The Application of Aluminum Toe Casing for Landing Production Strings in Extended Lateral Wells
ALTISS Technologies

Core Competencies
Advanced Engineering Studies
Product Development and Prototyping
HP/HT Design and Testing
High Performance and Exotic Thread Design
Third Party FEA Verification

Simulation
Abaqus, ANSYS, SolidWorks, DrillScan

Products
High Pressure Autoclaves for Corrosion Testing
Modular Stress Joint
Aluminum Drill Pipe
Aluminum Toe Casing
Industry Need for Additional Technology

Operators have had difficulties setting long casing strings
Industry trend is to increase length of laterals
Un-cased hole can’t produce or be booked as reserves
Major impact on financials (IP, ROI, Credit Line)
ALTiSS evaluated inserting aluminum on toe of lateral
Aluminum vs Steel Casing Properties

- Lower than Modulus of Elasticity of Steel
  10,300,000 psi vs 30,000,000 psi

- Lower than Density of Steel
  .101 lbs./in³ vs .284 lbs./in³

- Twice the Strength to Weight Ratio of Steel (P110)

- Twice the Flexibility of Steel Casing (5 ½”, 17#)
ALTISS Aluminum Premium Connection

Specifically designed for 5.5” Al tube body to Steel Coupling

Tested min / max / nominal dimensions

11,800 Ft.-Lbs. Make-up torque
29,500 Ft.-Lbs. Calculated yield torque
56,000+ Ft.-Lbs. Observed yield torque

Exceeds 75% tube body torsional strength
Collapse Testing

API Collapse equation not applicable for aluminum alloys (low modulus)

Testing on four full scale test pieces

Analyzed Lamé, Timoshenko, and Tamano collapse equations

Results validated collapse equations
Three Aluminum alloys tested
13 pH slurry for 1-6 hours at 200° F
Fluid velocity equivalent to pumping 6 BPM
No stress corrosion cracking
Coating technology available for acid treatments (15% HCl)
Torque and Drag Modeling

Utilized DrillScan Torque and Drag Software
  Stiff string model
    Pipe stiffness included
    Buckling calculations included

Evaluated installing different lengths of aluminum casing at the toe

Calculations did not include air sections or rotation
Torque and Drag Modeling

West Texas Well #1
- 10,000 ft. TVD
- 10,000 ft. Lateral

West Texas Well #2
- 10,000 ft. TVD
- 15,000 ft. Lateral

South Texas Well
- 10,000 ft. TVD
- 17,000 ft. Lateral

Photo courtesy of DrillScan, Inc.
Reduced drag from aluminum casing increases the predicted hook load at TD.

An increase in predicted hook load reduces risk of casing being stuck before reaching TD.
## Torque and Drag Results

<table>
<thead>
<tr>
<th>Joints AI (#)</th>
<th>West Texas Well #1 (10K lateral)</th>
<th>West Texas Well #2 (15K lateral)</th>
<th>South Texas Well (17K lateral)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>529</td>
<td>916</td>
<td>1,016</td>
</tr>
<tr>
<td>12</td>
<td>664</td>
<td>758</td>
<td>610</td>
</tr>
<tr>
<td>25</td>
<td>604</td>
<td>581</td>
<td>610</td>
</tr>
</tbody>
</table>
After normalizing the results on a per joint basis, the effect is most efficient with smaller lengths installed.

The ‘Toe Effect’ is likely due to the Al casing increased ability to navigate through tortuous well paths, guiding the casing to TD.
## Torque and Drag Results - Benefit

<table>
<thead>
<tr>
<th>Length AI (ft.)</th>
<th>West Texas Well #1 (10K lateral)</th>
<th>West Texas Well #2 (15K lateral)</th>
<th>South Texas Well (17K lateral)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Steel</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>160</td>
<td>+ 2,116</td>
<td>+ 3,665</td>
<td>+ 4,065</td>
</tr>
<tr>
<td>500</td>
<td>+ 8,306</td>
<td>+ 9,481</td>
<td>+ 7,629</td>
</tr>
<tr>
<td>1000</td>
<td>+ 15,112</td>
<td>+ 14,513</td>
<td>+ 15,240</td>
</tr>
</tbody>
</table>
Conclusion

Short sections of Aluminum Toe Casing can benefit casing runs by lowering casing string drag.

Minimum 10,000 lbs. of hook load can be added with few Al joints.

Aluminum Toe Casing prevents the need to rotate casing which leads to cost savings by avoiding premium connections.

Increases IP and booked reserves which improves financials.
QUESTIONS

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Thank You