Optimized Milling Operations

ECWS Fluid Rheology System
Essential Coil Well Service provides a Fluid Rheology System (FRS) that comprises of our Fluid Pump, Chemical Van and Engineered Job Modeling. This setup provides real-time monitoring and optimizing of Fluid Rheology by determining the Reynolds Number to maintain ideal flow regime.

Features and Benefits

- Optimization of Rheological metrics for solids transport
- Reduce cycle meters with less wiper trips
- Optimization of chemical consumption (eliminates gel sweeps)
- Reduced operating hours
- Real-time monitoring of Fluid Rheology
Case Study – 8 Well Bridge Plug Mill-Out

On a recent post-frac bridge plug milling project, using the newly designed milling metrics, ECWS was able to reduce operating time, decrease chemical costs and improve overall efficiencies.

Comparison of Bridge Plug Mill-Out Campaigns in Montney

<table>
<thead>
<tr>
<th>Description</th>
<th>Milling using Old Metrics</th>
<th>Optimized Milling using FRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deepest Well TD (mMD)</td>
<td>5030</td>
<td>5656</td>
</tr>
<tr>
<td>Total Plugs Milled</td>
<td>132</td>
<td>139</td>
</tr>
<tr>
<td>Gel Pumped (L)</td>
<td>730</td>
<td>0</td>
</tr>
<tr>
<td>Average Wiper Trips/Well</td>
<td>1.5</td>
<td>0</td>
</tr>
<tr>
<td>Operating Hours/Plug Milled</td>
<td>2.68</td>
<td>2</td>
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</table>

- 32% reduction in milling costs using the optimized milling
- Elimination of gel costs
- Elimination of wiper trips
- Reduced cycle meter charged
Chemical Van – Technical Specifications

- 2 x Waukesha & 4 x Eagle PC Pumps
- Accurate Chemical Injection to 0.05 L/min
- 6-10 Heated 1,000 L Chemical Tote Storage
- Lab Area including OFITE 900 Automated Viscometer
- Data Recording System
- PID system allowing remote and automated operation with feedback control system to keep required chemical loading consistent under changing pump rates
Twin Fluid Pumps – Tech. Specifications

- 10,000-15,000 psi Operating Pressure Rating
- 660 hp to 1,500 hp Deck Engines
- Dual 2.0-5.0 m³ Mixing Tanks with Overfill Alarms
- Shear Pumps and Chemical Injection Ports
- Pump-to-Coil Data Network onto OrionNET
- Fluid Rates, Fluid Totals, and Annular Velocity (AV)
- Real-Time Density Measurement
- Data Recording System
Fluid Rheology Tracking Sheet

- Daily Chemical Treatment Report
- Measurements of Viscosity, Density, Annular Velocity, and Reynolds Number
- Specialized Chem Van Operator
- 24 Hour Engineering and Field Superintendent Support
- AV and Viscosity vs. Time Graph
- Reynolds Number vs. Time Graph

Fluid Rheology Metrics | AV and Reynolds Number (Input and Return Parameters) | Chemical Usage and Loading Records

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
<th>Dimension</th>
<th>Description</th>
<th>Viscosity (cP)</th>
<th>Density (g/mL)</th>
<th>Annular Velocity (ft/s)</th>
<th>Reynolds Number</th>
<th>AV</th>
<th>Viscosity vs. Time Graph</th>
<th>Reynolds Number vs. Time Graph</th>
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<tbody>
<tr>
<td>1</td>
<td>0:01</td>
<td>0.05</td>
<td>Fluid Sample</td>
<td>4.5</td>
<td>0.6</td>
<td>58.0</td>
<td>2000</td>
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<td>0.05</td>
<td>Fluid Sample</td>
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<td>0.5</td>
<td>55.0</td>
<td>1800</td>
<td>2</td>
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<td>3</td>
<td>0:02</td>
<td>0.05</td>
<td>Fluid Sample</td>
<td>2.8</td>
<td>0.4</td>
<td>52.0</td>
<td>1600</td>
<td>3</td>
<td>0.0</td>
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<td>0:02</td>
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<tr>
<td>8</td>
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<td>0.05</td>
<td>Fluid Sample</td>
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<td>0.4</td>
<td>42.0</td>
<td>600</td>
<td>8</td>
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24 Hour Engineering Support - Job Monitoring - 24 Hour Dispatch Hotline
Call 1-844-ESN-COIL (376-2645) for Service
Fluid Rheology

Real-Time Reynolds Number

- Data acquisition of Fluid Density and Annular Velocity with multiple samples of Viscosity per hour to provide accurate and up to date Reynolds Number
- Data Connection between Fluid/N2 Pumps and CT Rig to display Real-Time Reynolds Number on CTES OrionNET
- Display Von Mises criteria real-time to ensure operating within CT limits
- Real-time data acquisition to generate WOB, accurate surface weight vs. depth graph and live CoF matching.
P&ID

- Viscosity reading will be obtained from sample point on Fluid Pump
- Density reading will be recorded by Fluid Pump DAS
- Optimize flow regime for High AV, Low Viscosity and High Reynolds Number