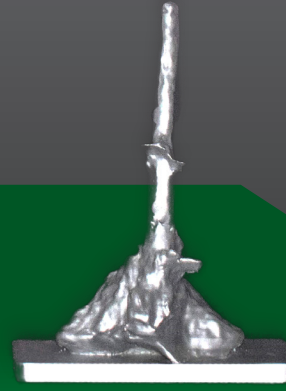


*Optimize  
Completions  
Efficiency*



*CoFrac*

*Conventional*

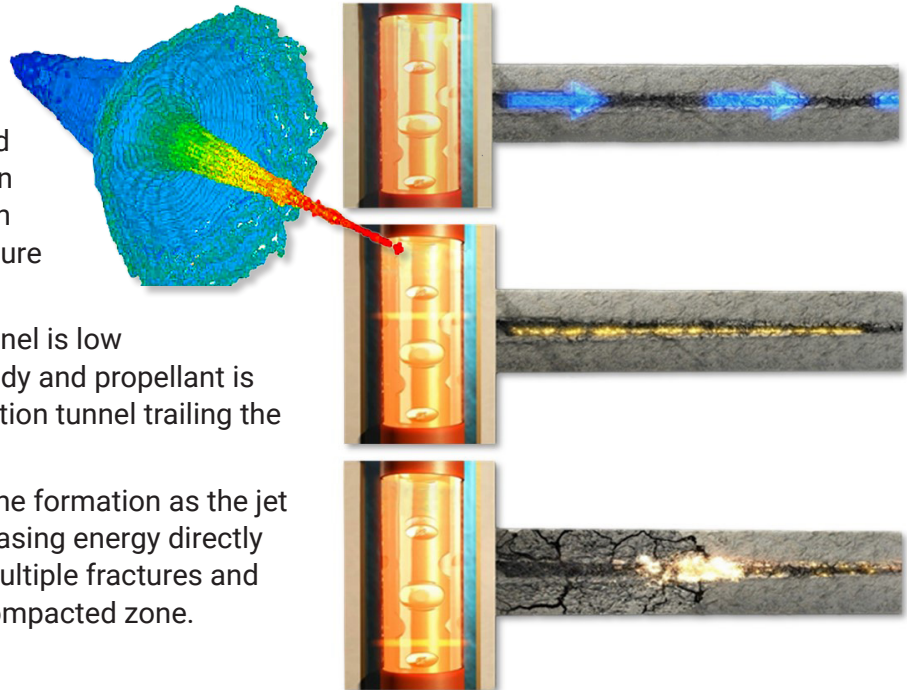
## *Optimize Completions with the Right Perforating System*



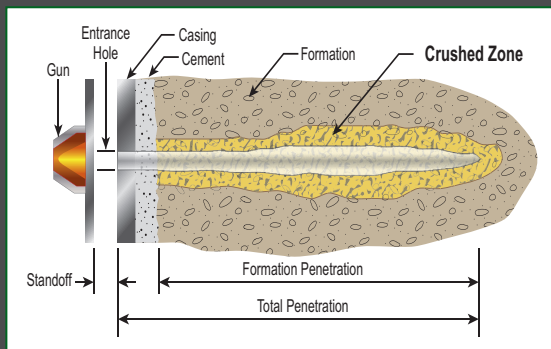
The CoFrac™ Perforating System generates multiple fractures to optimize the connection between the wellbore and reservoir, **lowering operating cost and increasing production.**

### How It Works

1. Shaped charge detonates and initiates the perforation
2. As the perforation jet is formed super high pressure (more than 145,000 psi) is produced within the gun body. Under this pressure propellant won't burn.
3. Pressure in the perforation tunnel is low compared to inside the gun body and propellant is pushed/pulled into the perforation tunnel trailing the jet tip.
4. Propellant deflagrates within the formation as the jet energy extends the tunnel releasing energy directly to the formation, generating multiple fractures and breaking through the tunnel compacted zone.



**The Problem - Compaction & Reduced Permeability**



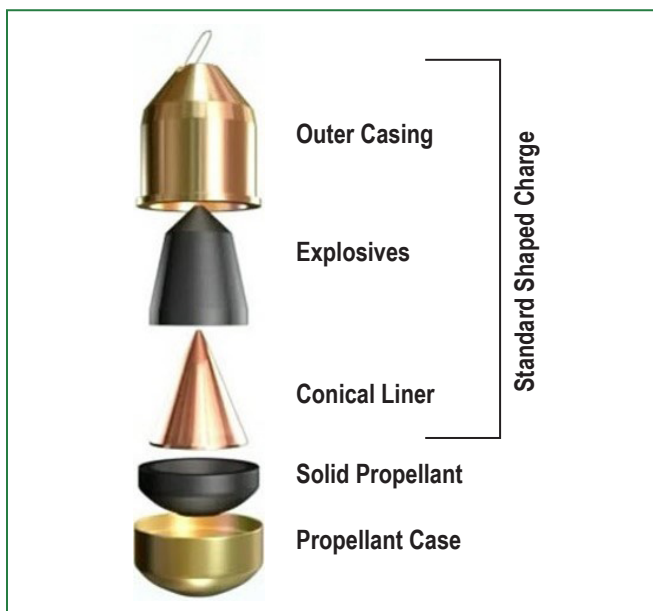
Shaped charges are constructed of high energy explosives that burn very fast when detonated and produce a high-speed jet stream of metallic particles penetrating the gun body, casing, cement annulus and formation to create the perforation tunnel.

This high-speed jet creates a crushed zone around the perforating tunnel that reduces permeability between wellbore and reservoir. This effect can limit reservoir productivity.

**What is Propellant**

It is an explosive product that can be poured into a form and baked into a rubbery solid material that burns furiously when ignited and creates large volumes of gas. Solid propellant boosters are used as the fuel to propel rockets into orbit and the material will produce more energy than an equivalent volume of gun powder.

**Integrating propellant and shaped charges to deliver maximum energy, remove compaction and improve permeability.**



Combining shaped charges of high-speed explosives with slower burning propellant, CoFrac creates two explosive events. The first explosion produces the perforating jet penetrating the gun body, casing, cement and formation. The second explosive event occurs later in time releasing direct energy into the formation to break through the crushed zone and eliminate near well-bore damage.

- Eliminates skin effect and formation damage
- Enhances formation permeability
- Creates ideal flow path for fracturing and production fluids
- Generates optimal fracture networks
- Reduces frac initiation pressure
- Increases injection rate/volume of frac fluids and proppants.
- Reduces cost of fracturing and acidizing operations
- Extends the working life of wells
- Dramatically improves productivity for conventional and unconventional reservoirs



**CoFrac™  
Shaped Charge**



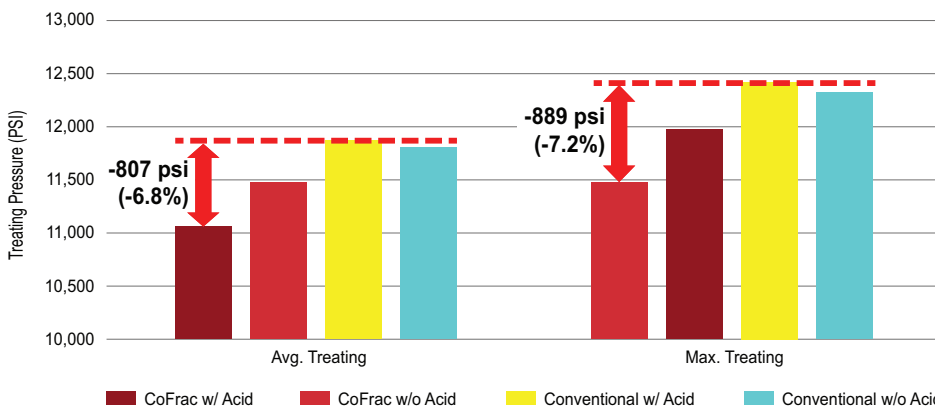
**Conventional  
Shaped Charge**

- *Creates multiple fractures, extending penetration*
- *Plug and Play with conventional shaped charges*
- *Requires no extra equipment, tools or personnel*
- *Simple, reliable & safe process with less environmental impact*
- *Avoid risk of casing and cement damage*
- *Field tested in more than 2,000 wells.*

**CoFrac™ vs. Conventional Perforating - 5 Well Pad with 154 Stages**

	CoFrac w/ Acid	CoFrac w/o Acid	Conventional w/Acid	Conventional w/o Acid
Avg. Treating	11,077	11,449	11,884	11,828
Max. Treating	11,544	11,985	12,433	12,336

**Overall Treating Parameter Comparison**



Overall treating pressures lower with CoFrac versus conventional perforating

The lowest treating pressures were CoFrac stages with acid.

**Completion in a Tight Carbonate**

**THE CHALLENGE**

This is a vertical stage completion in a tight carbonate with average porosity ~ 3%. The reservoir is ~ 950 ft. thick, with varying intervals of porosity ranging from 1-7%. Based on the Microlog response, there were intervals with fracturing indicated, mostly in stage 3.

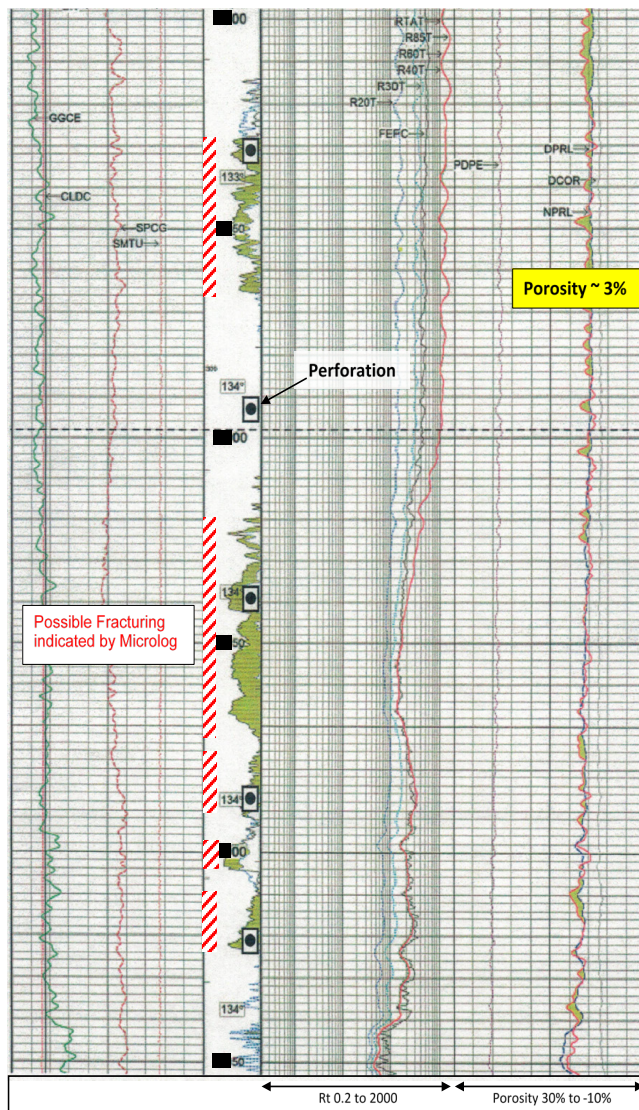
Low porosity carbonate reservoir can be difficult to breakdown and hydraulically fracture. The key to production is to connect the wellbore to the natural fracture network.

**OUR RESPONSE**

A small 4-stage frac job was designed, pumping 4k gals acid, 33k bbls fluid and 200k lbs of sand per stage. Each stage of the frac job was tagged with a chemical tracer.

**DETAILS OF OPERATION**

Perforated with 6 ft. 2spf CoFrac guns, 5 guns per stage, for a total of 60 perforations per stage. Each perforation (shaped charge) deploys 13.5 grams of propellant into the formation, which equates to 162 grams per gun, or 810 grams per stage (~ 1.8 lbs). An M-67 hand grenade has about 180 grams of explosives, so each of the 6 ft. 12 shot perforating guns had an equivalent volume of propellant (that is 5 hand grenades per stage!).



Stage 3 OH Logs – porosity is very low, with possible fractures indicated by Microlog.

**THE RESULTS:**

Each stage frac was successfully completed with 100% of proppant pumped.

The initial oil production on this well (170 bopd) exceeded customer expectations and is much better than offset wells. The results of the chemical tracer matched the Microlog fracture indications, with 50% of production from stage 3. The customer comments...***"the only thing different on this well compared to offset completions was CoFrac. We believe CoFrac made a difference!"***

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