Guidance for Successful Cement Plugs

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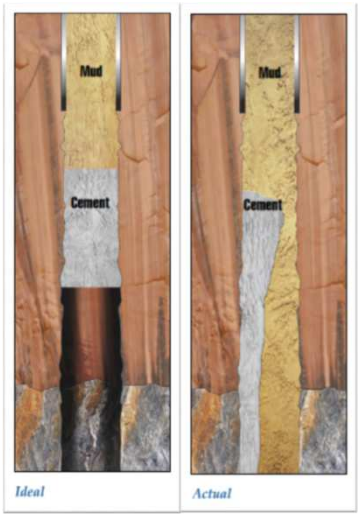
- Challenges Associated With Plugs
- Key Reasons for Failures
- Recommended Best Practices
- Latest Developments to Minimize Risks
- Summary

Challenges Associated with Plugs

- Inadequate planning, last minute requests, KOP
- Contamination of cement:
  - Lack of proper support, resulting in fluid swapping
  - Inadequate volume of separation spacer & slurry itself
  - Poor mud removal
  - Properties of fluids: Non-optimal density, viscosity
- Setting plug across too hard formation
- Insufficient WOC time
- Poor placement techniques



Proper Planning

- Define Job Objective & KPIs
- Review logs and drilling records
- Establish competent formation
- Hole condition
  - Wellbore fluids
  - Formation integrity
  - Deviation
- Potential movement/fluid swapping
- Determine accurate BHT (temp. simulator)

Successful Plugs: Addressing Contamination

- Lack of proper support: Need a properly designed viscous fluid as base to support the cement plug
- Adequate spacer volumes/minimum 500 ft separation for vertical holes and water based drilling fluids
- Higher number recommended for synthetic/non-acqueous drilling fluids and deviated to horizontal wells, eg. 750 ft or more
- Follow min 10% density differential & 20% friction hierarchy

Support Base for the Plug

Viscous Reactive Pill:

- Forms a highly gelatinous base below cement plug
- Reaction between cement slurry interface that comes in contact with Viscous Pill forms a highly viscous gelatinous mass
- Further Fluid swapping is minimized
- This will keep cement plug in place

Mechanical Support:

Bridge plug & other available tools

Cement Plug: Design Considerations

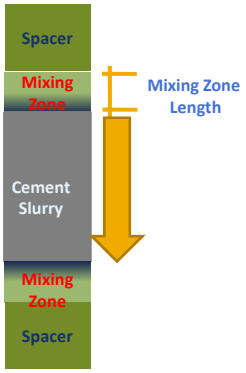
- Placement simulations: design temperature (BHCT)
- Slurry and spacer fluid: compatibility tests
  - 5/95
  - 25/75
  - 50/50
  - 95/5
- Slurry and spacer fluid properties: density & viscosities
- Thickening time tests
- Compressive strength, especially at top of cement
- Compressive strength to be tested with some contamination
- Monitor results of the changes made

Cement Plugs: Placement Considerations

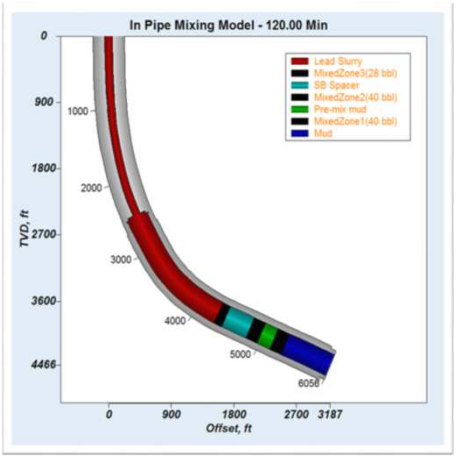
- Placement Rates
- Displacement volume considering under displacement
- Benchmarking success with clearly defined KPIs
- Apply field experience: What has & has not worked?
- Diverter Sub–to ensure fluid flows radially into the annulus to avoid jetting
- What was changed?
- Monitor results of the changes made

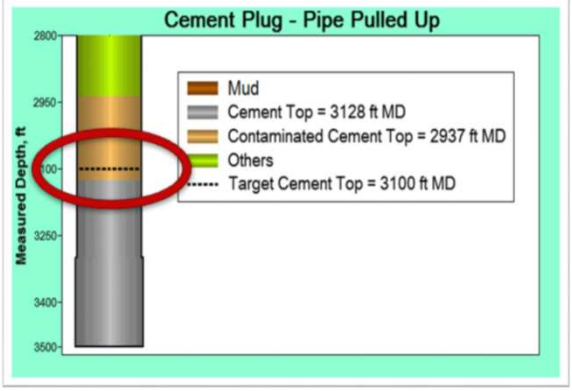
Plug Simulation Software: Features & Benefits

- Success rate of cement plug placement on the 1st attempt is very low
- This is true for non-aqueous drilling fluids & deviated wells
- Software can be utilized for plug placement to address:
  - In pipe contamination
  - Well geometry, pipe configuration, and displacement volumes considering under-displacement
  - Plug contamination while POOH the drill pipe
  - **More accurate estimation of top of cement plug**
  - Removes inconsistency with plug placement 'habits'

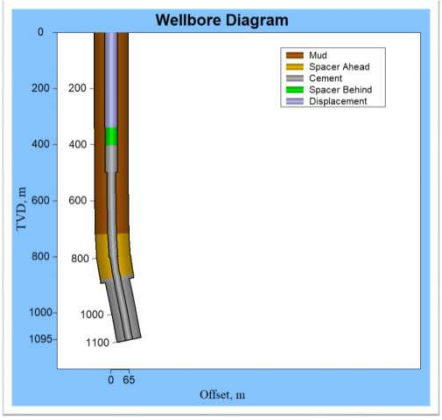


In-Pipe Mixing Simulation

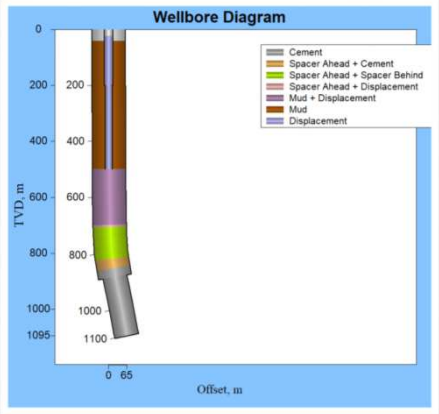




Under displacement before pulling out



TOC after pulling out



Summary

- **Proper Planning**
- **Proper Support for the Plug**
  - **Chemical**
  - **Mechanical**
- **Best Cementing Practices**
  - **Hole Conditioning**
  - **Compatible Spacer**
  - **Accurate Slurry Density**
  - **Improved Placement Techniques**
  - **Plug Placement Software**
  - **Set Balanced Plug**
  - **Pull Out of Plug Slowly**
- **Define JOB objectives, KPIs, and Measure Success for Improvements**

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Questions and Comments…