StimGun™ and StimTube™ Tool Successes in West Texas

4/26/2013
Propellant Tool Components

• Cast potassium perchlorate sleeve slid over the perforating gun.
• StimGun™ sleeves available for most gun systems from 2.00” OD through 7.00” OD

• The sleeve is fragile and requires protection.
  • Centralized tandems prevent the sleeve from contacting the casing wall.
  • Retainer collars keep the sleeves in place on the perforating gun.
Propellant Assisted Perforating

- Propellant tools are made up of Potassium Perchlorate and a bonding resin

- It is an oxidizer, safe for storage and transport

- Product requires containment to initiate proper burn sequence
  - A lazy yellow flame is produced when ignited in open air

- When confined, Propellant burns and creates high pressure gas waves that propagate micro fractures extending past the perforation tunnel

- These high pressure gas waves follow the explosive train and thus remain perpendicular to the well bore
  - This “Dynamic” event exceeds fracture pressure of the formation but does not crush the formation rock
  - Gas waves break away the perforation crush zone and carry the debris past the perforation tunnel
    - Provides connectivity to fresh formation rock

- Fractures are created past the damage caused by the drilling process which equates to lower skins
The Grayburg Formation

- A carbonate reservoir, 1 to 5 mD permeability
- 10-15% porosity
- 1,200 to 1,500 psi reservoir pressure
- .75 psi/ ft. fracture gradient.
Client Problem

- Barium Sulphate scaling had severely reduced injectivity in majority of their waterflood wells.
- The scaling collected in and around the perforation tunnels in both injectors and producers.
- Typical Workovers required coiled tubing with chemical washing to restore injectivity or sufficient inflow for pumps.
- On water producers, cavitation and cycling of the pumps were constant problems due to chronic low fluid levels.
- StimGun and StimTube were recommended as potential money and time saving enhancement tools for the client.

4/26/2013
Modeling

- Each well used PulsFrac™ modeling software to predict the success of the job and to highlight any potential problems that might occur when using high energy propellants.
Modeling Can Help us
You Can See Trouble Coming (Sometimes)
It was not all roses.

• Several tools were lost.
• On occasion the wireline was damaged when the tools were shot up the hole.

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Results

- To date more than 350 wells have been treated in the West Texas New Mexico basin for various clients.
- More than 95% of the wells have responded favourably to propellant stimulation.
Case Histories

• CVO Eunice King 14
  – Well completed without acid treatment, but with a similar injection profile to offset wells.
    • Client saved $220,000.00 on this well by eliminating acid and related costs.
    • 14 additional wells completed with similar results, totals savings to the client: $3,080,000.00

• CVO Lockhart #8
  – The initial test was very positive with significantly lower pressures for flow rates
  – However the well was not put on production for more than seven months and has not performed as well as it tested.
  – Flow rates are still better than offset wells that had been acidized.
  – Savings of $200,000.00 in acid and rig time.

4/26/2013
Water Producer

- 100 BWPD Increase, upgraded pump and can run the pump 24/7
- 25 BOPD Increase in production
Propellant stimulation resulted in 200 BWPD increase in production. Pump was upsized and no longer cycles.
Water Injectors

Propellant Treated Wells

4/26/2013
Using StimTube to overcome Barium Sulphate Scaling in Oil Producer

- CVO Sims A #6
  - This well treated with a StimTube tool.
  - Significant problems with Barium Sulfate Scale
  - Working with in house Chemists, additives along with a slicking agent used treat scale were placed across the perforations with a bailer.
  - The propellant was used to inject the chemicals and to further clean and break down the perforations.
  - Large quantities of scale were recovered with a bailer.
  - The well doubled production by over 200 bbls/day for six months
Propellant Rejuvenates North Dakota Producer

- South Pine 24X 15A
  - Production had dropped to 102 BOPD from 280 BOPD
  - Client looking for alternate solutions due to remoteness of location
  - Recommended Propellant Re Perforation

<table>
<thead>
<tr>
<th>Intervals</th>
<th>Propellant Load</th>
<th>Estimated Peak pressure</th>
<th>Estimated fracture length</th>
<th>Assumed skin Before</th>
<th>Estimated Skin After</th>
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<td>8331-8335</td>
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4/26/2013
Propellant Rejuvenates North Dakota Producer

Propellant Stimulation Summary Report

Propellant Stimulation Result

4/26/2013
Propellant Rejuvenates North Dakota Producer

- Well was put on production at 380 BOPD, production has been sustained for more than 5 months.
- 5 wells in the field have shown similar success.
- Propellants prove to be an excellent method of near wellbore damage removal at significantly reduced cost.
Conclusion

• Propellants are an effective means of overcoming near wellbore damage and recovering lost production.
• Modeling of the jobs are a critical part of the design process.
• Significant cost savings can be realized in rig time, pumping equipment and acid
• Total savings to the clients in the region is estimated at more than $36,000,000.00