Production Enhancement in the Permian Basin

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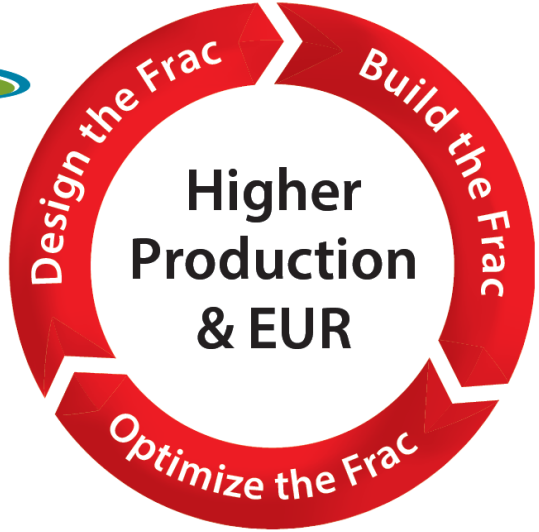
Technical Manager – Permian Basin

Leading Production Enhancement Company

FRACPRO

- Frac Design
- Economic Optimization
- Reservoir Performance
- Post Job Analysis



CARBO CERAMICS & TECHNOLOGIES

- Frac Conductivity & Durability
- Production Assurance
- Flow Enhancement
- Fracture Evaluation

StrataGen

- Well Site Supervision
- Frac Diagnostics & Optimization
- Field Development Optimization
- Reservoir & Formation Analysis

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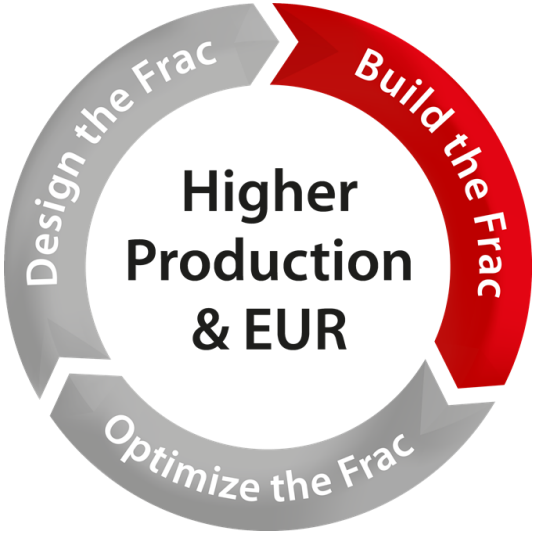

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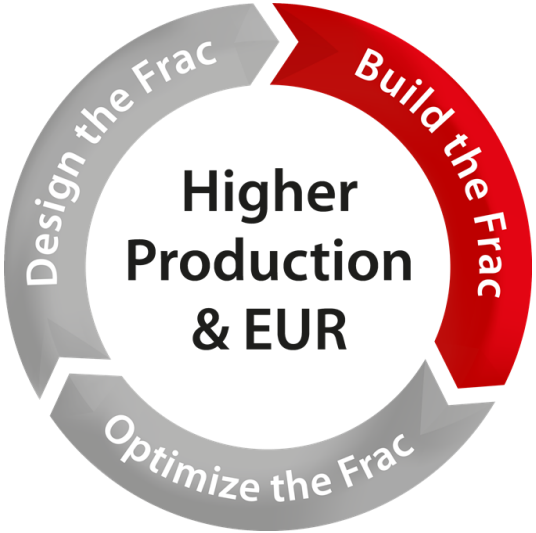

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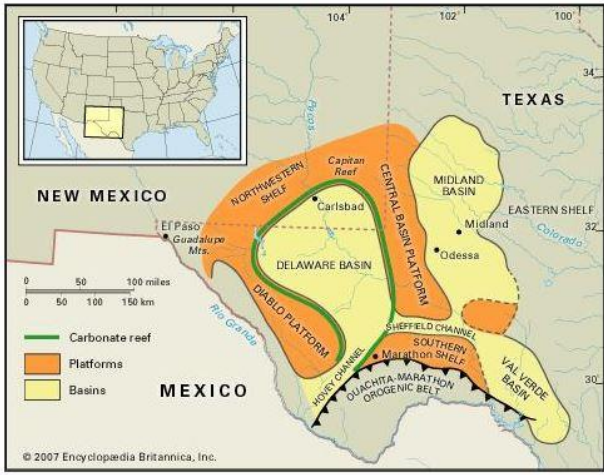
Benefits of Conductivity in the Delaware Basin

Challenges in Delaware Basin Plays:

- Wolfcamp & Bone Springs
- Interbedded shale, carbonate & sands
  - Wolfcamp - Four distinct units (A, B, C, & D)
  - Avalon Shale, 1st, 2nd & 3rd, Bone Springs sand
- Tight formation (10-3000 nD)
- 7,500 to 12,000 ft TVD



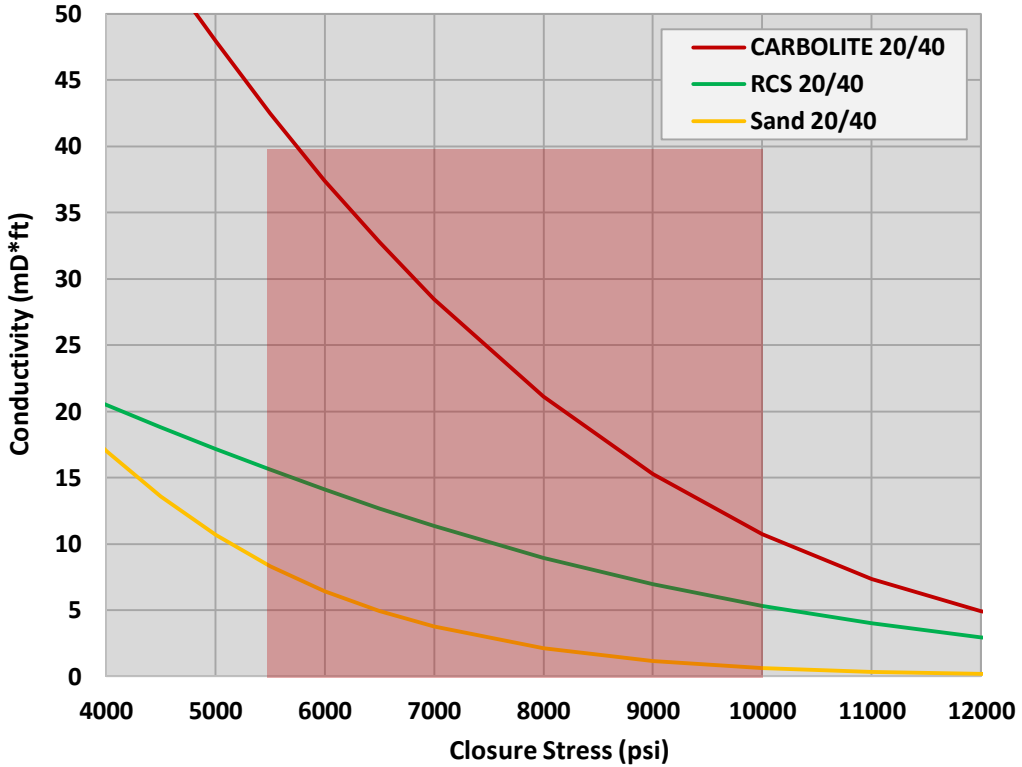
Delaware Basin	
	Dewey Lake
	Rustler
	Salado
	Castile
Delaware Mountain Group	Lamar
	Bell Canyon
	Cherry Canyon
	Brushy Canyon
Bone Spring	Avalon Shale
	1st Bone Spring Sand
	2nd Bone Spring Sand
	3rd Bone Spring Sand
	Wolfcamp
	Cisco
	Canyon
	Strawn
	Atoka
	Morrow

Courtesy Murchison Oil

Benefits of Conductivity in the Delaware Basin

Challenges in Delaware Basin Plays:

- 5,500 to 10,000 psi closure stress
- Horizontal multistage treatments
  - 3,800 to 4,500 ft lateral lengths
  - 15-25 stages
  - 35,000 to 75,000 lbs proppant per cluster

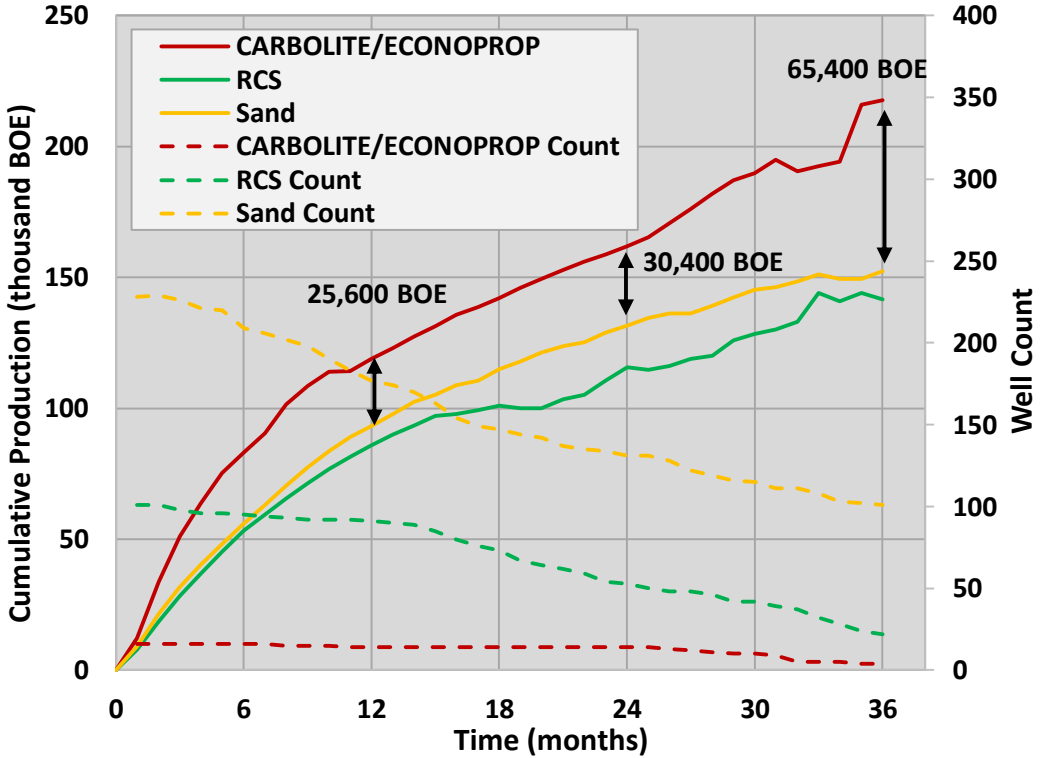


Courtesy Murchison Oil

Production Benefits of Conductivity in the Wolfcamp

Challenges in Delaware Basin Plays:

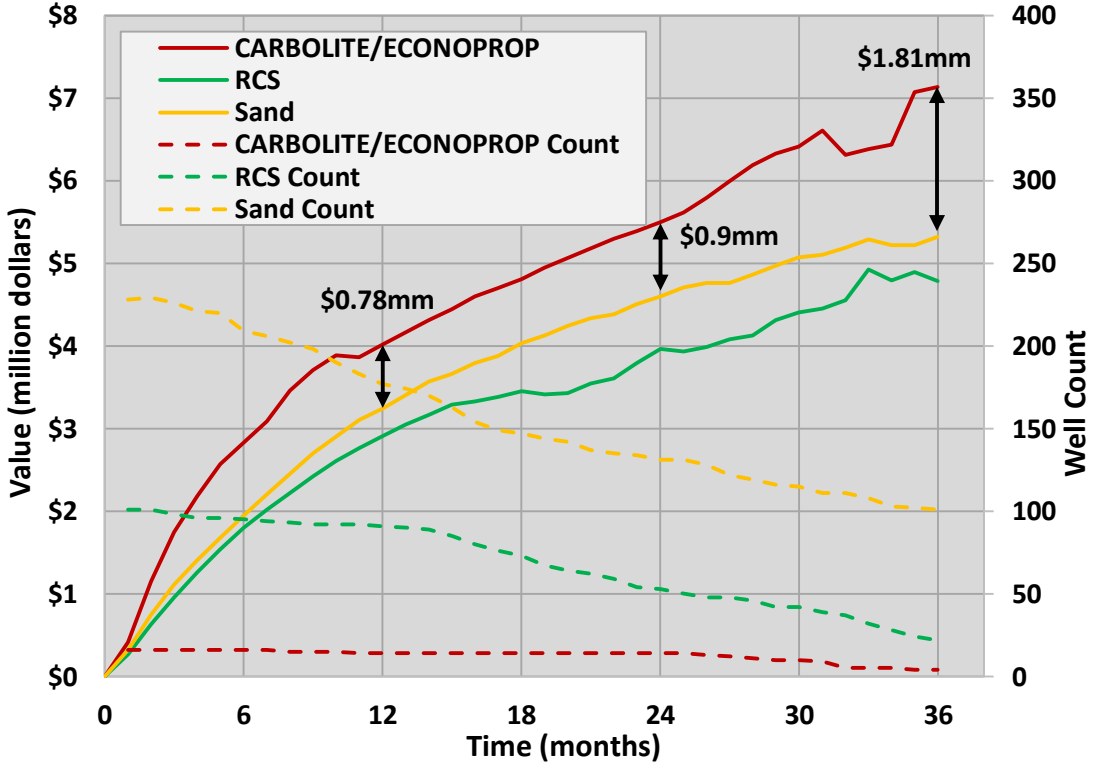
- CARBOLITE and CARBOECONOPROP wells increase production
- Production increases from 20% to 45%



Value of Conductivity in the Wolfcamp

Challenges in Delaware Basin Plays:

- CARBOLITE and ECONOPROP wells increase production
- Production Increases from 20% to 45%
- Conductivity adds value even at current depressed pricing
- Value increases 20% to 35%



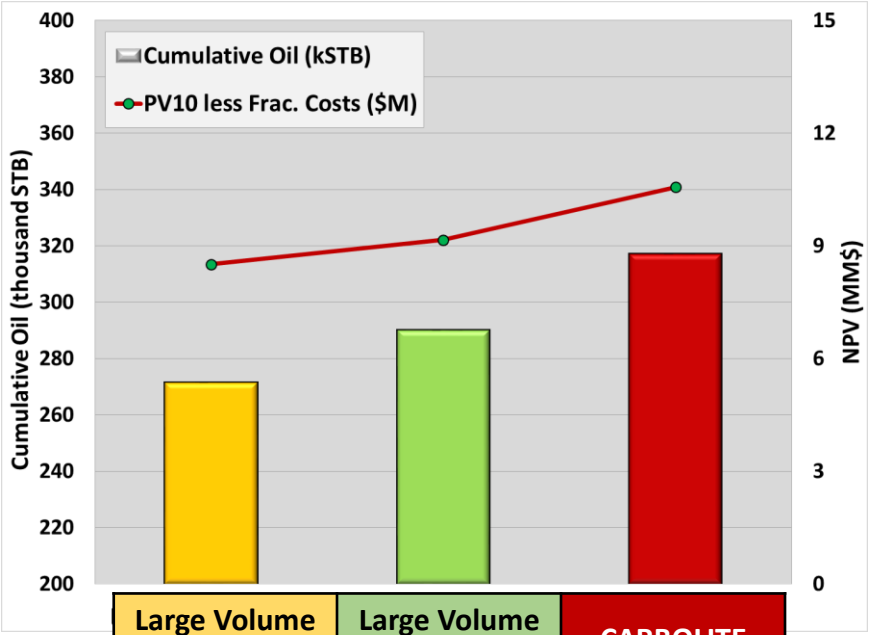
Engineered Completion Design - 2nd Bone Springs

- Objective
  - Evaluate fracture designs based on NPV
- Utilize an existing 2nd Bone Springs well
  - Reservoir, completion, production, treatment & cost
- Modeling
  - FRACPRO
  - Reservoir model
- Design alternate treatments
- The forecast production to calculate NPV
- Selected treatment design based upon NPV and time to payout

Design Options	Large Volume Sand	Large Volume RCS	CARBOLITE
Frac Cost per Stage (USD)	$115,300	$147,000	$159,600
Total Cost per Stage (USD)	$130,900	$161,500	$169,300
Stage Time (hr:min)	2:11	2:04	1:22
Acid (gals)	3000	3000	3000
Slickwater (gals)	56500	17500	33000
Linear Gel (gals)	30000	190000	0
XL Fluid (gals)	242000	97000	171641
Total Fluid (bbls)	7893	7321	4944
100 Mesh	0	20000	0
White Sand 40/70	20000	0	0
White Sand 30/50	0	65000	0
White Sand 20/40	380000	0	0
RCS-C 20/40	0	225000	0
CARBOLITE 30/50	0	0	45000
CARBOLITE 20/40	0	0	220000
Total Prop (lbs)	400000	310000	265000
lbs of prop/cluster	133333	103333	88333
lbs of prop/ft of lateral	1368	1061	907
rate (bpm)/cluster	23	23	23

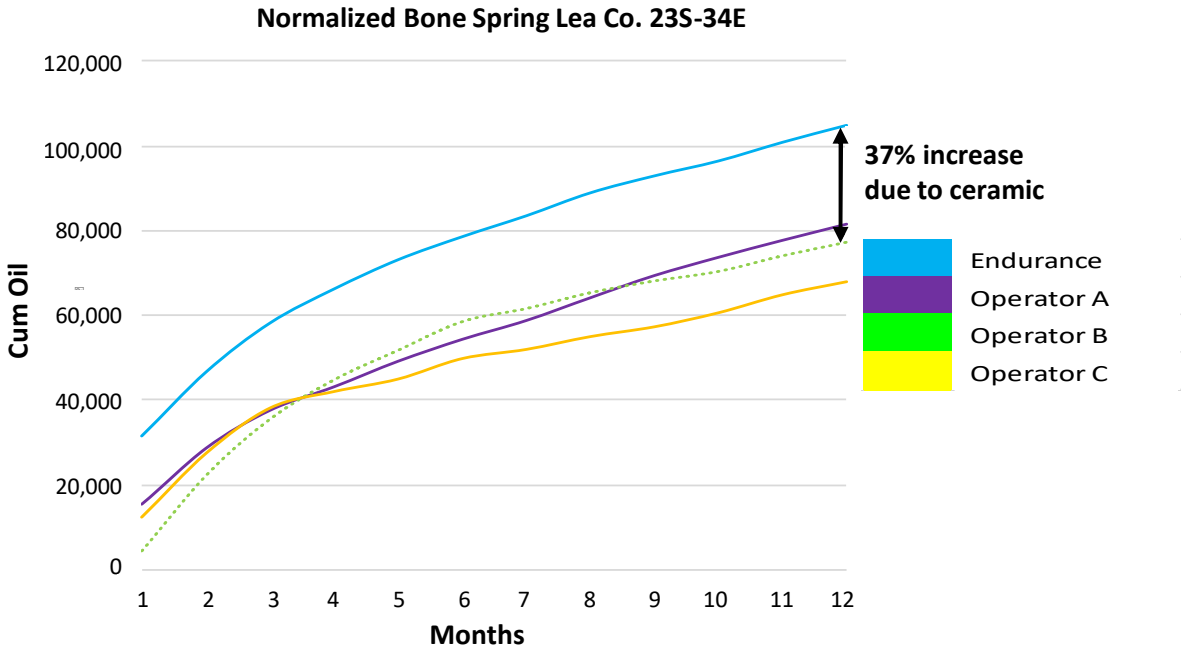
Selecting an Optimized Completion Design – 2nd Bone Springs

- CARBOLITE generates a 17% increase in production compared to the large volume sand design
- CARBOLITE design creates an incremental NPV of $2.06 million compared to the large volume sand design
- CARBOLITE design reduces fracture treatment cost payout time by 1.5 months



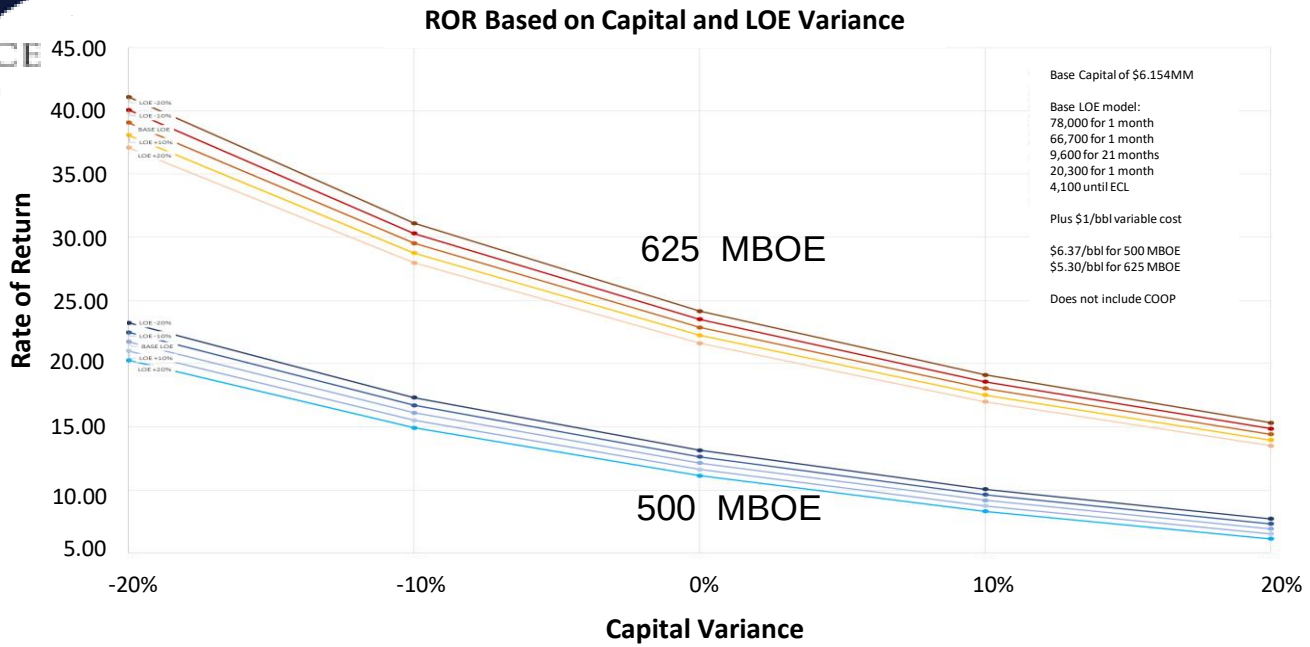
	Large Volume Sand	Large Volume RCS	CARBOLITE
Time (years)	5	5	5
Cum. Oil (MBO)	271	290	317
Cum. Gas (BCF)	0.52	0.66	0.84
Fracturing Cost	$1.7M	$2.1M	$2.2M
PV10 less Frac. Cost	$8.51	$9.16	$10.57
Pay Out - Fracturing Costs	4.3 mo	3.9 mo	2.8 mo

Offset wells - sand vs ceramic



Actual offset ceramic vs sand completions

Economics flat $45



A 10% reduction in Capex gives 3-5% gain in ROR
A 10% reduction in LOE give a 1-2% gain in ROR
A 25% gain in EUR gives a 12% gain in ROR

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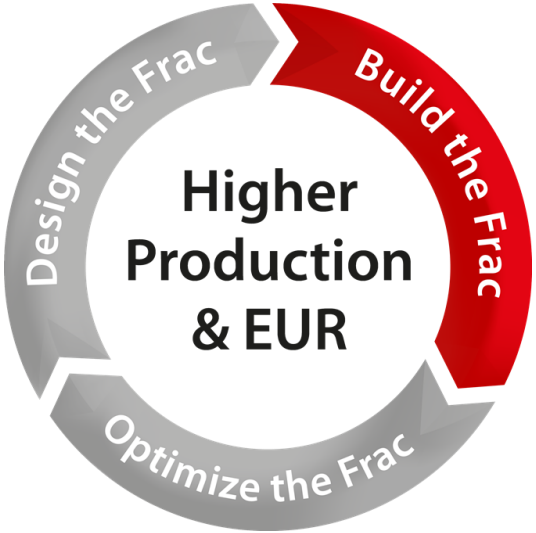

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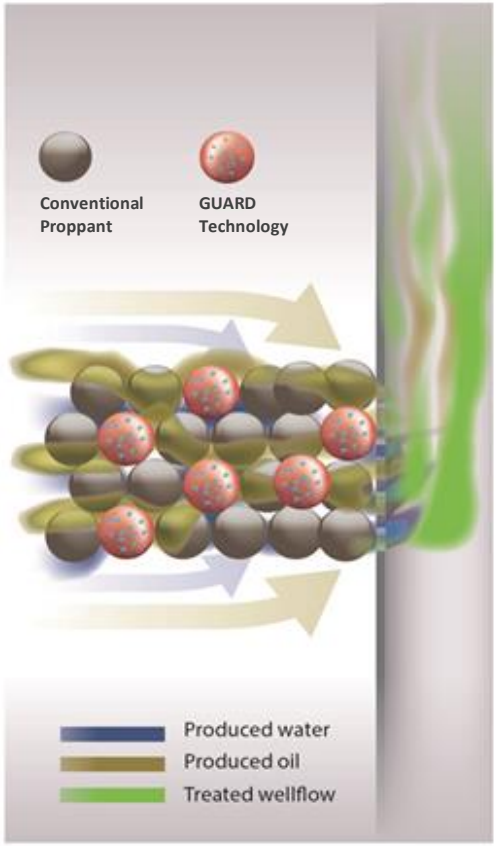
Production Assurance

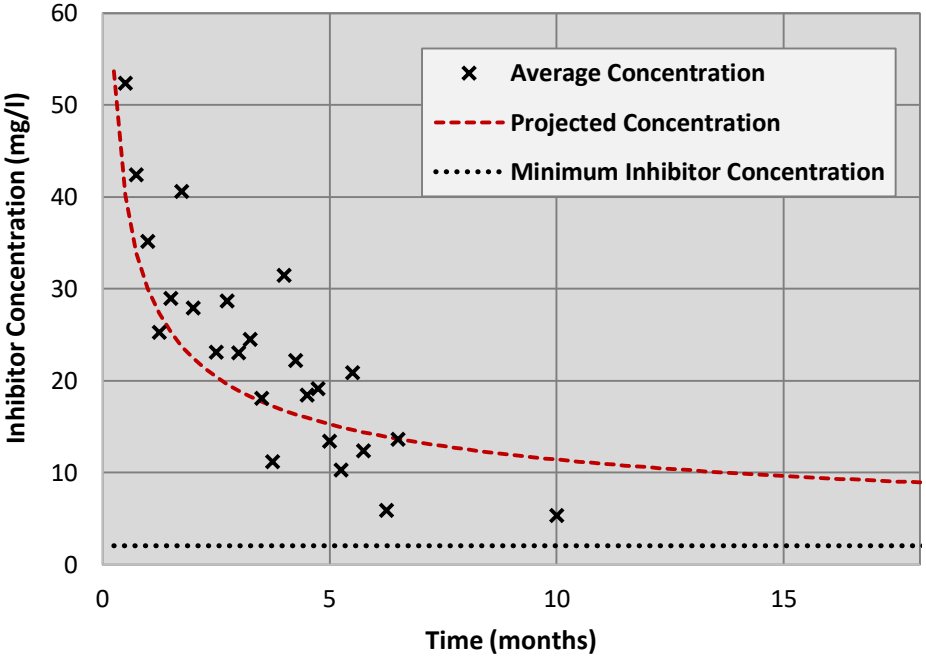
- Permian basin production challenges
  - Scaling tendencies in many formations
- Economic impact and value opportunities
  - Maintain conductivity
  - Limit production downtime
  - Reduce LOE
- SCALEGUARD
  - Chemically-infused porous proppant
  - Controlled release technology
  - Placed in the fracture
  - Long-term protection



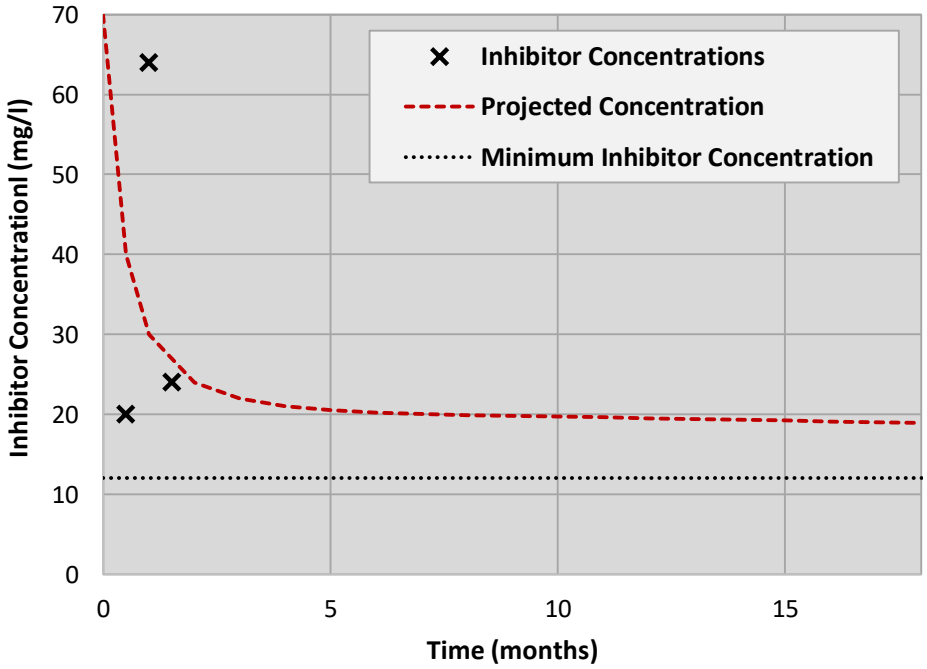
SPE 173792

Production Assurance

Case History – Uinta Basin (SPE 173792)



Avalon Shale



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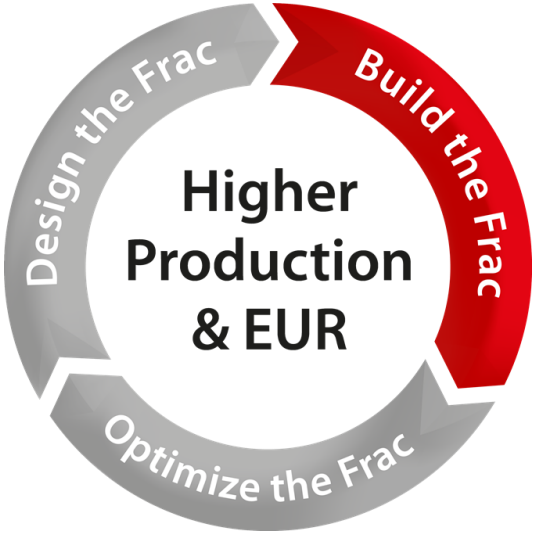

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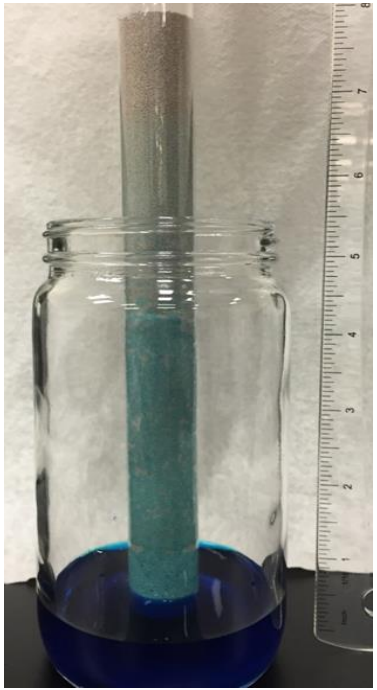
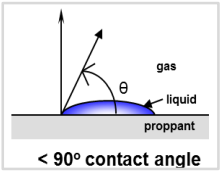
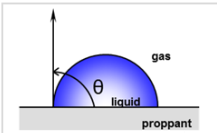
Flow Enhancement - CARBORPM

- Traditional proppant surfaces are water-wet
  - Wetting angle of traditional proppant causes capillary forces
  - Water-wet proppant surfaces reduce relative permeability to hydrocarbons
  - Leads to reduced effective fracture half-length
- CARBORPM creates a neutral-wettability surface
  - Treatment applied to surface of proppant modifies wettability to neutral
  - Improves fracture clean-up and relative permeability to hydrocarbons
  - Reduces pressure drop in the fracture and increases effective conductivity





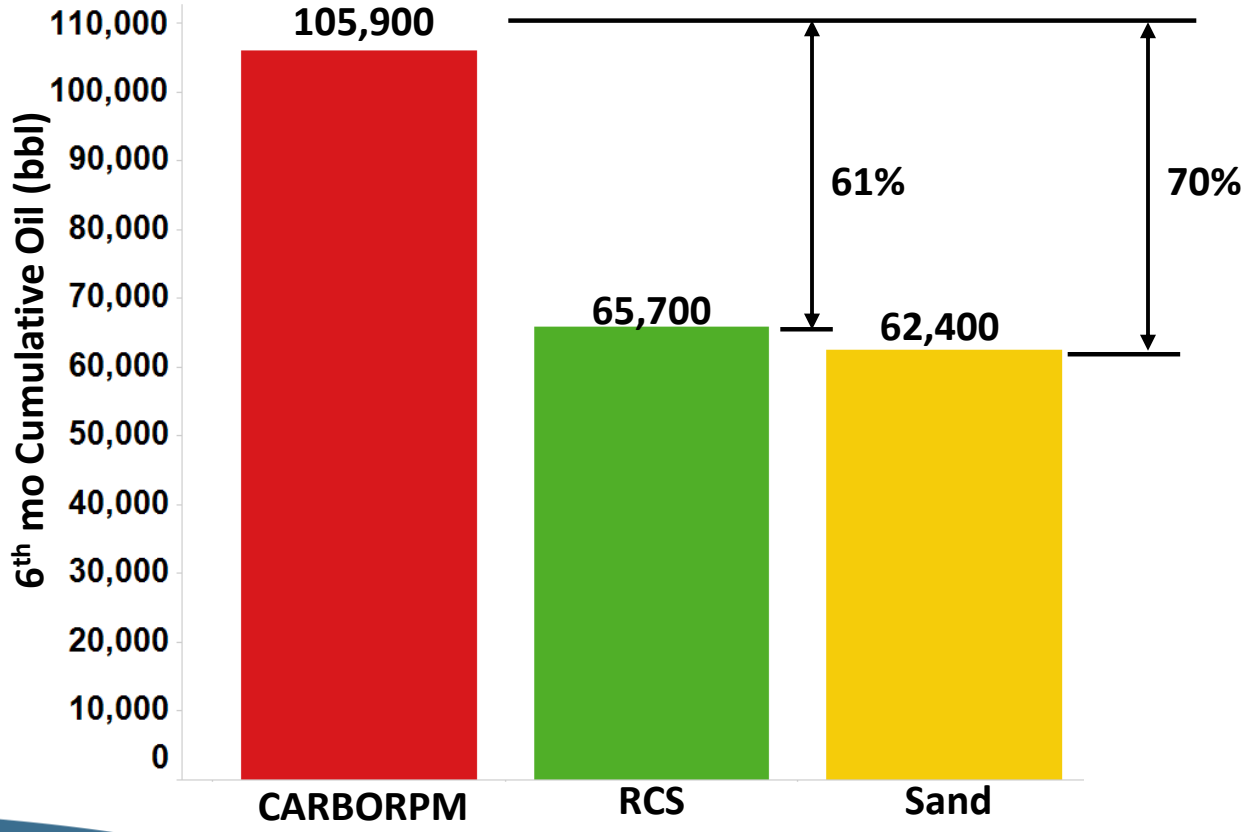
< 90° contact angle



90° contact angle

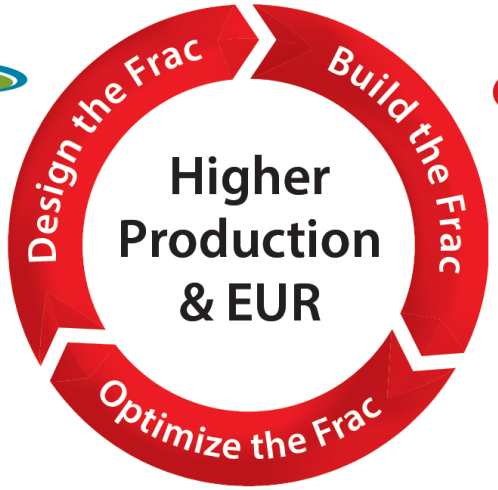
Neutral Wettability → **Reduced Capillary Pressure** → **Increased Load Recovery** → **Higher Permeability to Hydrocarbons** → **Increased Effective Drainage Area** → **Higher Productivity & EUR**

Flow Enhancement – Wolfcamp Example



StrataGen
A CARBO business

Thank You!



Questions?