SPE 158092

High-Strength, Low-Density Cement Pumped On-The-Fly using Volumetric Mixing Achieves Cement to Surface in Heavy Loss Coal Seam Gas Field

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presenting on behalf of
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CSG Cementing Considerations

- Cement properties must satisfy isolation standards with the ability to support future loads
  - Slurry Density
  - Short thickening time
  - Fast compressive strength development
  - Fluid loss
  - Thixotropic
- Compared to conventional cementing, there is a greater need to control slurry invasion into the formation/coal cleats
- Lightweight cementing
  - Water-extended
  - Nitrified (Foam)
  - Hollow spheres (High-Strength, Low-Density)
- Lost circulation material
- Reactive Spacers
- Excess slurry volume
High-Strength, Low-Density (HSLD) Cement Design

- Lightweight slurry using hollow spheres
- Hollow microspheres SG is less than water
- Maintaining a high solids volume content which gives higher compressive strengths
- Highest short term compressive strengths
- Strength of cement is dependent on the Solids to Water Ratio (SWR)
- Typical densities of 8.6ppg to 13.0ppg
Solids to Water Ratio (SWR)

- For conventional-weight slurries, SWR varies only slightly with minor density changes.
- For some lightweight slurries, minor density changes result in drastic changes in SWR since SG of the solids is approaching SG of water.
- SWR affects all major slurry characteristics.
Volumetric Mixing

- Slurry mixing is conventionally based on density control
  - Density, water requirement, yield are inputs
  - Solids and water are adjusted until desired density is achieved
- Lightweight slurries should either be mixed in a batch mixer (if volume permits), or volumetrically mixed on-the-fly
- Volumetric mixing examines changes in volume of the mixing tub, and then changes the volume of solids while keeping mix water rate constant.

\[ \text{Bulk} = \text{Slurry} - \text{Mix Fluid} \]
Field Implementation

- A trial was set up over a 3 well pad in a Queensland CSG field which is prone to heavy losses
- Objective was to achieve cement returns to surface and sufficient zonal isolation for future fracturing operations on each well’s production casing
- Improved methods of cementing were used on each subsequent well
## Case Study

<table>
<thead>
<tr>
<th></th>
<th>Well 1</th>
<th>Well 2</th>
<th>Well 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spacer Type</strong></td>
<td>Standard</td>
<td>Reactive</td>
<td>Reactive</td>
</tr>
<tr>
<td><strong>Slurry Density</strong></td>
<td>12.0 ppg HSLD</td>
<td>12.0 ppg HSLD</td>
<td>11.0 ppg HSLD</td>
</tr>
<tr>
<td><strong>Mixing System</strong></td>
<td>Density-Control</td>
<td>Density-Control</td>
<td>Volumetric</td>
</tr>
<tr>
<td><strong>LCM Additives</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Excess Volume</strong></td>
<td>50%</td>
<td>100%</td>
<td>125%</td>
</tr>
<tr>
<td><strong>Cement Returns to</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Top of Cement Achieved</strong></td>
<td>Below Previous Shoe</td>
<td>Above Previous Shoe</td>
<td>Surface</td>
</tr>
</tbody>
</table>

HSLD Cement pumped on-the-fly using Volumetric Mixing achieves Cement to Surface in Heavy Loss CSG Field

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