P&A considerations for proper lifecycle design

Henry St Aubyn, OTM Consulting

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Why design for P&A

• All wells require P&A at the end of their productive life
• P&A is responsible for up to 40% of total decommissioning costs for some operators
• Current efforts focus on activities with immediate cost reduction by:
  • Improving operational best practice
  • Developing cost-effective solutions to common technical challenges
• Although effective in the short term, operators need to adopt a long-term view to:
  • Improve understanding of existing barrier quality and potential leak paths
  • Provide effective zonal isolation through the well life that continues through P&A
  • Rethink cable and control line routing to enable cost-effective removal

Significant cost exposure
Complex, multi-discipline challenges
Dynamic regulatory environment
Key areas of concern

- Rigless P&A: 20%
- Barrier verification and multi string logging: 19%
- Cost effective plugging and sealing: 21%
- Longevity of tubulars and metal-to-metal seals: 2%
- Monitoring of abandoned wells for leakage/possible leak paths: 10%
- Novel barrier materials: 12%
- Remediation of poor P&A: 5%
- Removing entire casing and lower completion including screens: 3%
- Removing equipment, debris, and/or collapsed casings and/or screens: 8%
Examples of innovative technologies

The lack of innovative solutions a decade ago is now being rectified with some exciting and disruptive technologies entering the market

- Bismuth plugs
  - Provide a metal-to-metal seal across casing
- Resins
  - Can provide seals between annulus and formation
- Thermite seals
  - High energy downhole reaction negates requirement to pull tubulars
- Rigless P&A
  - No requirement for costly rigs, enables concurrent activity
- Shale as a barrier
  - In-situ annular seal
Macra challenges

There are three key macro drivers: regional regulations and liability of previously abandoned wells, major costs of P&A in the climate of low oil price, high and increasing rate of wells requiring P&A

Regional regulations

• Currently there is no single internationally recognised P&A standard
• It is expensive to prove that new technologies comply with regional regulations
• Differences hinder the ability to drive economies of scale through common tooling and equipment
• By ensuring that P&A globally is carried out to the highest standards, the risk of historic liability repercussions is reduced

Increasing costs and number of wells

• Lessons learnt in one area should be transferred to another, reducing expensive learning curves on every operation start up
• Sharing experience from past decommissioning projects will improve the accuracy of P&A cost estimation
• Collaboration and sharing of challenges will enable more generic equipment design
How PACE is working to address these

PACE brings together operators, service companies and vendors to address key challenges in the industry through:

- Technology presentations
- Discussion sessions to formulate innovative solutions
- Alignment of understanding
- Development of problem statements and design parameters
- Engagement of stakeholders

PACE is an incubator of ideas fostering increased collaboration

“An excellent opportunity to develop relationships with counterparts in other companies, as well as to provide targeted information in a small audience format. Going forward, the dissemination of key cost reduction concepts will hopefully gain critical mass for industry acceptance”

Joseph Witt, ExxonMobil

“As a growing international service company with a particular focus on reducing the cost of P&A operations for operators, Abrado is excited to be a member of PACE and welcomes the collaborative industry dialogue that such a global network provides”

Sandy Esslemont, Abrado Wellbore Services
Who is involved?

PACE member companies meet four times per year to:

• Understand capabilities of current and emerging technology
• Collaborate on cost effective solutions to common technical challenges
• Increase awareness of the global regulation
• Share knowledge and experiences to improve operational best practice

Current PACE member companies:
Activity to date – barrier verification

Needs
- A standard for the evaluation of formation creep as a barrier
- Multi string logging to evaluate sealing capability of primary concept
- Through-tubing barrier evaluation
- Multi annuli barrier evaluation
- Ability to log cement outside 13 3/8” casing from inside 9 3/8”
- Ability to log cement behind 9 5/8” casing from inside 4 1/2” tubing
- Ability to effectively test a barrier in the appropriate flow direction and to quickly understand long-term sealing capability with statistical certainty
- Tools that are not calibration sensitive
- Reliable information about the qualification of installed barriers, independently, in-situ
  - during well construction
  - prior to PA
  - during/after PA
- Risked based barrier validation
- Hydraulic/gas tight isolation verification
- Self verifying materials
- Flexible
- Long lasting

Solutions
- X-ray
- Hydrophone array
- INTeX
- Better (more) sensors in right location at the right time, duration telemetry – to the right place – analytics – turn into valuable, timely, actionable information
- Video validation
- Baker Hughes compressional, shear and lamb cement evaluation
- Multiple independent logging technology
  - 1) + pressure test
  - 2) - pressure test
  - 3) set weight down
  - 4) video monitoring
  - 5) place gas below plug and monitor above plug (e.g. helium)?
- Penetrate and test
- nXis – Newtron/x-ray inspection system; a multi-annulus cement bond logging tool

Challenges
- Isolation confirmation
- Regulator engagement and consistent message from industry
- Prescriptive regulations vs ALARP
- Cost (sensors, telemetry)
- Interoperability (need “open source” solutions)
- Overcoming industry perceptions/norms
- We have too much data/information already;
  - we “fear” all this new data
  - decision makers don’t “foresee” the value
- Tubing in the well
- Multiple annuli
- Industry (operating company) support

Key: Operators – Pink; Services Companies – Green; Equipment Vendors – Orange
Activity to date – barrier verification

Collaborate on cost-effective solutions to common technical challenges

- Outside of the box thinking/solutions
- Multi string/annuli through-tubing barrier evaluation
- Tools that are not calibration sensitive
- Self-verifying materials: flexible and long lasting
- Video validation
- Penetrate and test
- Better (more) sensors in right location at the right time, turn data into valuable, timely, actionable information (real-time monitoring)

Understand capabilities of current and emerging technology

- Ability to effectively test a barrier in the appropriate flow direction and to quickly understand long-term sealing capability with statistical certainty
- Reliable information about the qualification of installed barriers, independently, in-situ during well construction, prior to P&A and during/after P&A
- Barrier validation technologies: hydraulic/gas tight isolation verification, x-ray, hydrophone array, video validation, compressional, shear and lamb cement evaluation
- Real time monitoring of B Annulus (new wells current technology with brownfield not yet available)
Activity to date – common themes

Increase awareness of the global regulations/testing/standards

- Regulatory influence through stakeholders (fishermen, academics, operators, regulators), regulator engagement and consistent message from industry
- Need more capability to measure/monitor barrier state/quality in situ and independently - could be need only periodically for some measurements (install, well start up, pre-P&A)
- Risked based barrier validation
- Regulatory guidelines outdated, requirement is often unclear, but still require regulatory approval. Key requirements:
  - Standard for the evaluation of formation creep as a barrier
  - Standard for resin testing
  - Standard for identification and qualification of shale barriers
  - Lab evaluation: different temperatures, different well fluids – impossible to test all combinations
  - Verification and durability testing
  - Online/digital barrier verification management
  - Barrier verification by pressure testing for a short time
  - Qualification program showing barrier for all eternity
Activity to date – common themes

Share knowledge and experiences to improve operational best practice

- Design for P&A at well beginning, present cost for future risk
- Industry (operating company) support
- Overcoming industry perceptions/norms
- Cost-efficient practices
- Interoperability (need “open source” solutions)
- Share results of lab testing and field trials
- Understand lifecycle impact to annular cement
- Experience with isolation confirmation
- Use of production/DTS data for understanding longer term integrity
How else are OTM helping operators plan for P&A?

- As an oil & gas technology advisory consultancy, OTM works with individual clients to develop their P&A plans
- Examples of past projects include:
  - Technology gap analysis
  - State of the art review of cost saving technologies
  - Identification of potential cross-over technologies outside oil & gas
  - Global trend survey on decommissioning and well abandonment
Key take-aways

• There is an increasingly urgent need to address growing P&A liabilities
• The top three technology areas of concern are:
  • Barrier verification and multi string logging
  • Cost effective plugging and sealing
  • Rigless P&A
• The challenges in addressing these concerns are driven by:
  • Multiple regulatory environments
  • Multiple perspectives on challenges which are in fact common
  • The ever-present challenges in deploying new technology
• PACE adds value directly in the areas of concern by tackling these challenges head on
• The first PACE meeting was held this month (multi-annular barrier verification)
  • Five confidential technology presentations heard by the PACE operator panel
  • Problem statement definition ongoing on agreed set of challenges
  • Format and objectives clearly defined for future meetings
• The next meeting is scheduled for June 2017
Plugging & Abandonment Collaborative Environment (PACE)

With many offshore oil fields reaching the end of their productive lives, operators are preparing to decommission a substantial number of wells in the coming years, with well plugging and abandonment responsible for up to 40% of total decommissioning costs worldwide. PACE was launched by OTM Consulting to promote P&A collaboration in order to:

- Understand capabilities of current and emerging technology
- Collaborate on cost-effective solutions to common technical challenges
- Increase awareness of the global regulation
- Share knowledge and experiences to improve operational best practice

Following a successful first meeting in March, the second PACE meeting will be held in the summer of 2017. During this two-day event, invited service companies and vendors will confidentially present their new technologies to PACE’s operator panel; then all members will come together for knowledge-sharing presentations and discussion sessions in order to explore potential collaborative opportunities and drive improved operational best practice.

To learn more about PACE and enquire about membership, please contact Debbie McIntosh at debbie.mcintosh@otmconsulting.com

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