Development of a Subsurface Mudline Packer to Reduce Risk of Flow after Cementing and Sustained Casing Pressure, While Providing a Platform for P&A.

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Agenda

- Problem Statement
- Technology Gaps
- Solutions
- Risk Mitigation
- Impact
- Conclusions
- Questions
Problem Statement

- Overwhelming number of offshore wells with Sustained Casing Pressure (SCP)
  - Approximately 8000 wells in the Gulf of Mexico alone (MMS)
  - Following bleed off, pressure rebuilds again
- Flow after cement of large diameter casing (9-5/8")
  - HSE problems with gas discharge and disposal
  - 38 incidents in the Gulf of Mexico
- Continual flow of gas / oil to surface poses many problems
  - Lack of primary barrier for well control
  - Inability to properly abandon well in emergency cases (hurricanes, etc,…)
  - Surface handling challenges
  - Explosive dangers
SCP and Flow After Cement

Micro annulus channeling in unset cement leads to pressure at surface.

Poor cementing across gas / oil zone leads to micro annulus flow.
Technology Gaps

- Typical methods to address these issues involve:
  - Cement squeeze (inconsistent and usually requires multiple days of down time) – Cost $$$
  - Bleed-off procedures – dangerous and involves onsite management (not viable solution for well abandonment)

- Currently no solutions to address this at the completion phase – Until now
Solution

- Focused on continental shelf wells initially since challenges from deepwater are very different.
- Majority of wells still are within 1000ft of water. (low hydrostatic pressure compared to deepwater)
- Goals
  - Create an isolation device to isolate flow after cement
  - Allow two methods of setting (intelligent acoustics recognitions and time)
  - Tool platform must be translatable to deepwater applications (future)
  - ISO 14310 VO rated seal
Mudline Packer

- Based on highly successful ZXP packing element
  - VO rated for primary gas isolation
- Incorporates intelligent setting mechanism
  - Reads and verifies a predetermined vibration signal – sequence from surface
  - Requires no additional pumping or inner string manipulation
  - Not affected by rig noise or pumping
  - No loss of casing integrity
Mudline Packer (Operation)

Step one: Cement 13-3/8” Casing

Step two: Drill out the 12-1/4” OH

Step three: program Mudline Packer for specific vibration sequence

Step four: Run-in 9-5/8” Casing w/ Mudline Packer

Step five: begin displacing cement to annular space on 9-5/8”

Step six: after pumping, rig up special air hammer signal device to 9-5/8” casing @ surface (connected to rig air supply)

Step seven: using air control box, begin sending pre-programmed signal down casing string

*Mudline Packer will set once signal is sent!*
Mudline Packer (testing)

- Extensive testing was conducted to validate the vibration signal identification
  - Amplitude significantly above in-situ levels
  - Frequency different from any rig equipment
  - Downhole recorders verified the signal
Risk Mitigation

- The following features are incorporated into the packer programming:
  - Hibernation mode for a given period of time (allows sufficient pumping time for cement)
  - Wake mode
    - Programmed to listen to signal to set or delay / reset timer
  - Redundant default mode that will cause the packer to set if a specified time passes
- Logical coding ensures that no matter what the scenario / conditions, the packer will perform
**Impact**

- Eliminate wait on cement time where flow after cement is an identified hazard
- Packer is accepted as a primary annular barrier for offshore with a VO rating (MMS)
  - 5000 psi rating inside 13-3/8” casing
  - Simplify P&A operations
- All surface signal equipment is intrinsically safe and air driven

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**Decision Tree for WOC to ND Surface Stacks**

1. Are there hydrocarbon bearing zones in the open hole?  
   - No  
   - Yes / unknown

2. Is potential flow contained by a “Mechanical barrier” between strings or special wellhead?  
   - No
   - Yes

3. Is 50 compressive strength data available for this cement?  
   - No or don’t know
   - Yes

4. **NOTE:** WOC should be 10 hours plus 2 hours for every 1000’ deeper than 5000’ prior to ND BOP if there is lost circulation during pumping of cement, gas units don’t drop to background level, or if there are other considerations.

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Data extracted for API RP-65-1 “Isolating Potential Flow Zones During Well Cementing”
Conclusion

- Need for isolation in large diameter casing to address sustained casing pressure and flow after cementing
- Billions of dollars spent each year on remediation and cement squeeze operations
  - Treating the symptoms and not the root cause
- Development of Mudline packer will give operators an approved method for isolation without running tools or pumping
Questions