HYDROJET PERFORATION OF OPEN HOLE WELLS
Advantages

- “Superpower” spiral Heavy Duty nozzle’s barrel design.
- Creation of multiple highly permeable channels in 1 run.
- Tool length is 78” and OD of 2.75”, 3.9”, 4.5”, 5.5”, 7.3”
- Creation of deep highly permeable caverns up to 2 meter to the reservoir.
- Perforation channels diameter ~20mm.
- Self-adopted built-in centralizers.
- Cavern jet-acidizing capability.
- Orientation of 4 perforator’s jets is 90°.
- No additives such as sand to be added to power fluid for channels creation.
- Simple and cost saving technology
Highly permeable channels (up to 2m to the reservoir) to make good communication between wellbore and reservoir in open hole section of the well.

Focused acid stimulation through perforator’s nozzles at high pumping pressure in all types of the wells.

Well stimulation at an initial stage right after drilling to bring well to the higher production level and create uniform production profile.

Perforation before RIH pre-sloted liner.
Equipment required for operation

- Pumping unit with ability to create pressure up to 22,000 - 24,000 kPa and maintain fluid rate around 20-22 l/sec.

- Drainage for backflow. In case if operation will be at Rig so backflow can be sent to shakers and then to circulation system and back to high pressure flow line.

- High pressure flow line.

- Circulation system.

- Water tank.
Workflow (Example)

a. Horizontal OH well is completed by Rig.

b. Mobilize crew with HydroJet perforator.

c. RIH perforator on 3 ½” IF tubing and using Rig’s circulation system and pump create multiple channels along wellbore.

d. Standard practice is 20-30 STOPS (1 STOP is 4 channels) for 700-800m horizontal well.

e. Perforation to be done using brine as a power fluid. No additives as a sand required.

f. Run WWS/PDL if planned to complete well or leave OH.
FMI after HydroJet perforation of horizontal well
Summary

- Simple operation.
- Deep penetration, i.e. wider surface area for the fluid flow.
- Easy planning of operation and short operation duration (1 stop takes 30-45 min to make depend upon formation type).
- Cost effective solution.
- Any OD of the tool available to fit diameter of the well for best result.
- Unique design of barrel of the perforator’s nozzles for long channels creation.
- Great effectiveness of the operation vs cost.
Case study

<table>
<thead>
<tr>
<th>Well #1</th>
<th>Initial Test</th>
<th>Nearby wells</th>
<th>Diff</th>
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<tbody>
<tr>
<td>Well #1</td>
<td>400</td>
<td>300</td>
<td>33%</td>
</tr>
<tr>
<td>Well #2</td>
<td>312</td>
<td>132</td>
<td>136%</td>
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<tr>
<td>Well #3</td>
<td>197</td>
<td>131</td>
<td>50%</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Well #1</th>
<th>Average first 3 months</th>
<th>Nearby wells Average</th>
<th>Diff</th>
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</thead>
<tbody>
<tr>
<td>Well #1</td>
<td>324</td>
<td>206</td>
<td>57%</td>
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<tr>
<td>Well #2</td>
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<td>24%</td>
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<tr>
<td>Well #3</td>
<td>197</td>
<td>116</td>
<td>70%</td>
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</tbody>
</table>

HydroJet perforation solution
Reference letter

TO: North Side Company
FROM: Saleh AL-Jabri
COPY: E & D Manager (Daleel Petroleum)
Date: 22 Dec 2013

SUBJECT: Successful Hydro-jet Jobs Conducted in Daleel Field

This letter is to confirm that North Side LLC performed 4 HydroJet perforation in 3 horizontal oil producers, in Daleel field area, using HydroJet tool. Campaign has started in August 2013 and completed in October of 2013. Perforations were done by the Rig right after drilling of the open hole sections of the wells. No operation issues were encountered during any of these jobs and no HSE issue were reported. Performance of the wells after HydroJet perforation is still under evolution with good initial rates.

Thank you.

Saleh AL-Jabri
RE section Head
Daleel Petroleum

Nasser AL-Rawahy
E&D Manager
Daleel Petroleum
Thank you!

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