CARBO is the world’s largest supplier of ceramic proppant, the provider of the industry’s most popular fracture simulation software, and a provider of fracture design and consulting services. The Company also provides a broad range of technologies for spill prevention, containment and countermeasures.

Gary Kolstad
Chief Executive Officer

Triumphs & Tribulations of Tight Sands & Shales
“Cracking the Code”
2010 IPAA Annual Meeting
Challenge: Permeability Keeps Getting Lower

Conventional Sands

Tight Sands

Shale

“millidarcies”
1 md

“microdarcies”
.001 md

“nanodarcies”
.000001 md
What Happened?

1996-2006 – We kept drilling more wells to offset declining production, but were not very successful. The downspacing of tight gas sands was a primary driver of drilling activity.
US Gas Wells Drilled vs Gas Supply & Demand 96-06

Wells

- Gas Wells Drilled
- US Gas Production - TCF
- US Gas Consumption - TCF

Horizontal Wells: 10% 13% 17%

Source: EIA - Oct 10 MER/STEO est for production and consumption, Oct10 MER gas wells drilled, BHI
What Happened?

1996-2006 – We kept drilling more wells to offset declining production, but were not very successful. The downspacing of tight gas sands was a primary driver of drilling activity.

2007-2010 - We “Cracked the Code”

1.) Accessing the Reservoir: Dramatically increased the reservoir contact area with Horizontal Drilling
US Gas Wells Drilled vs Gas Supply & Demand 96-10

Source: EIA - Oct 10 MER/STEO est for production and consumption, Oct10 MER gas wells drilled, BHI
US Oil Wells Drilled vs Oil Production  96-10

Source: EIA - Oct 10 MER/STEO est for production, Oct10 MER oil wells drilled
What Happened?

1996-2006 – We kept drilling more wells to offset declining production, but were not very successful. Downspacing tight gas sands was a primary driver of drilling activity.

2007-2010 - We “Cracked the Code”

1.) Accessing the Reservoir: Dramatically increased the reservoir contact area with Horizontal Drilling

2.) Producing the Reservoir: Increased the Conductivity of Fracs, which made low perm reservoirs economical
We Increased Fracture Conductivity

\[ c_f = k_f \times w_f \]

How wide is the road and how good is the pavement?

Wider roads and better pavement costs money .....however, the benefit of increased conductivity is overwhelming in well productivity gains
Why do Tight Sands & Shales need Conductivity?

- Very Low Permeability
- Pressure & Temperature
- Multi-phase Flow
- Transverse Fracs
Multiple Fluid Effects

Multiple Fluids can reduce effective conductivity by over 70% in both oil and gas wells.

Ref: PredictK & SPE 106301
Flow Convergence in Transverse Fracs
Flow Convergence in Transverse Fracs

- A 100’ tall vertical frac has over 100x the flow area at the wellbore than a 6” wellbore in a transverse frac. (200 Ft of wellbore connection versus 1.6 Ft)
- When fluids converge at the wellbore in a transverse frac, the pressure drop is 16,000 times higher than the vertical well at comparable rates.
- You will always benefit from more conductivity near-wellbore in transverse fracs.
Economic Conductivity

Proppant Types & Conductivity

Highest Conductivity

Tier 1 - High Conductivity
- Ceramic
- High strength (minimizes crush)
- Thermal resistant (durable, minimizes degradation)
- Engineered, Manufactured Product

Tier 2 - Medium Conductivity
- Resin Coated Sand
- Medium strength
- Irregular size and shape

Tier 3 - Low Conductivity
- Sand
- Low strength
- Irregular size and shape
- Naturally Occurring Product

Conductivity = Permeability of the frac \times \text{Width of the frac} = K_{\text{frac}} \times W_{\text{frac}}
Haynesville Field Study Results

Wells normalized to 4,500 ft laterals

- Ceramic Proppant (14 wells)
- Resin Coated Sand Proppant (32 wells)

~20% increase @ 12 months
Addt’l production in the first 12 months is ~ 0.23 Bcf
~$1.15 Million revenue increase @ $5/Mcf

Ref: SPE 134165
Bakken Field Study Results

- The three wells (1-3) receiving Ceramic proppant provide higher production than the adjacent wells (4-7) completed with Sand.
- Ceramics eliminated proppant flowback issues, improved oil production rates, delay pumping units, and increased EUR.
- Ceramics better production performance increases over time, widening the gap. Higher EUR with durable ceramic proppant.
Summary

• E&P companies have done a tremendous job of growing Natural Gas reserves in the US, and arresting the decline in Oil production

• Technology has once again allowed us to make lower permeability reservoirs economical
  • Accessing the Reservoir: Rotary steerable, MWD, LWD
  • Producing the Reservoir: High Conductivity proppants, enhancing the economics of low perm reservoirs

• The industry success means the US can lower our dependency on foreign energy sources, improve the environment with lower emissions Natural Gas, and improve the US balance of payments