Cost Effective Technologies for Onshore Well Abandonments and Verification

Matteo Loizzo and Jonathan Heseltine

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Webinars

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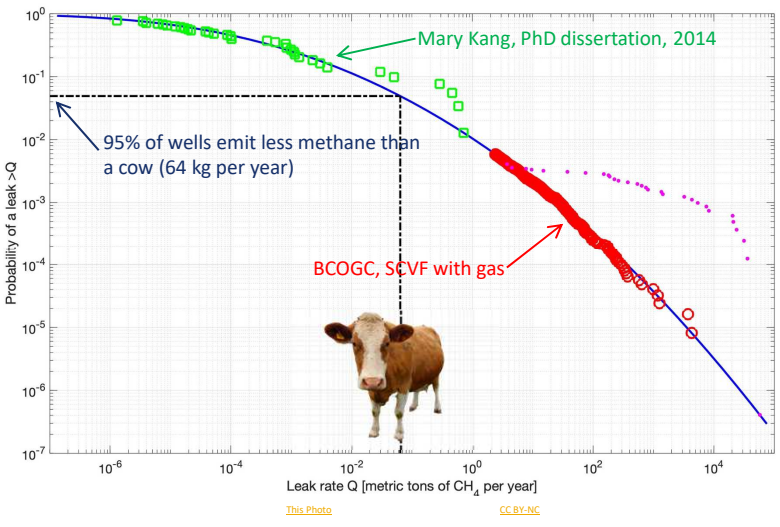
Outline of the Workshop

- Setting the stage: leaks and their causes
- Measurements and monitoring
- Technologies to fix leaks
- The path forward

Are Wells Leaking?

Super-Pareto: 2% of wells account for 98% of leaks (Q>0.4 tpa)

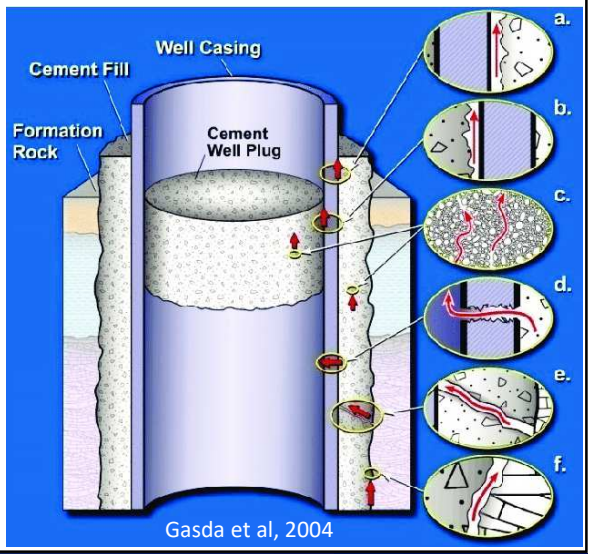


Which Ones Do We Fix First?

- Prioritize based on risk → tackle the 2%-5% bigger emitters
  - API 14B → 15 $ft^3\ min^{-1}$ for gas, 0.4 l min^{-1} for liquid
    - 146 and 210 tpa
  - AER directive 87 → 300 $m^3\ day^{-1}$
    - 79 tpa
- Methane leak rate is not the only risk driver
  - Location and exposure
    - ‘‘Methane Seepage District Regulations”, part of City of LA Building Code issued in 1985
  - Resource damage
    - Drinking water, but also O&G, mining, storage, geothermal…

Where Are They Leaking?

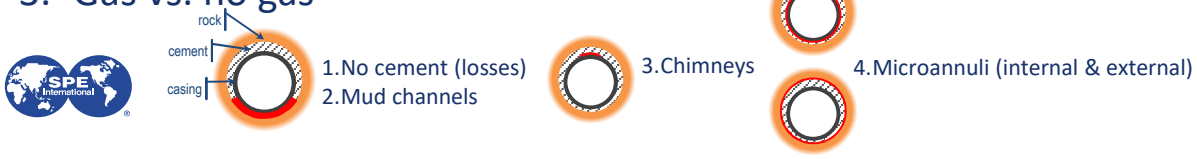
- Internal to casing
  - Through plugs
- External to casing
  - Within well envelope → SCVF/SCP/SAP
  - Through soil → GM
    - More difficult to locate
    - More difficult to measure
    - More difficult to repair
- Evolution as regulations and technology have changed



Gasda et al, 2004

What Drives Leak Risk?

1. Cement sheath defects → four types
   - Microannuli (debonding) have smallest leak rate, but they are the only ones that can appear at any time
2. Geology
   - Creeping formations act like reverse packers and shut microannuli
   - Intermediate horizons and lost-circulation zones
3. Gas vs. no gas



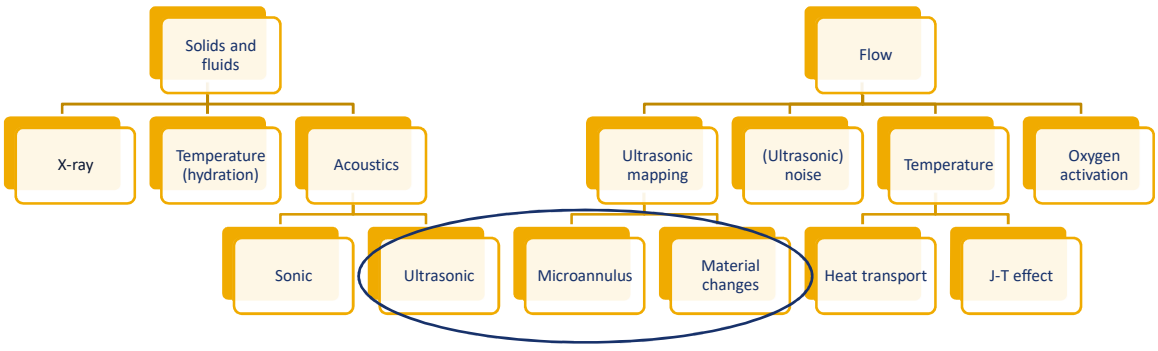
Can Technology Solve Problems?

- Locate the leak source and pathway
  - Measurements, monitoring and detection
  - Better communication vs. silos → better data
- Plan the intervention
- Seal the leak
  - Barrier materials and methods
- Assess results
  - Data management and accessibility

Measurements and Monitoring

- Wireline logging
- Pressure testing
  - Pressure and inflow test
  - Injectivity test
  - Build-up/draw-down
  - Leak rate → best option, no volume uncertainty
    - Harder when through the soil
- Chemical fingerprinting
- Imaging → IR cameras, or side scan sonar offshore
- Physical effects → stressed vegetation, bubbles, sheen…

Wireline Logging



The Logging Dilemma

- Data is expensive, so it must drive actions
  - We cannot repair if we don't know the defect
    - Multiple blind trials can be more expensive than a log
- Everyone uses CBL, even though it provides little evidence of zonal isolation
  - Can just help you spot free pipe and microannulus
  - Hope for outer casing logging, but then only a CBL…
- Ultrasonic + CBL can pinpoint all defects
  - But only if you can read it → no value is a waste of money
- Do we really need to log?

Alternative Barrier Materials

- Potential Advantages
  - Solids-free composition, low viscosity, rheological properties allowing placement in small flow pathways
  - Superior mechanical properties (strength, flexibility) to withstand geological/operational stresses
  - Environmental resistance (chemical, corrosion, temperature)
  - Very low permeability
  - Expansion upon setting
  - Rigless deployment, GHG emissions with less equipment and allowing treatment of remote wells
  - Lower CO_2 emissions during manufacturing

Relate to cost by

Performance advantages requiring fewer interventions

Carbon pricing, liability

Required Characteristics of Materials

- Impermeable
- Long term integrity (what is permanent? 1,000,000 days / 3000 years?)
- Chemical compatibility, resistance
- Not harmful to steel tubular integrity
- Locational and dimensional stability
- Bonding to steel and formation
- Non-brittle, mechanically capable
- Non-shrinking
- HSE, toxicity (handling, transportation, in-situ-especially above base groundwater protection)
- Other considerations
  - Future use of well/reservoir (EOR, CCUS)
  - Enabling technologies (placement, verification, monitoring)

PTAC WARI 1801 Cement Alternatives 2019
Energy Safety Canada IRP 26 Wellbore Remediation 2020
OGUK Guidelines for the Qualifications of Materials for the Abandonment of Wells 2015
NORSOK D-10 Rev.4 2013

Types of Alternate Materials and Methods

- Thermosetting polymers
- Geopolymers, inorganic polymers
- Chemical treatments, silicates, precipitates, dissolved glass
- Low melting point metal alloys
- Casing expansion
- Unconsolidated materials
- Swellable clays
- Magma, thermite
- Modified cements

Qualifying Materials (Lab Testing)

- Risk assessment
- HSE, toxicity
- Small-scale material testing
  - Material properties
    - Density
    - Young's modulus
    - Permeability
    - Strength
    - Viscosity and other flow characteristics
    - Setting behavior
  - Bonding, stability
  - Endurance testing
    - Chemical
    - Temperature
    - Corrosion
- Often no clear pass/fail criteria exist
  - Cement as a benchmark
- Medium to full-scale
  - Placeability and barrier performance (pressure test)

Qualifying Materials (Field Testing)

- Preplanning is critical
  - Understanding downhole conditions
  - Pre and post monitoring (performance assessment and documentation)
  - Ensure lab practices and SOPs match actual field practices
- Challenges
  - Monitoring downhole environment is difficult; however, adequate data is critical
- InnoTech Alberta and OGTC collaboration
  - Workshop series in progress (alternate barriers and enabling technology)
  - Cost and P&A emission targets
  - Trial materials/materials in land wells - experience is an asset
  - Seeking support of operators, PTAC, funding organizations

Roles and Responsibilities

- Operators
- Regulators and governments
- Technology vendors
- Service companies
- Research organizations
- Industry committees/institutions
- Public

Where Do We Go From Here?

- Alternative materials – range of TRLs
  - Lab qualification
  - Field trials

  } Materials, placement, monitoring
- Collaboration, data sharing – successes and failures
- Support mentorship – knowledge is being lost
- Decision making tools
  - Prioritize wells (risk)
  - When to decommission and planning interventions
- Incentives to take on risk of adopting new technology
- Regulations→ routine operations, IRPs, SOPs