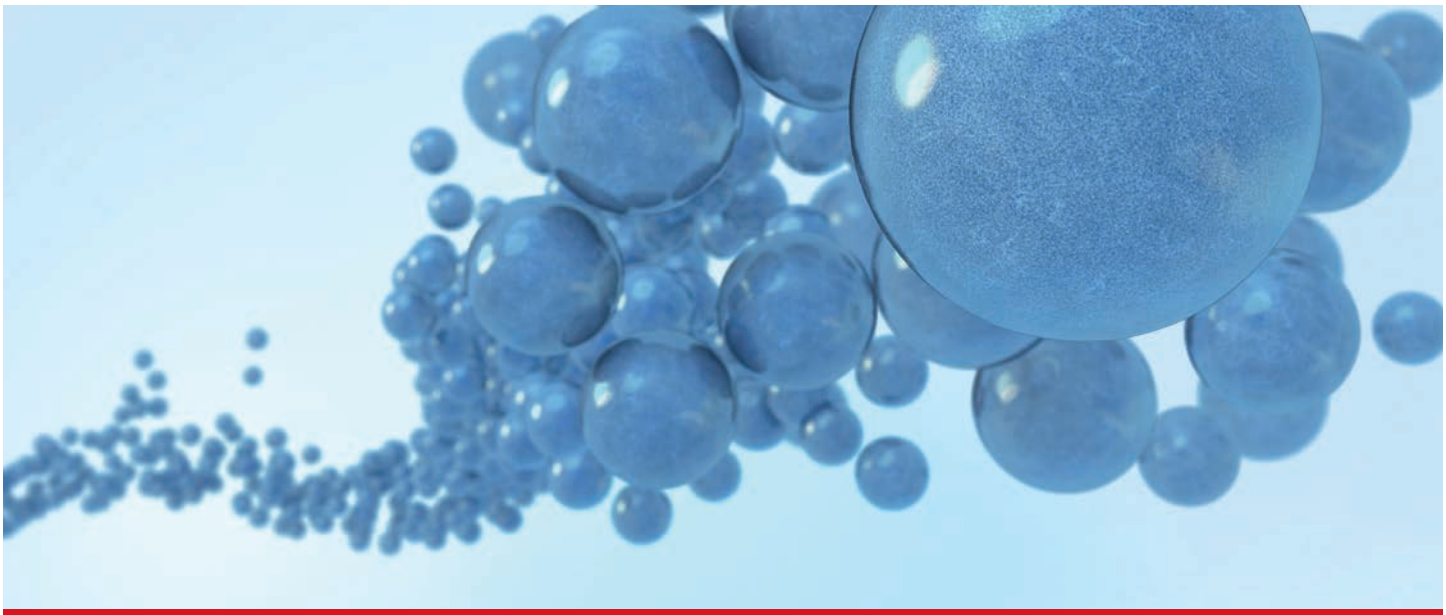
TECHNOLOGY PROFILE

CARBOAIR

High-transport, ultra low-density ceramic proppant technology



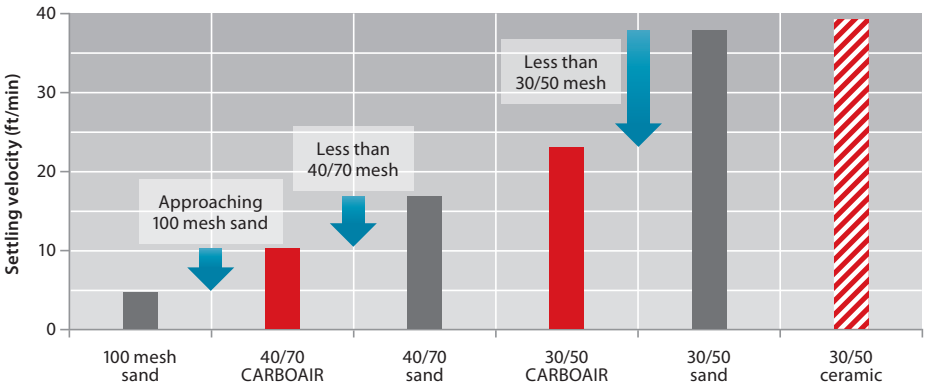
Higher proppant transport for improved reservoir contact

CARBOAIR™ high-transport, ultra low-density ceramic proppant technology has been developed primarily to increase production and EUR from slickwater fracturing operations. The technology enables operators to avoid the introduction of gel into their fracs while improving reservoir contact and fracture conductivity.

30%-65% slower settling rates compared to sand or RCS

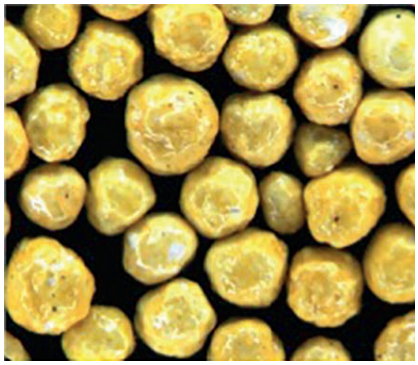
CARBO® has engineered CARBOAIR technology to have exceptional transport characteristics and significantly more volume per pound. This results in an increased propped fracture height and length to maximize reservoir coverage and contact.

Significantly lower settling velocity than comparable products



CARBO

Production. Enhanced.



Features

- Ultra low-density ceramic proppant with chemically-engineered internal porosity
- Apparent specific gravity of 2.0; approximately 25% lower than sand, resin-coated sand (RCS) or low-density ceramic (LDC)
- Enhanced transport characteristics: 30%-65% slower settling rates compared to sand or RCS
- Meets or exceeds the conductivity, strength and durability of sand and RCS
- Available in 30/50 and 40/70 mesh sizes

Benefits

- Exceptional proppant transport in slickwater and low gel fracturing fluids
- Increases effective fracture length and fracture height to improve reservoir contact
- Lower total mass of proppant required to prop the same fracture volume as conventional proppant
- Reduces water consumption and flowback treatment costs in equal volume frac designs
- Higher production and EUR while lowering finding and development cost per BOE

Achieve higher quality and increased reservoir contact from your AFE

Employing CARBOAIR proppant will increase effective fracture contact and can reduce stimulation costs. In an equal volume frac design, CARBOAIR technology requires less proppant mass to achieve the same propped fracture volume as conventional proppant.

The low settling rate of CARBOAIR technology means that fracturing gel concentrations can be reduced or eliminated to avoid gel damage and improve clean-up to further reduce stimulation treatment costs.

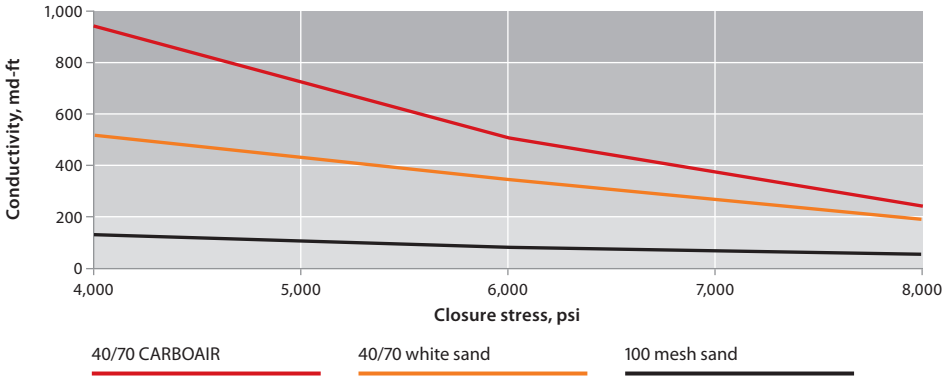
Sustains transport and performance characteristics

Proppant with gel coatings designed to improve proppant transport characteristics are continuously stripped of its gel by turbulence and other downhole interactions during the pumping process thereby negating transport and performance benefits. The highly-engineered CARBOAIR technology sustains its consistent proppant transport and physical characteristics, performing as per specifications during the pumping process and throughout the frac.

Higher long-term conductivity than sand and RCS

The higher conductivity of CARBOAIR technology compared to sand and RCS along with exceptional proppant transport means that the quality and quantity of reservoir contact is improved.

Reference conductivity comparison



The conductivity performance of CARBOAIR technology is significantly higher than sand.

Outperforms conventional proppant

CARBOAIR technology delivers production, recovery, operational and cost benefits across many different applications.

Applications	Lead/Tail	Alt Stage	Mixture	100%
Water usage	Similar	Similar	Similar or Less	Less
Fracture length	Increased	Increased	Similar or Increased	Increased
Fracture height	Increased	Increased	Increased	Similar or Increased
Simplify operations	Normal	Normal	Simpler	Simpler
Fracture fluid	Slickwater-Hybrid	Slickwater	Hybrid	Slickwater

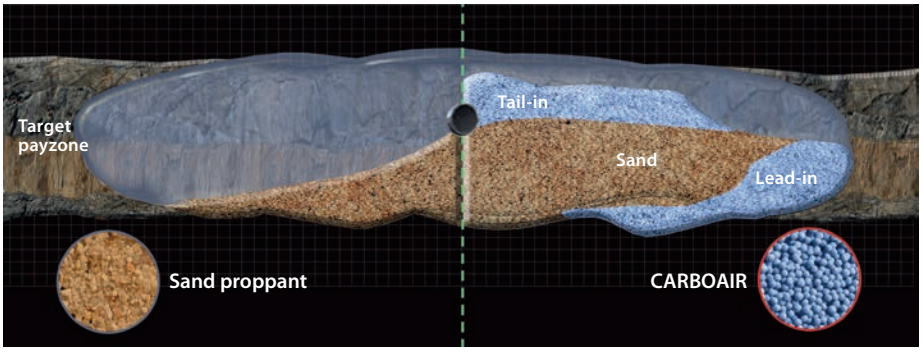
Improve your completion efficiency and ROI

In nearly every reservoir, the higher fracture contact and conductivity delivered by CARBOAIR technology results in higher production and EUR.

Due to the improved contact, it is possible to utilize more efficient completion designs with fewer stages or smaller fracture designs to deliver the same or increased production, with no increase in AFE. Any required investment has rapid payback and will result in a lower finding and development cost per BOE.

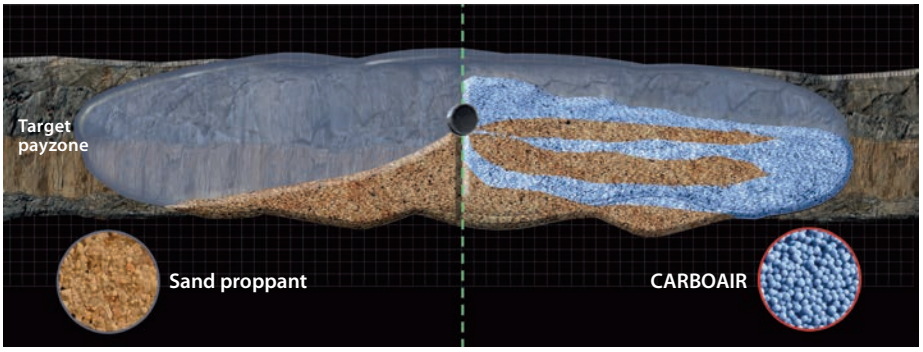
Lead-in/Tail-in with CARBOAIR

As a lead-in, CARBOAIR technology can provide increased propped half length, which increases the drainage area of the fracture. As a tail-in, CARBOAIR technology will cover more of the productive pay zone and lead to increased production compared to conventional sand, RCS or ceramic proppant.



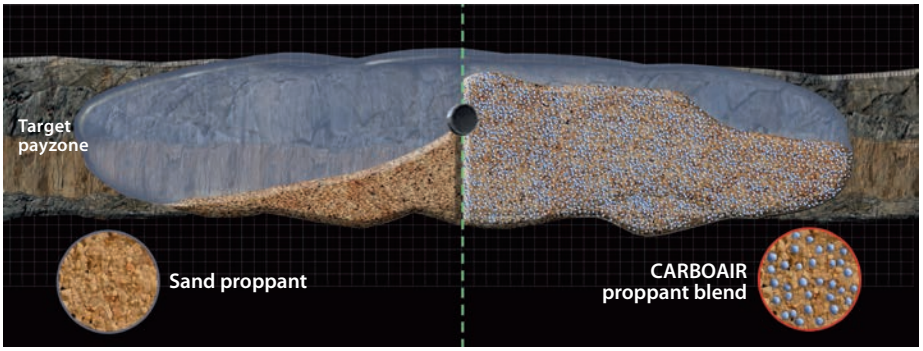
Alternating stages of CARBOAIR and conventional proppant

By alternating CARBOAIR technology with standard proppant within a frac stage using slickwater fluids, the technology can provide increased effective propped length as well as full productive zone coverage, leading to additional production and ultimate recovery.



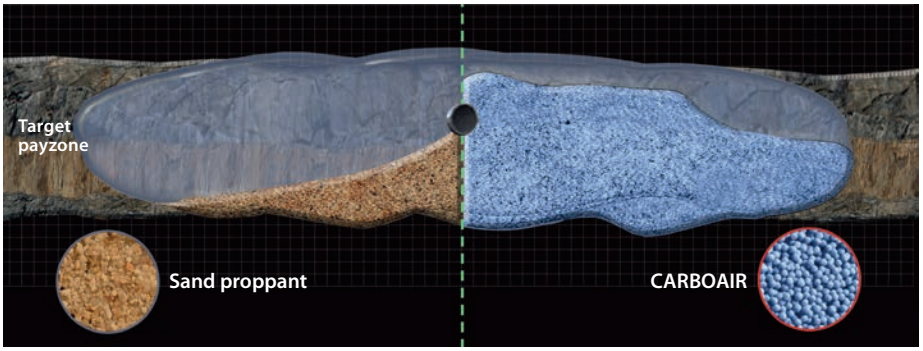
Mixture of CARBOAIR and sand

Blending CARBOAIR technology with sand improves overall proppant transport by hindering the settlement of the sand. This results in increased propped length and height, and pay zone coverage, leading to higher production and recovery.



Replace all sand with CARBOAIR

Due to the significantly lower density, 30% less mass of CARBOAIR technology can be used to replace the same volume of sand proppant, thereby reducing the amount of water and chemicals used for the treatment. CARBOAIR technology also provides more coverage across the pay zone, leading to increased production.



Long-term conductivity

Reference conductivity, md-ft* @ 250˚F (121°C)

Closure stress [psi]	2lb/ft² 40/70
2,000	1,460
4,000	930
6,000	500
8,000	250

Reference permeability, Darcies* @ 250˚F (121°C)

Closure stress [psi]	2lb/ft² 40/70
2,000	62
4,000	41
6,000	23
8,000	12

* Reference conductivity and permeability are measured with a single phase fluid under laminar flow conditions in accordance with API RP 19D. In an actual fracture, the effective conductivity will be much lower due to non-Darcy and multiphase flow effects. For more information, please refer to SPE Paper #106301 - "Determining Realistic Fracture Conductivity and Understanding its Impact on Well Performance – Theory and Field Examples."

Physical properties

Typical sieve analysis [weight % retained]

U.S. Mesh [mesh]	Microns	30/50	40/70
-16+20 mesh	-1180+850	0	0
-20+30 mesh	-850+600	1	0
-30+40 mesh	-600+425	75	0
-40+50 mesh	-425+300	24	55
-50+70 mesh	-300+212	0	44
-70 mesh	-212	0	1
Mean particle diameter [microns]		465	302
API/ISO crush test % by weight fines generated	@6,000 psi	1	1
	@8,000 psi	4	3
	@10,000 psi	7	5

Sizing requirements:
A minimum of 90% of the tested sample should fall between the designated sieve sizes. These specifications meet the recommended practices as detailed in API RP 19C.

Typical additional properties

Apparent absolute gravity		2.0
Absolute volume (gal/lb)		0.06
Bulk density	[lb/ft³] [g/cm³]	72 1.15

Talk to CARBO to find out how we can help you enhance your production.

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