Design Process for Sustainable Long-Term Wellbore Integrity

Building the Well Right

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Barrier Definition

A component or practice that contributes to the total system reliability by preventing liquid or gas flow if properly installed.*

How is this achieved?

* API Standard 65 - Part 2
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Design Process

Gather the Right People
Identify and Document Objectives and Goals
Resolve Conflicts
Core Principles

Protect groundwater and the environment
   Proper wellbore construction and installation of barriers

Well design and construction
   Ensure environmentally sound, safe production of hydrocarbons
Cementing Design Process

Understand the Chemistry of the system
Optimize the Physics of Cement Placement
Determine Well Site Logistics and Equipment Limits
Evaluate to Confirm Objectives are Met
API Standard 65 – Part 2

• Industry accepted **design** best practices
  – Hole quality - Drilling fluid properties
  – Engineering design
  – Mud removal - Slurry design & testing

• Industry accepted **execution** best practices
  – QA/QC - Execute as per design
Pre Job Engineering

Pre-Job Laboratory Data – Slurry Design

Design the cement slurry to meet well requirements

Utilize Pre-Job Engineering Software

Simulate fluid placement and pressures

Optimizes rates and volumes for cement placement
Slurry Design

Evaluate well requirements
  Short term - during cement placement
  Long term - throughout entire well life

Customize material usage for cement design
  Fit-for-purpose design
  Customize for each well / field

Slurry design is not a “one size fits all” process
Engineering Software

Placement Modeling

Temperature Modeling

Wellbore Stress Analysis
Placement rates
Pipe movement
Pre-job drilling fluid circulation rates and volumes
Utilization of downhole tools
  Centralizers, float equipment, etc.
Stress Modeling

Cement Compressive Strength

Young’s Modulus

Tensile Strengths
“Flexible” Cement Systems

Function by altering the mechanical properties of the set cement

Generally have lower strengths due to dilution of the base cement

Can alter the methods used for cement evaluation

May not show up well on conventional bond logs
Mechanical Barriers

Swelling Technologies

Swell Packers
Annular Inflatable Packers
“Self Healing” Cement Materials

Use with cement
Job Execution Planning

- Anticipated Pressures
- Design Fluid Rates
- Volumes for all fluids
- Density control of spacers and cement slurries
- Data Recording
Western Pennsylvania

Challenges:
- Shallow Gas Migration
- Lost Circulation
- Poor Bond Log Responses
Western Pennsylvania

Solutions:

- Fit-for-purpose slurry design
  - Incorporation of gas migration materials
- Improved cement placement
  - Optimized spacer systems
  - Customized displacement process
Conclusions

Successful barrier installation requires:

Understanding the objectives of the operation

Identification of methods and materials to be used to achieve the objectives

Adherence to design plans

Proper evaluation of the final operation to assure objectives have been met