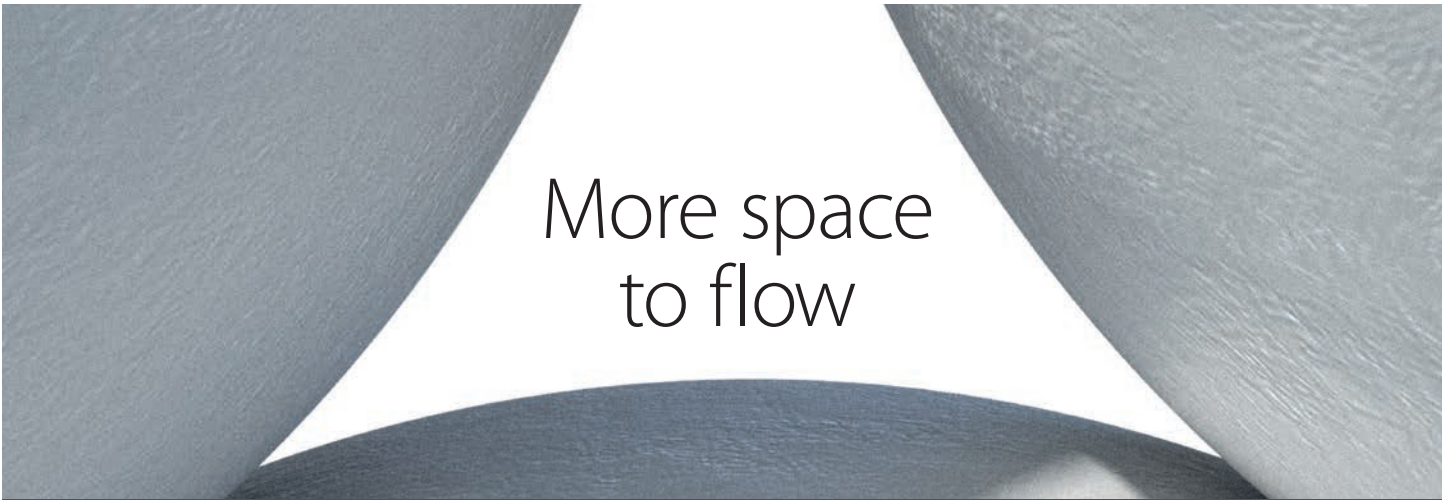


# KRYPTOSPHERE HD

Ultra-conductive, high-density ceramic proppant



More space  
to flow

Higher production and increased recovery in ultra-high closure stress environments

KRYPTOSPHERE® HD ultra-conductive, high-density ceramic proppant technology has been specifically engineered for high closure stress and risk environments, including ultra-deepwater regions such as the Gulf of Mexico.

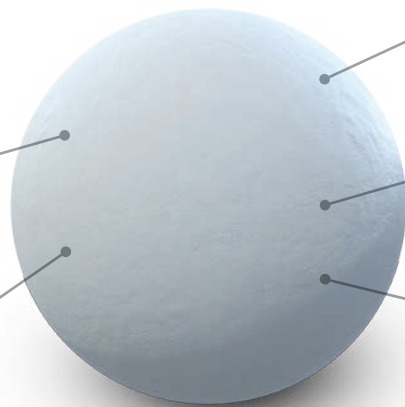
As the only proppant suitable for ultra-high closure stress environments, KRYPTOSPHERE HD provides a step-change in conductivity, compressive strength and durability: significantly outperforming any other proppant available.

Attain higher flow rates at the highest closure stresses to increase recovery and return on investment, thereby lowering finding and development costs per barrel of oil equivalent.

**KRYPTOSPHERE HD technology:**  
Precision-engineered, strong, durable, round, single-mesh-sized and smooth proppant grains

Excellent roundness, sphericity and smoothness. Significantly less erosion to equipment during pumping

Round and smooth. Reduces flow path tortuosity to reduce non-Darcy impacts and improve overall conductivity



Extraordinary strength and durability. Maintains higher conductivity and flow for the life of the well

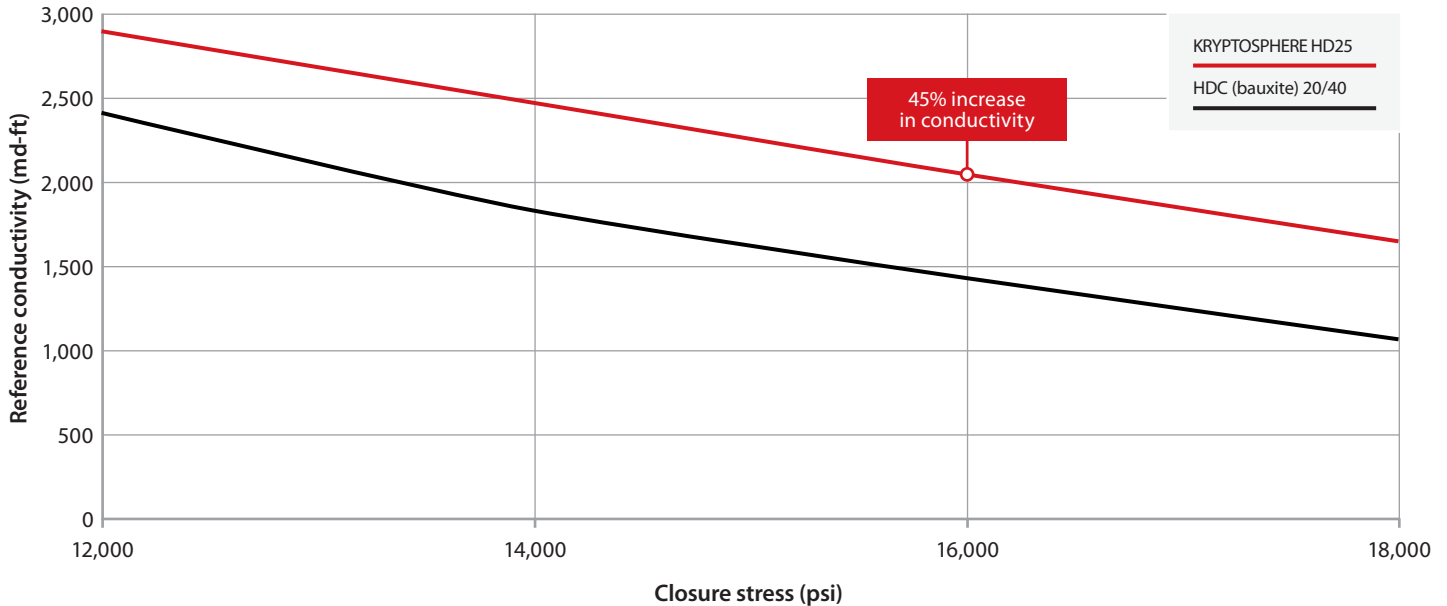
Improved proppant transport and higher propped volume compared to intermediate-density proppant

Uniform size and shape for optimal proppant packing. Creates a frac with more space for hydrocarbon flow

## A step-change in performance

KRYPTOSPHERE HD technology has a significantly higher baseline conductivity at stresses above 12,000 psi compared to typical bauxite-based high-strength proppant.

### Conductivity comparison

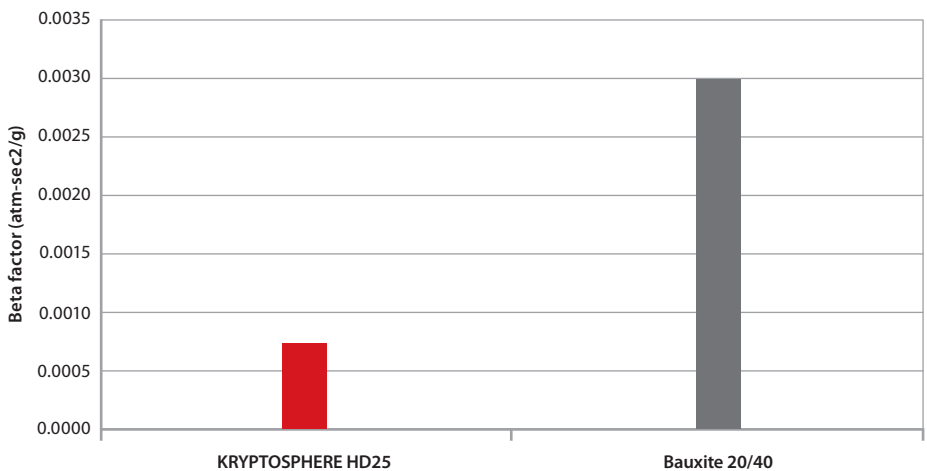


## Lower beta factor and pressure drop

The spherical, smooth and uniform size characteristics of KRYPTOSPHERE HD technology creates a frac with more uniform flow paths.

The reduced flow path tortuosity minimizes the pressure drop due to non-Darcy flow effects across the fracture which further enhances overall conductivity, flow rates and ultimate recovery.

KRYPTOSPHERE HD has a significantly lower beta factor, minimizing impact of non-Darcy and multiphase pressure drop in fracture



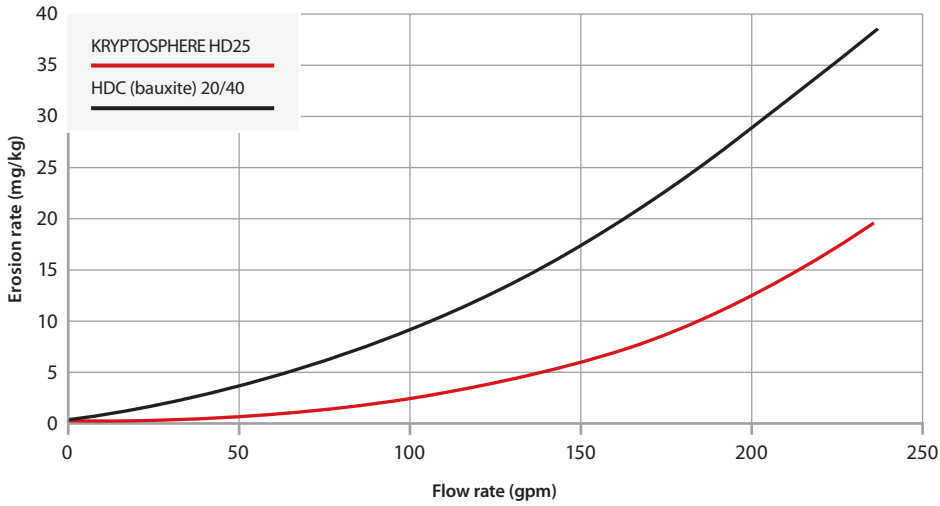
## Outperforms conventional ceramic proppant

The unique engineering of KRYPTOSPHERE HD technology yields higher levels of performance than conventional ceramic proppant.

\* KRYPTOSPHERE HD technology compared to comparable density proppant.

Performance characteristic	% Improvement*	Impact
Conductivity	40-60%	Increased production
Erosion	100-200%	Reduced equipment wear and tear Placement of higher proppant volumes
Beta Factor	100-300%	Minimized impact of non-Darcy and multiphase pressure drop
Acid/Solubility	25-250%	Increased durability
Crush	50-400%	Increased durability, long-term production and EUR

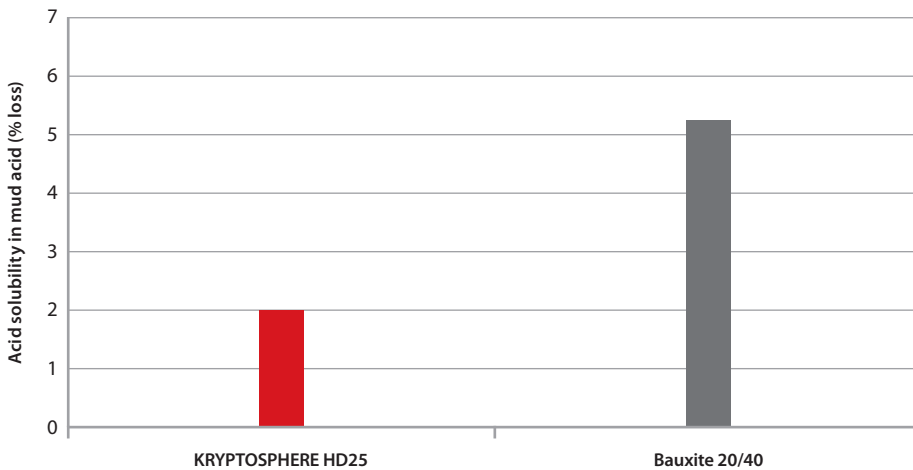
**KRYPTOSPHERE HD is less erosive, minimizing downhole tool and equipment damage**



**Significantly less erosive to surface and downhole equipment**

The high sphericity and smoothness of KRYPTOSPHERE HD technology means it is significantly less erosive during pumping. As a result, equipment wear is reduced and fracture design constraints, due to erosivity concerns, are removed: enabling higher proppant volumes to be used.

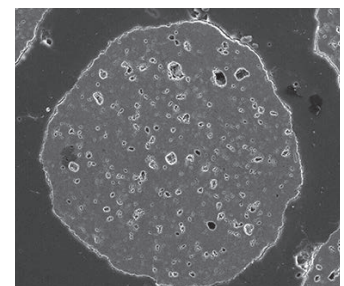
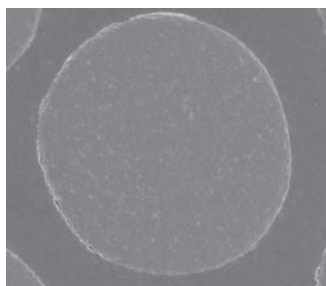
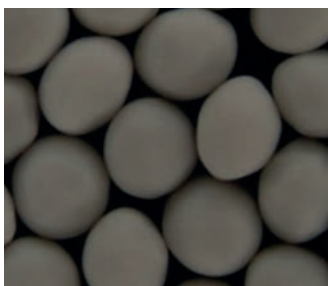
**KRYPTOSPHERE HD is much more acid resistant than standard bauxites**



**Increased acid resistance and fracturing fluid compatibility**

The high quality of materials and the precision manufacturing process used for KRYPTOSPHERE HD technology improves acid resistance, ensuring increased proppant durability and compatibility with production chemicals.

**Exceptional microstructure for increased strength and durability**



**KRYPTOSPHERE HD**

KRYPTOSPHERE HD technology has an exceptionally low and uniformly distributed internal porosity which creates a proppant with extraordinary compressive strength and durability.

**Standard high-strength proppant (bauxite)**

High internal porosity with irregular distribution dramatically reduces strength leading to the creation of fines that rapidly reduce conductivity and production.

## Physical and chemical properties

### Typical sieve analysis [weight % retained]

U.S. Mesh [mesh]	Microns	HD20	HD25	HD35
-18+20 mesh	-1000+850	100	0	0
-20+25 mesh	-850+710	0	100	0
-30+35 mesh	-600+500	0	0	100
<b>Median particle diameter [microns]</b>		960	815	580
	@ 15,000 psi	3	1	0
<b>API/ISO crush test</b>	@ 20,000 psi	8	4	2
<b>% by weight fines generated</b>	@ 30,000 psi	-	8	6

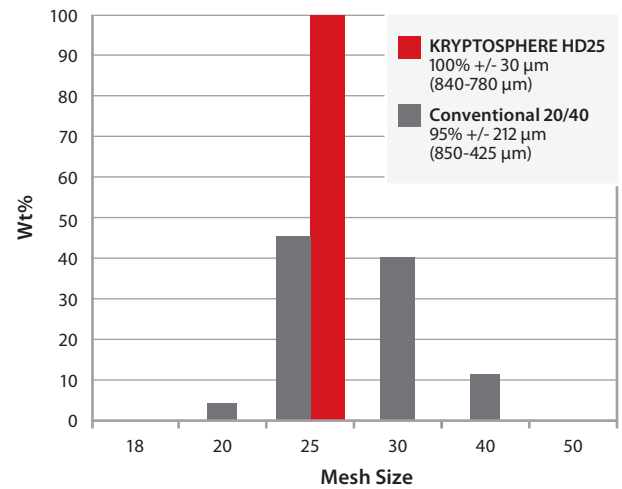
Sizing requirements:

These specifications meet the recommended practices as detailed in ISO 13503-2.

### Typical additional properties

Roundness	0.9	Apparent specific gravity	3.47
Sphericity	0.9	Absolute volume [gal/lb]	0.035
Bulk density [lb/ft <sup>3</sup> ] [g/cm <sup>3</sup> ]	128 2.06	Solubility in 12/3 HCl/HF acid [% weight loss]	2
Chemistry	>50% Alumina		

### Single mesh size technology



KRYPTOSPHERE HD technology is a single-mesh-sized product that can be manufactured at the optimal size for your fracture design and reservoir conditions.

## Long-term conductivity

Closure stress [psi]	Reference conductivity*, md-ft		
	20 Mesh	25 Mesh	35 Mesh
10,000	4,500	3,400	2,000
12,000	3,600	2,900	1,700
14,000	2,785	2,475	1,425
16,000	2,300	2,050	1,150
18,000	1,800	1,650	925

\* Reference conductivity and permeability are measured with a single phase fluid under laminar flow conditions in accordance with ISO 13503-5. 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.

Closure stress [psi]	Reference permeability, Darcies		
	20 Mesh	25 Mesh	35 Mesh
10,000	315	245	140
12,000	260	215	125
14,000	215	185	105
16,000	175	155	85
18,000	140	130	70

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