Maximizing Through Tubing Gun Performance in Dual Tubing Completion

Authors: Edo Raisa (Total E&P Indonesie)
Denny Gultom, Riko Mudayana (Schlumberger)
Well Productivity Basic

\[ p_r - p_{wf} = \frac{141.2 \, q \, B_o \mu}{kh} \left( \ln \frac{r_e}{r_w} - \frac{3}{4} + s_t \right) \]

\[ P_l = \frac{q}{p_r - p_{wf}} = \frac{kh}{141.2 \, B_o \mu \left( \ln \frac{r_e}{r_w} - \frac{3}{4} + s_t \right)} \]

Gun Parameters
Penetration
SPF
Phasing
Completion & Perforation Options

Perforation Options:
1. Large size casing gun
   • Wireline OB or TCP
2. Through Tubing – Shot Inside Casing
   • Exposed & Casing Gun
   • Oriented – non oriented
3. Through Tubing – Shot Inside tubing
   • Exposed & Casing Gun
   • Oriented – non oriented

SAFE ORIENTATION
Perforation Challenges in Dual Tubing

- Poor Performance
- Tubing Damage
- Gun Stuck
- Debris Issue
- Twisted Tubing

Preferred Option
Oriented Casing Gun Performance Progression

- **Orienting Device**: 60 Res, 5 Res, 5 Res
- **Gun Phasing**: 0 Phase, 0–180, 180+/–45
- **Penetration**: Deep Chg, XDeep, RockDeep
- **Shooting Density**: 4 SPF, 4 SPF, 6 SPF
Case Study

Overview
- Open HC zone above top packer.
- Dual 3–1/2” Tubing in 9–5/8” casing.
- Cementing to ensure integrity.
- Top cement evaluation.
- Integrity test.
- Unload well for UB Perf
- Perforate with 2” Rock–Deep Charge, 6 SPF, 180 +/- 45 deg.
- POP
Well Information

Completion

Well Deviation: 0 deg
Form Top (TVD): 1785.0 m
Form Bottom (TVD): 1789.0 m
Borehole Diameter: 12.25 in
Wellbore Fluid: Brine
Fluid Density: 8.763 ppg

Drainage Area: 31.42 acre
Dietz Shape Factor: 31.62
Formation Height (TVD): 4.0 m
Completion Percentage: (%) 100/100/100/100/100
Perf to Form Top (TVD): (m) 0.0/0.0/0.0/0.0/0.0

Formation

Rock Type: Sandstone
Porosity: 17.0 %
Horizontal Permeability: 300.00 md
Vertical Permeability: 80.00 md
kd/k: 0.20
Wellbore Damage: 8 in

Formation Fluid: Oil [GLR=436 SCF/STB]
Gravity (Density): 40.0 deg API
Form Volume Factor: 1.18 bbl/STB
Viscosity: 0.60 cp
Pore Pressure: 1020 psi
Formation Temperature: 190 deg F
Perforation Simulation

Well was producing 2600 BFPD with 92% WC

Δ Increase 60%

<table>
<thead>
<tr>
<th>Well</th>
<th>Well</th>
<th>Well</th>
<th>Well</th>
</tr>
</thead>
<tbody>
<tr>
<td>was</td>
<td>was</td>
<td>was</td>
<td>was</td>
</tr>
<tr>
<td>produc</td>
<td>2600</td>
<td>produc</td>
<td>2600</td>
</tr>
<tr>
<td>BFPD with</td>
<td>92%</td>
<td>BFPD with</td>
<td>92%</td>
</tr>
<tr>
<td>WC</td>
<td></td>
<td>WC</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gam #</th>
<th>Phasing</th>
<th>Effect (spf)</th>
<th>kc/k</th>
<th>Form Pen/ Dia Avg (m)</th>
<th>Comp Len Avg (m)</th>
<th>Comp %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 (360)</td>
<td>4.00</td>
<td>0.50</td>
<td>7.79/0.43 *</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>0 (360)</td>
<td>4.00</td>
<td>0.50</td>
<td>8.44/0.42 *</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>180</td>
<td>4.00</td>
<td>0.50</td>
<td>8.65/0.26 *</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>0,±45</td>
<td>6.00</td>
<td>0.50</td>
<td>8.68/0.38 *</td>
<td>4.0</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>0,±45</td>
<td>6.00</td>
<td>0.50</td>
<td>10.38/0.45 *</td>
<td>4.0</td>
<td>100</td>
</tr>
</tbody>
</table>
The key elements to maximize perforating gun performance in dual tubing are:
- High resolution gun orienting device
- Deep penetration charge
- Maintaining high shot density
- Multi phasing perforation

Good production result was achieved using 2” HSD, 6 SPF and 180+/−45 deg Rock-Deep Charge.

Application is not limited to the dual completion but also monobore completion and possibility for further productivity improvement using dynamic under balance technique.
Thank You

Question & Answer