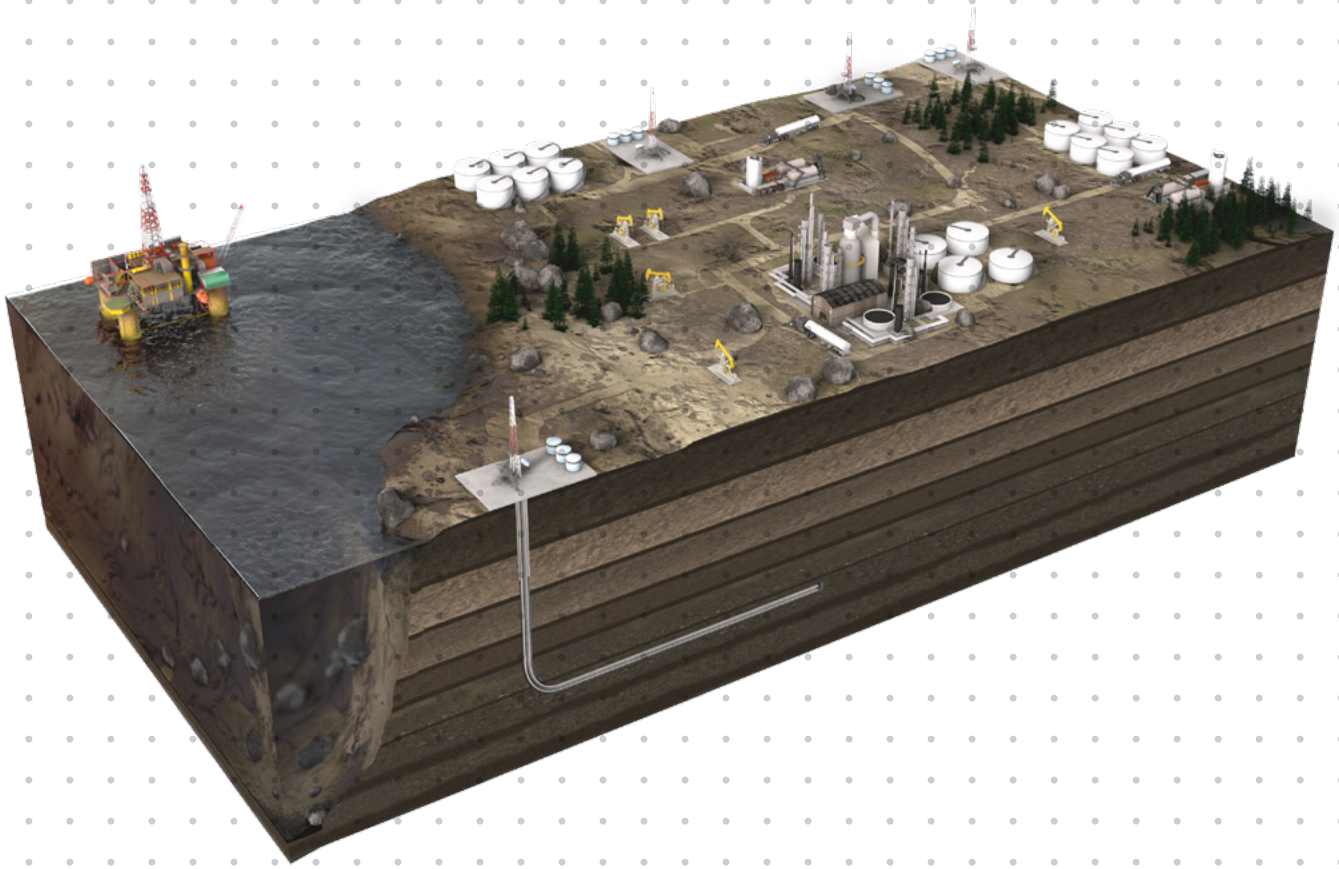
CoorsTek

Ceramic Materials Summary

Oil & Gas



Ceramic Materials Summary

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	ALUMINAS	
Strengths	Versatile, cost-effective combination of hardness, strength, and electrical resistivity with good wear & corrosion resistance	Tough, impact- a reliable, long-life
Examples	Wear liners, valves, insulators, dome discs, plungers	Ball check valves buttons, MWD/L

			94-96% Aluminas		98-99.5% Aluminas		MgO Partially Stabilized Zirconia
Properties*		Units	AD-94 nominal 94%	AD-96 nominal 96%	FG-995 nominal 98.5%	AD-995 nominal 99.5%	Dura-Z
GENERAL							
Density		g/cm^3	3.70	3.72	3.80	3.90	5.72
Gas Permeability			0	0	0	0	0
Color			WHITE	WHITE	WHITE	IVORY	IVORY
MECHANICAL							
Flexural Strength (MOR)	20 ° C	MPa (psi x 10^3)	352 (51)	358 (52)	375 (54)	379 (55)	900 (130)
Elastic Modulus	20 ° C	GPa (psi x 10^6)	303 (44)	303 (44)	350 (51)	370 (54)	200 (29)
Poisson's Ratio	20 ° C	–	0.21	0.21	0.22	0.22	0.30
Compressive Strength	20 ° C	MPa (psi x 10^3)	2103 (305)	2068 (300)	2500 (363)	2600 (377)	1750 (254)
Hardness	Knoop 1000 g	kg/mm^2	1175	1175	1400	1440	1200
	Knoop 100 g	kg/mm^2					
Tensile Strength	25 ° C	MPa (psi x 10^3)	193 (28)	221 (32)	248 (36)	262 (38)	483 (70)
Fracture Toughness	K(I c)	Mpa m$^{1/2}$	4 - 5	4 - 5	4 - 5	4 - 5	11
THERMAL							
Thermal Conductivity	20 ° C	W/m °K	22.4	24.7	27.5	30.0	2.2
Coefficient of Thermal Expansion	25-1000 ° C	1X 10^{-6}/°C	8.2	8.2	8.2	8.2	10.2
Specific Heat	100 ° C	J/kg*K	880	880	880	880	400
Maximum Use Temperature		°C	1700	1700	1700	1750	500
ELECTRICAL							
Dielectric Strength	6.35mm	ac-kV/mm (ac V/mil)	8.3 (210)	8.3 (210)	8.7 (220)	8.7 (220)	9.4 (240)
Dielectric Constant	1 MHz	25 ° C	9.1	9	9.6	9.7	28.0
Dielectric Loss (tan delta)	1 MHz	25 ° C	0.0004	0.0002	0.0002	0.0004	0.0010
Volume Resistivity	25 ° C	ohm-cm	> 10^{14}	> 10^{14}	> 10^{14}	> 10^{14}	> 10^{13}
	500 ° C	ohm-cm	4 x 10^9	4 x 10^9	2 x 10^{10}	2 x 10^{10}	2 x 10^5
WEAR							
Impingement[1]			0.52	0.50	0.48	0.47	0.63
Rubbing[1]				0.60			0.57
CHEMICAL							
Chemical Resistance | Acids[2]					●	●	●
Chemical Resistance | Bases[2]					●	●	●

*The chart is intended to illustrate typical properties. Property values vary with method of manufacture, size, and shape of part. Data contained herein is not to be construed as absolute and does not constitute a representation or warranty for which CoorsTek assumes legal responsibility. Close control of values of most properties can be maintained if specified.

ZIRCONIAS		CARBIDES				NITRIDES	
and erosion-resistant ceramics with durability.		Strong wear and corrosion resistance			Dense, wear-resistant	Superior mechanical & thermal performance, corrosion resistance	
s, bushings, fluid handling, frac plug LWD components		Seals, sleeves, rotors			Chokes, thermal spray	Bearings, sleeves, turbines	
Yttria Partially Stabilized Zirconias		**Silicon Carbides (SiC)**			**Tungsten Carbide (WC)**	**Silicon Nitrides (Si_3N_4)**	
Yttria Partially Stablized Zirconia - Sintered	Yttria Partially Stablized Zirconia - Hot Isostatic Pressed (HIP)	UltraSiC™ SC-30	UltraSiC™ SC-90 Plus	UltraSiC™ LP SC-52	ACI-Co6	SN102 Sinter-HIP	Steel
6.02 - 6.05	6.05 - 6.07	3.15	3.15	3.22	14.90	3.23	7.5 - 8.0
0	0 - 0.07	0	0	0	0	0	0
IVORY to WHITE	BROWN to OLIVE	BLACK	BLACK	BLACK	GRAY	GRAY	GRAY
1000 - 1240	1400 - 1500	480 (70)	645	600 (87)	1550 (225)	1000	
205 - 210	205 - 210	410 (59)	410 (59)	375 (52)	627 (91)	290	210-235 (30-34)
0.30	0.30	0.21	0.21	0.21	0.21	0.27	0.29
2000 - 2500	2000 - 2300	3500 (507)	3750		5000 (725)	3500	1000-2000 (145-290)
1300	1330				1630		6.4 - 8.8 (650-900)
		2800	2800	2800			
							1110 (103)
8.5 - 10	10 - 13	4	4	6.3	> 6	6	50-80
2.0 - 2.2	2.0 - 2.2	150.0	150.0	80.0	100.0	18.0	35-55
10 - 10.3	10	4.4	4.4	4.7	5.1	3.5	12
400	400	800	800	820	209.3	740	475
1000 - 1500	1000 - 1500	1600			1000	1000	800
9.0 (228)	9.0 (228)					8.6	
29.0	29.0					8.15	
0.0010	0.0010					0.0017	
> 10^{12} - 10^{13}	> 10^{12} - 10^{14}	< 10^{5}	< 10^{5}		< 10^{3}	> 10^{15}	10^{-5}
2 x 10^{3} to 2 x 10^{4}	2 x 10^{3}	< 10^{3}	< 10^{3}		< 10^{3}		
0.20	0.20	0.12			0.12		
0.20	0.20						
		●	●	●	●	●	●
		●	●	●	●	●	●

Notes:

1. **Wear Resistance** – Impingement tests are run using a dry fused alumina abrasive. Rubbing tests are run using a dry 240 grit fused alumina abrasive. The indices in the chart are calculated by dividing the material volume loss by the volume loss of an AD-85 alumina control. The lower in the index, the better the wear resistance.
2. **Chemical Resistance** – These are general qualitative indications only. Performance is dependent on specific chemical solution, concentration, temperature, and other variables. Please request information for your specific conditions.

PARTNER WITH COORSTEK.

We engineer advanced ceramics to solve your biggest challenges. When you choose CoorsTek, you get a complete package to ensure superior performance for your custom engineered components:

1. **Design Consultation**
   Our materials experts work with your team to understand your application and create an optimal, best value solution. And if engineered ceramics aren't the best fit, we tell you.
2. **Performance Testing**
   Our engineered ceramics are designed for high performance, so we evaluate lab and field test data to make sure they're measurably better – delivering the results you require.
3. **Manufacturing Expertise**
   Our solutions could incorporate virtually every ceramic manufacturing technology known from powder to part – but we use what fits you best. We design for manufacturability, build with excellence, and deliver with speed.

GOT A CHALLENGE?

Put us to the test, and see how CoorsTek engineered ceramics can help you deliver better solutions and results. Contact us for a free design consultation for your application at **coorstek.com/contact.** For more information on our Oil and Gas offering, please visit us at **coorstek.com/oilandgas.**

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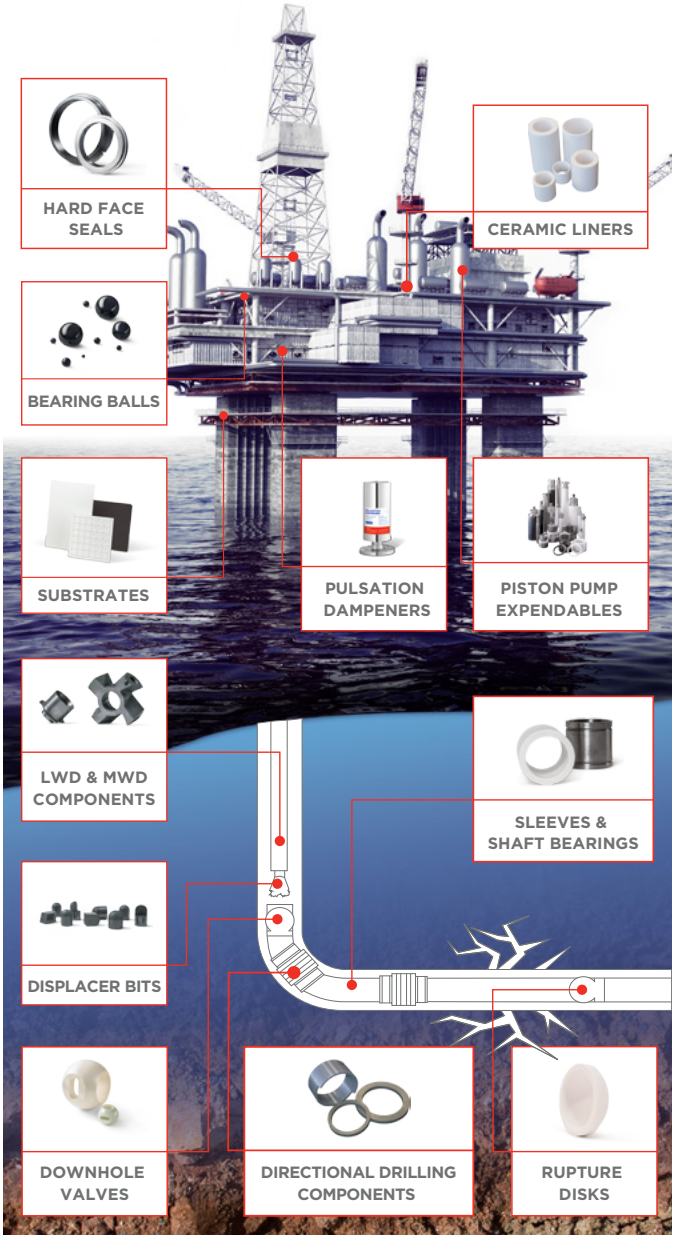
Zirconias

Serving Oil & Gas

About CoorsTek

CoorsTek engineered ceramics are hard at work behind the scenes in all kinds of oil & gas applications – consistently extending performance and profitability.



CoorsTek

Americas
+1 303 271 7100 tel
+1 855 929 7100 toll free in USA
coorstek.com
info@coorstek.com

Europe
+49 160 530 3768
infoeurope@coorstek.com

Japan
+1 81 3 5437 8411
japaninfo@coorstek.com

China
+86 21 6232 1125
info_shanghai@coorstek.com

Korea
+82 31 613 2946
koreainfo@coorstek.com