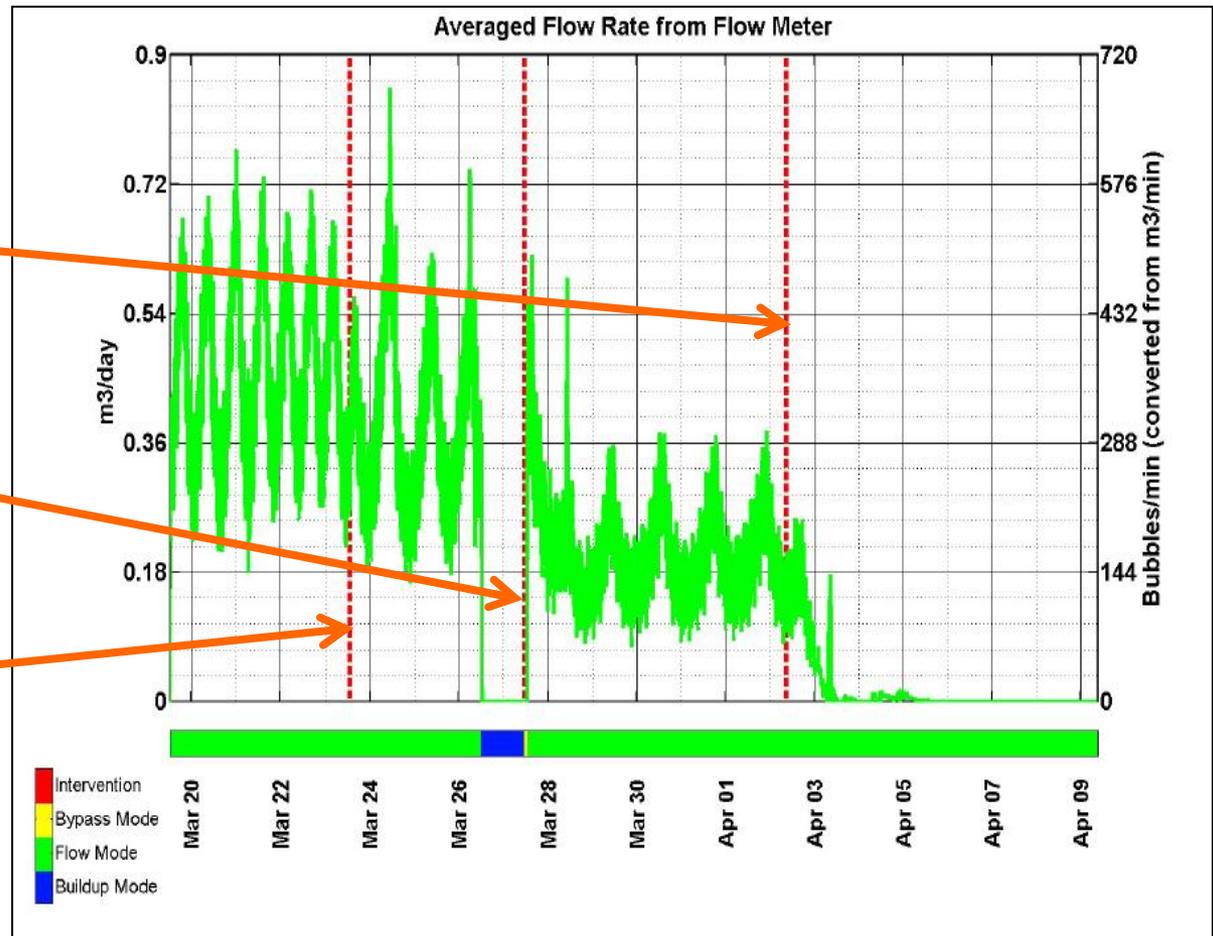
- April 02, 2013
- 6m3 Cement @ 2.8 mPa
- Leak stopped

#2 Intervention

- March 27, 2013
- 6m3 Cement @ 5.8 mPa
- Altered Flow pattern and reduced flow

#1 Intervention

- March 23, 2013
- 6m3 Cement @ 6.8 mPa
- Altered flow pattern



Without the long term monitoring, the first 2 attempts either go unnoticed or could indicate a negative impact depending when sampled

Conclusions & Remarks

1. All data was real time, conclusive, provided instant feedback, and required very little 'interpretation'.
 1. MiQro tool identified 3 very clear distinct zones all resulted in a successful feed rate – Magnitude standard did not confidently flag these areas
 2. VentMeter confirmed a change in flow activity after each intervention was completed - visual monitoring or standard meters would not have recognized this.
2. The Surface Casing Vent Flow was successfully eliminated and the well was abandoned.
3. Intervention #1 could have been performed and waited to see if it would bleed off – not possible to leave equipment due to spring breakup.
4. Estimated single well abandonment cost savings to operator between 50k and 500k
5. Proven and Verified
 - Verified at Alberta Research Council, ERCB approved
 - Customers include Conoco, Cenovus, Husky, Devon, Suncor, Talisman, Shell
 - Over 500 wells logged
6. New technology / gathering proper data can make a significant difference - these technologies are commercially available today.

Thank You – Questions?