Predicting Gun Jump Possibility by Gun Blow-up Model

Yurawoot Sripornprasert
Completion Engineer
Date: April 24th, 2013

APPS-13-002
Background:

Completion type: Slimhole Monobore

Perforation strategy: Thru Tubing Underbalanced Perforation by E-line

2007

- Chevron has implemented “Underbalanced Perforation”
  - Better Productivity Index
  - Higher chance of gun jump >> Fish >> Lost Production

2009

- The percentage blown-up fish was continuously increased (1.12% or 61 fish)
- Consequently,…
  - Lost production opportunity
  - Spent time for fishing (14,652 hrs or 610 days)

Opportunity Statement:
To reduce the blown-up fish with continuity of underbalanced perforation
Introduction

How to minimize the blow-up fish?

- Shut-in the well
- Pressure up
- Anchoring tool

Equalizing shot (EQ)
- Less cost
- Practical for all wells
- Extra run (time)

How to optimize number of EQ?
Methodology

Principle

What makes the gun jump?

**Downward Force**
- Cable weight
- Tool string weight

**Upward Force**
- Function of Fluid Density, Well deviation, Tool string dimension
- Lifting force
  - Function of Formation Pressure, Porosity, Perforation interval etc.
  - “Darcy Law”

Downward force < Upward force

- Upward force – Downward force > 0  **Blow up**
- Upward force – Downward force < 0  **Not Blow up**
Methodology

**Step 1**: Determine the flow rate (Q) by Darcy Law

\[ Q_g = \frac{703 \times 10^{-6}kh(P_r^2 - P_{wf}^2)}{\mu_g ZT \ln\left(\frac{0.472r_e}{r_w}\right)} \]

\[ Q_o = \frac{0.00708kh(P_r - P_{wf})}{\mu_o B_o \ln\left(\frac{r_e}{r_w}\right)} \]

**Step 2**: Convert flow rate (Q) to Lifting force

**Step 3**: Combine Lifting force with Buoyancy force to get Upward force

**Step 4**: Determine the Net force by subtracting Downward force from Upward force
Methodology

History Match
Data Point during 1-Jan-08 to 1-Oct-09 (Total 5131 points)

Matching Result

71% Blow-up Fish Reduction
15.4% of EQ runs Increase
Which sand requires the EQ shots?

<table>
<thead>
<tr>
<th>Sand</th>
<th>Top</th>
<th>Bottom</th>
<th>Interval</th>
<th>Formation Pressure</th>
<th>Porosity</th>
<th>Oil/Gas</th>
<th>Temp</th>
<th>Current SITP</th>
</tr>
</thead>
<tbody>
<tr>
<td>“A”</td>
<td>9000’</td>
<td>9006’</td>
<td>6 ft</td>
<td>2500 psi</td>
<td>25%</td>
<td>Gas</td>
<td>310 F</td>
<td>1200 psi</td>
</tr>
<tr>
<td>“B”</td>
<td>8900’</td>
<td>8910’</td>
<td>10 ft</td>
<td>3000 psi</td>
<td>20%</td>
<td>Gas</td>
<td>300 F</td>
<td>1300 psi</td>
</tr>
</tbody>
</table>
**Methodology**

<table>
<thead>
<tr>
<th>Sand</th>
<th>Top</th>
<th>Bottom</th>
<th>Interval</th>
<th>Formation Pressure</th>
<th>Porosity</th>
<th>Oil/Gas</th>
<th>Temp</th>
<th>Current SITP</th>
</tr>
</thead>
<tbody>
<tr>
<td>“A”</td>
<td>9000’</td>
<td>9006’</td>
<td>6 ft</td>
<td>2500 psi</td>
<td>25%</td>
<td>Gas</td>
<td>310 F</td>
<td>1200 psi</td>
</tr>
<tr>
<td>“B”</td>
<td>8900’</td>
<td>8910’</td>
<td>10 ft</td>
<td>3000 psi</td>
<td>20%</td>
<td>Gas</td>
<td>300 F</td>
<td>1300 psi</td>
</tr>
</tbody>
</table>

**Gun Blow-up Model**

<table>
<thead>
<tr>
<th>Field</th>
<th>“Red”</th>
<th>2.441 inch</th>
<th>-8900 TVDSS</th>
<th>9000 ftRKB</th>
<th>9006 ftRKB</th>
<th>2 inch</th>
<th>25%</th>
<th>310 deg F</th>
<th>2500 psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Green”</td>
<td>“Green”</td>
<td>2.441 inch</td>
<td>-8800 TVDSS</td>
<td>8900 ftRKB</td>
<td>8910 ftRKB</td>
<td>2 inch</td>
<td>20%</td>
<td>300 deg F</td>
<td>3000 psi</td>
</tr>
</tbody>
</table>

Result

**“A”**

EQ is required if SITP<=1324 psi

**“B”**

EQ is required if SITP<=1200 psi
Since Gun Blow-up Model has been implemented in 2009, percentage of blown-up fish was reduced significantly.

LPO due to fish was decreased by 42.7% (Gas), 79% (Oil)

Percentage of EQ runs was increased to 14%
Conclusions

✓ Gun Blow-up Model was developed to determine whether the gun will be blown up after perforating at given condition. As a result, the blow-up fish was drastically reduced (77% reduction).

✓ User friendly. Only few input is required.

✓ The Gun Blow-up Model could successfully improve the Production Deliverability, Efficiency and Safety Performance.

✓ The Gun Blow Up Model Concept could be applied to other operating area to improve the Underbalanced Perforation Efficiency.
Question & Answer

“Q & A”