LOWERING DRILLING COST, IMPROVING OPERATIONAL SAFETY, AND REDUCING ENVIRONMENTAL IMPACT THROUGH ZONAL ISOLATION IMPROVEMENTS OF HORIZONTAL WELLS DRILLED IN THE MARCELLUS SHALE

RPSEA and CSI Technologies
Outline

- Introduction
- Project Benefits
- Project Structure
- Summary and Further Information
Introduction

- Long term, comprehensive study
  - 2 phases over 2 years
- Working with an operator in the Marcellus Shale play
- Developing a process to achieve the goals of the project
  - Field observation
  - Lab testing
  - Engineering analysis
The goals of the project are to achieve the following in the Marcellus Shale play:

– Decrease drilling cost
– Decrease environmental impact
– Increase safety on and around the well site
Data Collection

- **Historical data**
  - 20 wells, 60 cement jobs
  - Drilling, cementing, and bond log data

- **Real time data**
  - 33 wells, 60 cement jobs
  - Testing cement samples from field
  - Facility conditions/practices
  - Operator concerns – Gas migration
Gas Migration Timeline

Immediate: Underbalanced well

3-12 hours: Gas migration through cement during set time

Days: Formation of a micro annulus or channel

Months - Years: Damaged or permeable cement

Short – Term

Long – Term
Data Collection: Results

• Observed and analyzed around 120 cement jobs in the Marcellus Shale play
• Drilling, cement jobs, well performance data
• Practices that greatly impact integrity of cement sheath
  ▪ Density and mixing
  ▪ Data acquisition and job execution equipment
  ▪ Job execution skills
Laboratory Testing

- Baseline testing – Field Samples
  - Blended cement + location water
  - Compared to pilot
- Specialized testing
  - Fluid migration analysis
  - Shrinkage/expansion testing
  - Permeability testing
  - Impact testing
  - Mechanical properties tests
  - Optimization testing
• Initial testing indicated most slurries did not pass
  ▪ High potential for gas migration
• Little to no fluid loss control
• Long gel transition times
• Displayed shrinkage
• Re-design system: Thixotropic cement
Laboratory Testing: Results

Re-designed Slurry Gas Migration Chart

- Gas Delivery
- Gas Recieving
- Mass Flow Rate

Graph showing volume (mL) and mass flow rate (SCCM) over time (hr:min) from 9:36 to 13:26.
Recommend Improvements

- Recommendations
  - Better communication
  - Consistent density control
  - Mix water temperature in optimal range

- Design recommendations
  - Cement stability
  - Gas migration reduction
    - Thixotropic systems
  - Cement durability

- These and other recommendations have improved cement sheath performance
  - Operator reported reduced sustained casing pressure
Identify Potential for Problems

- Statistical Analysis
- Working with University of Houston
- Developed several statistical models
  - Predict failure correctly 80% of the time
- Links various parameters to failure
  - Spacer volume
  - Centralizers
  - Annular volume
  - Mix water temperature
  - Cementing additives
Estimate Improvements

- Estimate improvements
  - Initial field assessment
  - Receiving well performance data over last 6 months
  - Analyzing recommendations
CSI will develop training material and have engineers and field advisors share the information in 1-3 day seminars with various groups:

- Engineering
- Field operations
- Service companies

Each group will be informed of the recommendations and provided procedures and personnel to help implement changes.
Assess Improvement

- **Field operations**
  - Field advisor presence in Pennsylvania

- **Laboratory testing**
  - Testing cement samples

- **Engineering analysis**
  - Reviewing and analyzing data provided by field and lab
  - Analyzing well performance through data provided by the operator
Quantify Effectiveness

- Quantify the effectiveness of new cementing protocol
  - Zonal isolation
  - Operations safety
  - Environmental impact
- Compare actual to predicted results
  - Use statistical analysis
Summary

- **Goals**
  - Lower drilling cost
  - Improve operational safety
  - Reduce environmental impact

- **Achieved through:**
  - Field observation, lab testing, engineering analysis
  - Developing recommendations
  - Implementation through training
Further Information

- RPSEA Link:
  - http://www.rpsea.org/1012219/

- Articles related to project:
  - Magazine
    - Oilfield Technology
      - “Horizontal Learning Curve” Vol 6, Issue 2
    - American Oil and Gas Reporter
      - “Zonal Isolation Critical in Developing Unconventional Resources” August 2013 issue
  - 1 SPE article
    - “Lowering Drilling Cost, Improving Operational Safety, and Reducing Environmental Impact through Zonal Isolation Improvements for Horizontal Wells Drilled in the Marcellus Shale” SPE1582346
DEVELOPMENT DRIVEN. FIELD FOCUSED.

THANK YOU

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