Perforating charges traditionally have been designed for natural completions, which focus on depth of penetration with little regard to hole size and consistency. Oil and gas reservoirs, including unconventionals, that require stimulation to be productive, benefit from consistent hole size to improve fracture placement.

Jet Research Center’s MaxForce-FRAC is an engineered charge that addresses perforating for stimulation. The charge is designed to maximize hole size performance while maintaining entry hole consistency in the casing regardless of the gun’s azimuth orientation and standoff.

**Benefits**
- Provides hole size consistency without centralization
- Ensures even distribution of fracture pumping pressure
- Highly suited for ball seal applications
- Designed for stimulation or injection wells
- Improves injection rates
- Reduces treating pressures
- Increases flow efficiency

**Features**
- Compatible with industry-standard perforating guns
- High-pressure systems available up to 25,000 psi (172.4 MPa)

**Modeling**
Advanced fracture simulations using finite element analysis support the performance improvements demonstrated by consistent hole sizes and observed during extensive field testing.

Results show that if the variation of the entrance hole diameter of the neighboring perforation tunnels is too large, then the fracture can initiate at the edge of the larger holes, leaving the smaller hole diameter perforations less effective during stimulation. Jet Research Center’s MaxForce-FRAC charge provides less variance of the entrance hole diameters compared to conventional deep penetrating (DP) and good hole (GH) charges, thus improving pressure distribution, even treatment of perforations, and stimulation efficiency.
Hole Size Consistency (% Standard Deviation)*

<table>
<thead>
<tr>
<th>Charge</th>
<th>3-1/8 in. System</th>
<th>3-3/8 in. System</th>
</tr>
</thead>
<tbody>
<tr>
<td>MaxForce-FRAC</td>
<td>13.0</td>
<td>27.9</td>
</tr>
<tr>
<td>A</td>
<td>26.8</td>
<td>52.4</td>
</tr>
<tr>
<td>B</td>
<td>31.8</td>
<td>75.0</td>
</tr>
</tbody>
</table>

*(Maximum – Minimum /Average Hole Size) x 100

Case Histories

Martin County, Texas, USA
Using the new 210 MaxForce-FRAC charge in a 3-3/8 in. 6 spf 60° gun system, an operator increased injectivity by 20% during a stimulation treatment compared to the same cluster, hole density, phasing, and GH charge used previously.

Reagan County, Texas, USA
The new 210 MaxForce-FRAC charge was thoroughly and independently evaluated over 15 separate frac stages to comparable offset wells perforated with an industry-available GH shaped-charge perforating system. The MaxForce-FRAC charge consistently demonstrated lower treating pressures at the same pump rate, or 8-10 percent higher pump rate at the same treating pressure.

Charge Specifications

<table>
<thead>
<tr>
<th>Gun Size</th>
<th>Explosive Type</th>
<th>Gun Type</th>
<th>Maximum Shot Density (ft)</th>
<th>Explosive Mass</th>
<th>Casing Size Tested</th>
<th>Average Exit Hole Diameter</th>
<th>Hole Size Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-1/8 in.</td>
<td>RDX</td>
<td>HSC</td>
<td>6</td>
<td>21.0 gram</td>
<td>4-1/2 in.</td>
<td>0.46 in.</td>
<td>13.0%</td>
</tr>
<tr>
<td>3-1/8 in.</td>
<td>RDX</td>
<td>HSC</td>
<td>6</td>
<td>21.0 gram</td>
<td>5-1/2 in.</td>
<td>0.43 in.</td>
<td>27.9%</td>
</tr>
</tbody>
</table>

For more case histories or additional information, please contact your local Jet Research Center Business Development Representative.

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