Cement Barriers: Assessment of Foamed Cement Systems used in Deep Offshore Wells (GOM)

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EPAct Complementary Ultra-Deepwater R&D Portfolio
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Complementary Program is focused on key offshore materials for which data in extreme environments are limited.

Phase I: Assessment of Research Needs - focus of this presentation

- Review of the current state of knowledge regarding research needs & knowledge gaps
- Input directly from industry experts & literature research


Phase II: Research based on results of Phase I

- Improve knowledge to ensure safe operation in which foam cements are used in the deep offshore environment
  - Evaluating performance of foam cements at atmospheric and in situ conditions
  - Utilizing NETL’s unique facilities and capabilities
Phase I: Cement Technical Report


- Roadmap for future wellbore cement research?
  - Literature and Expert Review
    - Industry Expert: someone with strategic knowledge, insight, and significant experience in drilling and cementing
    - Variety of major oil & gas and service companies
    - Members of API, IADC, DEA
    - Glen Benge – 2 day drilling and cementing workshop at NETL
  - 5 Key research findings
    - Related to cement design, placement, and long-term integrity
Phase I: Cement Technical Report

Schematic representation of offshore spill risk profile

- Deviated (30%, 48%) & Exploratory Drilling (29%, 14%)
- Completion &/or Workover (20%, 14%)

% of recorded spills & drilling phase in the GOM & North Sea
- Source: SINTEF Database

- Cementing Failures
- Equipment & Casing Failures
- Higher risk targets, “exploratory” systems

Deep water and offshore frontier face production risks that are fundamentally distinct from onshore operations.

Drilling phase identified as having highest number of risks and uncertainties.

Concerns about fracturing the formation can have a big impact on well design, lost circulation, and loss of well control.

Well design incorporating multiple barriers are essential to safety.
Phase I: Cement Technical Report

• **Improvements to the process**
  – Can we find more effective ways to get a good cement job?
  – Do we need:
    – Better standards?
    – New procedures and protocols?
    – New technologies?

• **Overcoming data quality limitations**
  – Need to obtain more accurate or representative data to design, implement, and evaluate a cement job

• **Improving predictive tools**
  – Develop better models (simulators) for understanding and predicting operations

• **Developing additional basic data**
  – Acquiring fundamental data from laboratory or field testing that can support all of the above
• Failure to monitor cement placement and cement integrity
  – Long-term monitoring of zonal isolation performance is needed to understand the performance of cement over time
  – Is the cement where it should be?

Findings: Research needs include the development of a tracer than could be pumped with the cement and measured after it set, tools to efficiently and accurately survey cement bond logging, and in situ sensors to evaluate integrity
Phase I: Cement Technical Report

• Better understanding of cement stability under field conditions
  – Uncertainties in risk assessment: During placement and post placement
    • Fluid loss control, contamination, dynamic setting
    • Cement expansion/shrinkage, development of free water, temperature and pressure stability, cement/formation interaction
    • Foamed cement stability
    • Gas migration prevention

Findings: Further research under field conditions of cement setting and stability parameters
Cement Quality Control

- Industry experts expressed that often there is a disconnect between cement as tested in the laboratory and as mixed and pumped in the field.
  - The job as modeled in the lab is often not the job pumped
  - Need to understand the influence of particle shear, settling during transportation, and a number of other factors.

Findings: Research focused on quantifying the potential impact of poor quality control, or on developing improved “best practices” for insuring that cement pumped is the same as cement tested should be given a high priority. There is a need to design ways to improve, simplify, and possibly automate testing technology.
Design of cements for frequent stress loading and unloading events post placement

- Pressure/temperature cycles in the wellbore can cause mechanical failure, microannuli, or loss of zonal isolation
- Ultradeep offshore wells – large heat exchangers
- Need better understanding of thermal cycling effects of cement during placement and upon setting

Findings: Research is needed to focus on the thermal and pressure stress cycles in ultradeep offshore wells. Wellbore thermal modeling is needed to understand temperature uncertainties.
Phase I: Cement Technical Report

- Lack of industry standard calculations to determine cement characteristics and properties
  - While tests may be available, many are not considered standard tests because they are not consistent throughout industry
    - Static gel strength and gas migration tests
    - Lack of a standard stress calculation for set cement

Findings: Research to develop a set of “industry standard” tests of cement properties is a significant focus of investigation by oil-field service companies for the writing and updating of API standards and recommended practices
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