HAISCO GROUP

AZCO Diamond Drill Bits



HAISCO Group

Engineering Excellence

Energy Solutions

AzcoDiamond PDC

HAISCO Group for Energy Solutions
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Contents

Welcome. 3

Technology and Design. 4

- AZCO Lifecycle
- Bit Design
- Bit Manufacturing
- PexusT^{M} Inserts
- PDC Cutter Technology
- Shankless Bit Body
- Azlog system
- Roadmao
- Post Run Analyss

Hybrid Bits 10

PDC Bits 15

Milling – Remedial. 19

Available Features 21

Technical Reference 25

AzcoDiamond PDC

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Welcome to AZCO Diamond

Since 2012 AZCO Diamond has provided exceptional drilling performance for operators in North Africa and the Middle East.



In collaboration with Shear Technology Solutions, a Texas-based engineering firm with extensive expertise in the design of drill bits and downhole tools, HAISCO Group is proud to introduce the next generation of AZCODiamond drill bits.



This combination of HAISCO Group's comprehensive understanding of local application requirements, with the engineering expertise and patented solutions from Shear Technologies , will enable the next generation of AZCO drill bits to maintain their position as industry leaders while delivering tangible value to our customers.

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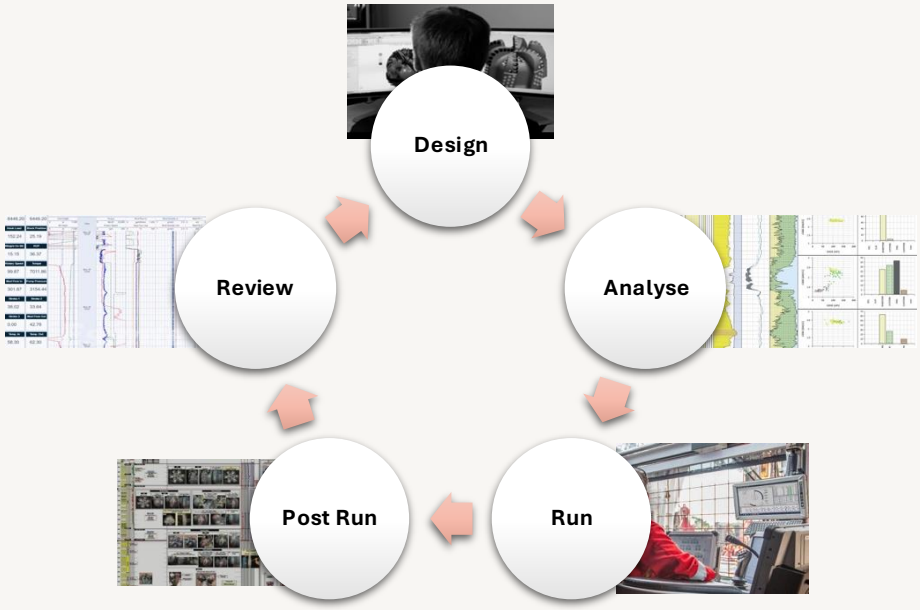
Technology and Design

Blending engineering know-how and local application insight with proven processes, systems, manufacturing and raw materials to deliver exceptional performance and value.

Engineering Excellence

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The AZCO lifecycle approach



At AZCO, we adopt a comprehensive lifecycle approach to bit selection and application. Starting with available offset data, including mud logs, bit records, DDRs, well logs, directional profiles, BHA configurations, fluid properties, and location data. Using Azlog and other tools, we create a bit program that exceeds performance expectations, is cost-effective, and meets Rig capacity, BHA configuration, and mud program requirements.

Post-run analysis compares actual versus planned performance and evaluates bit dull, informing design reviews and updates to the bit selection process. Our continuous improvement cycle ensures our drilling products remain competitive and our clients' well economics are optimized.

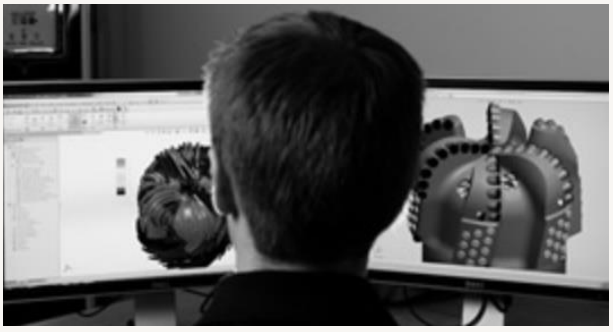
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Technology and Design

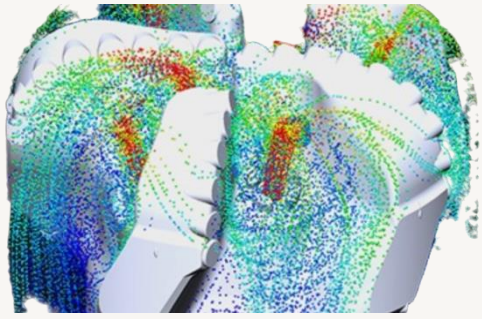
Engineering excellence

AzcoDiamond PDC

Bit design - Shear Technologies, with decades of bit design and engineering expertise, has crafted industry-leading drill bits.
By combining cutting-edge design with The AZCO application process and local field experience, we create tailored drill bit designs. Our modern CAD bit modeling incorporates complex numerical analysis for cutter force balancing and cutting structure layout, directly feeding into advanced manufacturing processes.



Hydraulic design: Our drill bits feature a multi-tiered hydraulic optimization approach for superior performance, validated by CFD verification. Key features include contoured waterways and junk slots that minimize dead spots, oversized junk slots, and multiple nozzles per blade layout for further optimization. This comprehensive design approach delivers exceptional hydraulic system capabilities, superior cleaning and cooling, and adaptability for field adjustments to the TFA.



Engineering experience together with local application delivers superior operational value

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Technology and Design

Engineering excellence

AzcoDiamond PDC

The industries toughest steel

body - Traditional fixed-cutter drill bit bodies are constructed from matrix or steel, each with its advantages and disadvantages.. The Shear technologies proprietary Hardmetal material, in conjunction with unique in-house application technology, enables the AZCODiamond bit bodies to possess the strength and precision of steel and the superior wear resistance of matrix. This combination results in highly aggressive yet durable bit designs that surpass the performance of traditional steel-bodied or matrix-bodied bits.



Manufacturing – All bits are manufactured in the United States using modern CNC equipment and proprietary processes.

We use industry quality assurance standards, API (Q1) and ISO (9001, 14001, and 45001). This ensures strict vendor control, material traceability, and industry-leading design standards.

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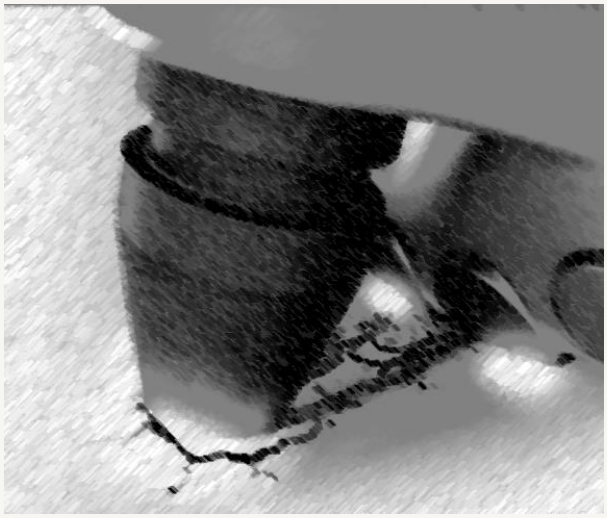
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AzcoDiamond PDC

Pexus™ Inserts – Our patented Pexus™ inserts originated in the mining industry where carbide ”Picks” are often used on hard rock cutting tools.

Shear Technologies invented the oilfield insert design for use in hybrid bits, that use both traditional PDC shearing cutters and Pexus™ gouging inserts. The inserts are available in either Diamond or Carbide with multiple tip radius and shape options. A rotating Insert is available for surface or boulder drilling applications.



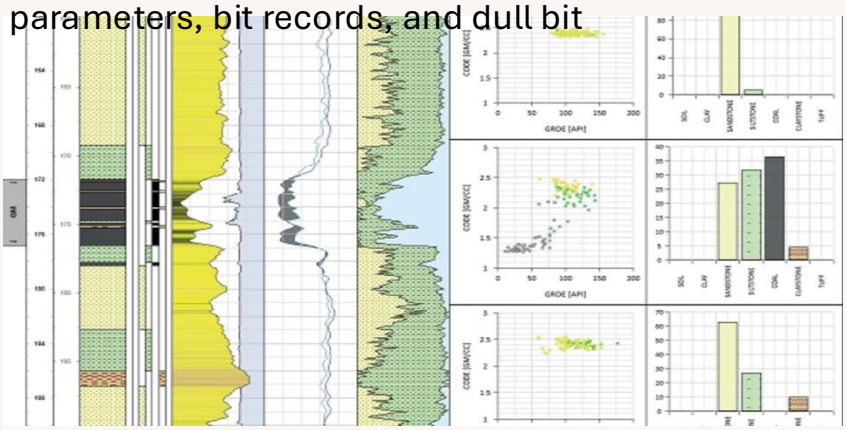
Cutter Technology – Our engineers work with the major cutter manufacturers to create proprietary cutters that outperform industry expectations.

- **Z1 Cutter** – high-density cutter with an exceptional combination of impact and wear resistance
- **Z2 Cutter** – high thermal cutters designed for maximum resistance in the most demanding thermal applications.



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AZLOG: Formation Analysis and Bit Selection Analyzes Offset Well Data AZLOG performs comprehensive formation analysis and bit selection by examining offset well data, including well logs, formation tops, mud logs, rock mechanics, drilling parameters, bit records, and dull bit conditions. This analysis determines the optimal cutting structure, gauge requirements, and hydraulic configuration. Additionally, AZLOG optimizes and other features to minimize drilling costs per foot, thereby reducing the reliance on trial and error.

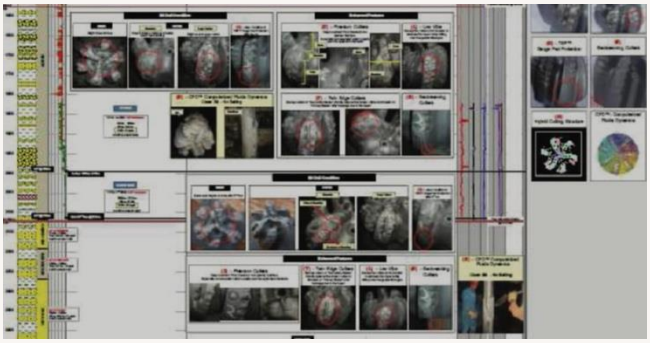


Data Requirements:

- Gamma Ray & Sonic Log
- Mud Log
- Bit Record
- Formation Tops
- *Drilling Parameters

* - if available

Post run analyses evaluate actual bit performance from available data such as real time penetration rates, weight on bit, RPM, torque, bit dull conditions, and more. This provides our design team with detailed engineering feedback to launch continuous bit



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Hybrid Bits

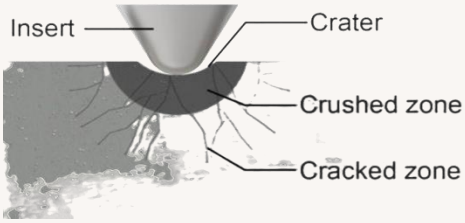
Hybrid bits with combined PDC shearing and Insert gouging.

Fast, durable, tough and smooth

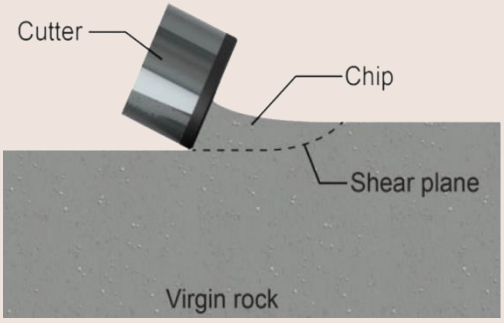
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Hybrid cutting structure that combines Pexus™ Inserts and PDC cutters.

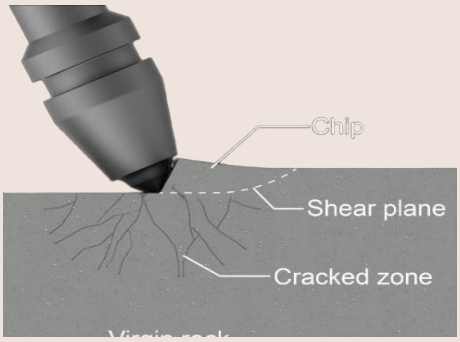
How it works: Hybrid bits employ a combination of roller cone crushing action and PDC shearing action to provide smooth response and extended life in hard transitional formation drilling.



Conventional roller cone insert crushing action



PDC cutter shearing action



Pexus™ element gouging action

The patented Pexus™ technology introduces a hybrid solution with no moving parts. The leading gouging element pre-fractures and relieves stress ahead of the PDC cutter, thereby lowering the cutter work rate and protecting it from debris encountered during even the hardest drilling. Fine tuning of the cutting structure determines how each component engages the formation allowing greater flexibility for specific application design.

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Hybrid Bits

Powere by Pexus™

AzcoDiamond PDC

Low vibration, smooth torque, extended life, high ROP, precise control

The Pexus™ Advantage

- Smooth Torque response - comparable to roller cone bits.
- No rotating cones in the cutting structure.
- Unique body construction gives improved hydraulics, accurate aggressive cutting structure and extremely high abrasive resistance
- High level of cutting structure and shaped insert design flexibility.



Patents
EU. Pat. No 3,042,022 B1
CDN. Pat. No 2,923,060
US. Pat. No 10,107,041 B2



Benefits of Pexus™

<u>Improve drilling efficiency</u>

- Faster, more accurate directional sections
- Excellent ROP in transitional and hard abrasive formations.

<u>Reduce unplanned trips</u>

- No rotating cone limitation gives extended bit life
- Smooth drilling action, very low bit induced vibration for longer BHA tool life and less component wear

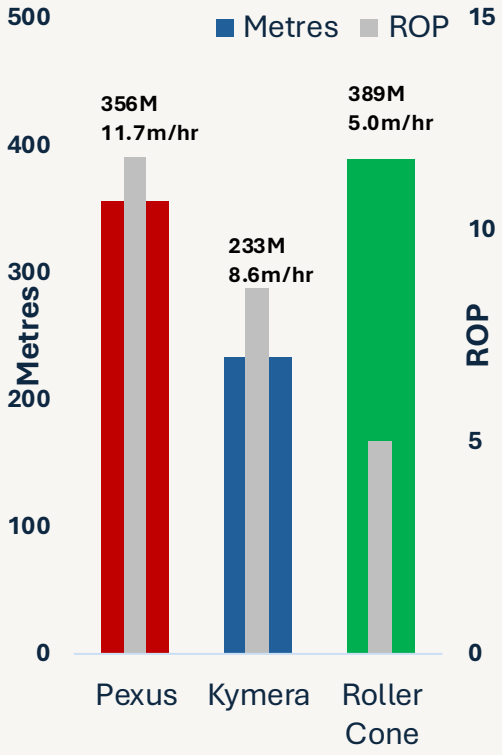
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Performance
Harts Energy EP World Record Hybrid Bit

Drilling Challenge

Alberta Canada : Challenging Build section 0^0 -89^0 with PDM through interbedded siltstone shale with sandstone limestone stringers and sideritic concentrations. Operator faced difficulty with poor bit dull conditions, excessive bit trips and difficulty maintaining directional control.

Baseline performance was set with a roller cone bit drilling the entire section with an ROP of 5 m/hr. A hybrid Kymera K524 bit improved ROP to 8.6 m/hr and drilled to TD.



Dull Grades	
Pexus	1-1-WT-N-X-CT-TD
Kymera	1-3-BT-S-E-I-WT-TD
Roller Cone	3-3-BT-A-E-I-WT-TD

Solution

A Pexus™ hybrid SDP3313D was proposed. The run objective was to achieve consistent one run sections with improved dull condition, better directional control and higher ROP.

Results

The Pexus™ hybrid set the new benchmark performance in the application, consistently drilling one run to TD with better dull than offsets.

- **134%** ROP increase compared to Roller Cone baseline performance
- **36% ROP** increase compared to Kymera hybrid
- **100%** one run to TD
- **0** toolface or directional issues

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Hybrid Bit Nomenclature

AZCO Hybrid bits are available from 6” to 22” size with multiple blade / hybrid row combinations that can be custom designed for any application.

For demanding directional work a shankless body is available, bit design attributes are matched to directional drive system, RSS or PDM.

A	D	P	3	6	16	BZ
1	2	3	4	5	6	7

1. **AZCO Diamond Bit**
2. **Bit Series – Shankless Directional, Mill**
3. **Pexus**
4. **Number of Pexus Rows**
5. **Number of Blades**
6. **PDC Cutter Size (mm)**
7. **Optional Features – Double row of PDC, Extended gage, Shankless, Fixed ports, H –Enhanced Hydraulics, Z – Premium Cutters**

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PDC Bits

Custom PDC bits with unique body construction, optimized hydraulics and industry leading cutter technology,

Stay sharper longer

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Engineered for performance and durability

AZCO PDC bits are meticulously engineered to deliver exceptional performance and durability. Our experienced engineers are highly proficient in designing drill bit solutions tailored to your specific drilling challenges.
Our comprehensive range of PDC bits is continuously updated and enhanced to meet evolving demand, contact us for latest design information.



PDC Cutter Selection: We collaborate with leading manufacturers to continuously develop a diverse range of PDC cutters that optimize cost-effectiveness for your application.



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Directional Control: AZCO Diamond PDC drill bits are equipped with targeted features and technologies to maximize steerability in directional applications without sacrificing ROP.



Shankless Body: For the shortest makeup length and precise directional control with either RSS or PDM in the most demanding well profiles, AzcoDiamond's shankless design brings the cutting structure closer to the directional system.
Unlike other shankless designs the bit maintains full gauge cover for enhanced stability and better hole condition.

Super tough body: The unique body material and blade geometry ensure an aggressive, precise layout with unmatched wear resistance and gauge protection.

.



. *Tough, aggressive, durable and precise directional control*

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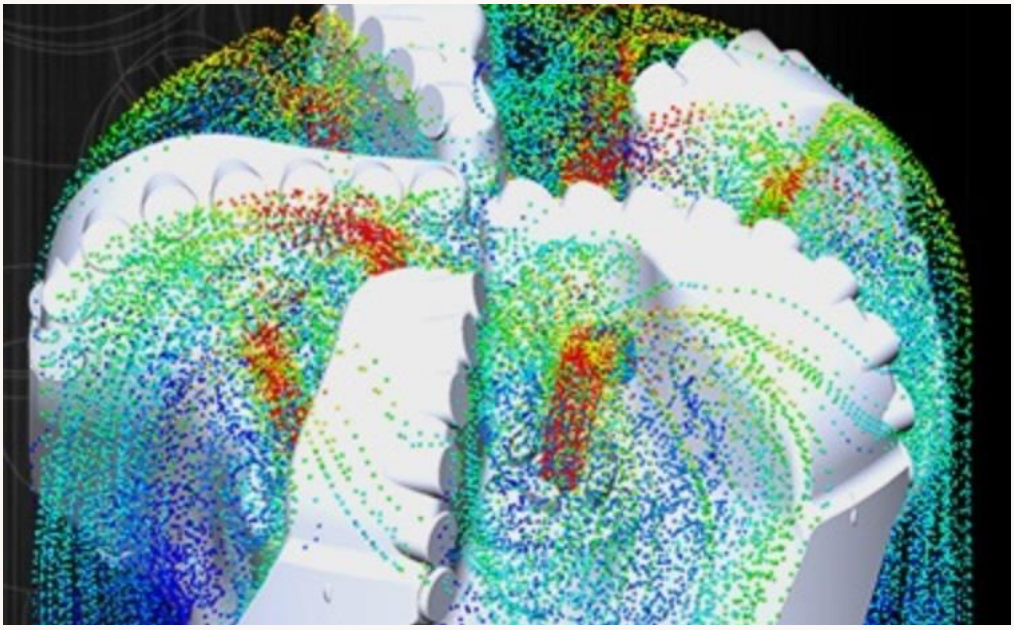
Optimized hydraulics, highly efficient cutter cooling and cuttings removal for maximum drilling performance

High-Performance Hydraulics: All AZCO Diamond bits undergo rigorous verification through computational fluid dynamics (CFD). The waterways and junk slots are meticulously contoured to minimize dead zones within the flow field. Additionally, all nozzles are designed for interchangeability, while the junk slots are oversized to enhance efficiency.

Most designs incorporate multiple nozzles per blade layout.

This comprehensive hydraulic design delivers exceptional cleaning and cooling performance while optimizing cuttings removal.

It effectively eliminates cuttings re-grinding, resulting in enhanced ROP and extended cutter durability.



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Milling - Remedial

Powered by Shear Technology

AzcoDiamond PDC

AZCO Mills offer a comprehensive range of milling solutions, including Mills equipped with both PDC cutters and/ or Pexus Inserts, tailored to meet the demands of the most demanding milling operations. These mills are built on a foundation of proven field expertise and innovation, ensuring unmatched durability, speed, and efficiency in milling tasks.



Features

- Available with Pexus Inserts or PDC cutters
- Smooth torque response for efficient drill out
- Fewer Milling interruptions for lower NPT
- Faster drill out – more plugs
- All common sizes available



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PDC Bit Nomenclature

AZCO PDC bits are available from 3 ¾” to 22” size with multiple blade / cutter size and feature combinations that can be custom designed for any application.

For demanding directional work a shankless body is available, bit design attributes are matched to directional drive system, RSS or PDM.

A	D	6	16	BZ
1	2	3	4	5

1. **AZCO Diamond Bit**
2. **Bit Series – S**hankless**, D**irectional**, M**ill
3. **Number of Blades**
4. **PDC Cutter Size (mm)**
5. **Optional Features – B**ackreaming Cutters**, D**ouble row of PDC, **E**xtended gage, **F**ixed ports, **H** –Enhanced Hydraulics, **Z** – Premium Cutters, **R** - Reverse nozzle

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Optional Bit Features

Application specific optional bit features for cutting structure, body and gage customization.

Stay sharper longer

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Available Features

For Hybrid and PDC bits

AzcoDiamond PDC

B Feature: Backreaming Cutters

Strategic placement of cutters on the upside of each blade, to allow backreaming in tight spots, reduces the potential of “bit sticking” while pulling out of the hole.



R Feature: Reverse Nozzle Configuration

A small percentage of the overall flow volume is directed from behind the back bevel region of the bit body for cuttings beds agitation to promote and clean the backreamimg cutting structure when tripping out of the hole



D Feature: Double Row Cutter

Backup cutters are provided to reinforce specific areas of the cutting structure, thereby enhancing bit durability without compromising the rate of penetration.



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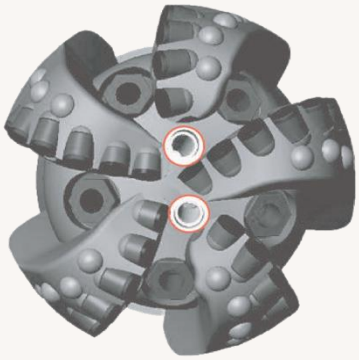
Available Features

For Hybrid and PDC bits

AzcoDiamond PDC

F Feature: Fixed Ports

Optimizes hydraulics in applications where the use of nozzles compromises the bit design because of space limitations or other similar reason; provides additional cleaning of the cutting structure.

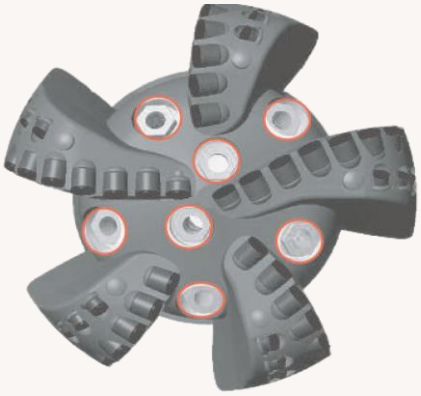


E Feature: Extended Gauge Pad Length Longer gauge than standard, Enhances bit stability and allows more area for gauge protection components.



H Feature: Non - standard nozzles count

Increased cleaning, cooling, and cuttings evacuation with available hydraulic flow: higher flow rate with minimal increase in pump pressure, and reduced risk of bit balling.



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Available Features

For Hybrid and PDC bits

AzcoDiamond PDC

Z Feature Premium Cutters

- **Z1 Cutter** – high-density cutter with an exceptional combination of impact and wear resistance
- **Z2 Cutter** – high thermal cutters designed for maximum resistance in the most demanding thermal applications



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Technical Reference

Casing dimensions

API Bit tolerances

Bit makeup torque

Bit breaker part numbers

Conversion factors

Bit TFA chart

Hydraulic formulae

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API Casing Dimensions

Casing OD (in.)	Coupling OD (in.)	Weight (lb/ft)	Inside ID (in.)	API drift ID (in.)	Roller OD (in.)	Roller OD (dec.)	Fixed OD (in.)	Fixed OD (dec.)
4-1/2*	5.000	9.50	4.090	3.965	3-7/8	3.875	3-7/8	3.875
4.500*	5.000	10.50	4.052	3.927	3-7/8	3.875	3-7/8	3.875
	5.000	11.60	4.000	3.875	3-7/8	3.875	3-7/8	3.875
	5.000	13.50	3.920	3.795	3-3/4	3.750	3-3/4	3.750
5	5.563	11.50	4.560	4.435	4-3/8	4.375	4-3/8	4.375
5.000	5.563	13.00	4.494	4.369	4-1/4	4.250	4-1/4	4.250
	5.563	15.00	4.408	4.283	4-1/4	4.250	4-3/8	4.375
	5.563	18.00	4.276	4.151	4-1/8	4.125	4-1/8	4.125
5-1/2	6.050	14.00	5.012	4.887	4-3/4	4.750	4-3/4	4.750
5.500	6.050	15.50	4.950	4.825	4-3/4	4.750	4-3/4	4.750
	6.050	17.00	4.892	4.767	4-3/4	4.750	4-3/4	4.750
	6.050	20.00	4.778	4.653	4-1/2	4.500	4-1/2	4.500
	6.050	23.00	4.670	4.545	4-1/2	4.500	4-1/2	4.500
6-5/8	7.390	20.00	6.049	5.924	5-7/8	5.875	5-7/8	5.875
6.625	7.390	24.00	5.921	5.796	4-3/4	4.750	4-3/4	4.750
	7.390	28.00	5.791	5.666	4-3/4	4.750	4-3/4	4.750
	7.390	32.00	5.675	5.550	4-3/4	4.750	4-3/4	4.750
7	7.656	17.00	6.538	6.413	6-1/4	6.250	6-1/4	6.250
7.000	7.656	20.00	6.456	6.331	6-1/4	6.250	6-1/4	6.250
	7.656	23.00	6.366	6.241	6-1/8	6.125	6-1/8	6.125
	7.656	26.00	6.276	6.151	6-1/8	6.125	6-1/8	6.125
	7.656	29.00	6.184	6.059	6	6.000	6	6.000
	7.656	32.00	6.094	5.969	5-7/8	5.875	5-7/8	5.875
	7.656	35.00	6.004	5.879	5-7/8	5.875	5-7/8	5.875
	7.656	38.00	5.920	5.795	4-3/4	4.750	4-3/4	4.750
7-5/8	8.500	20.00	7.125	7.000	6-3/4	6.750	6-3/4	6.750
7.625	8.500	24.00	7.025	6.900	6-3/4	6.750	6-3/4	6.750
	8.500	26.40	6.969	6.844	6-3/4	6.750	6-3/4	6.750
	8.500	29.70	6.875	6.750	6-3/4	6.750	6-3/4	6.750
	8.500	33.70	6.765	6.640	6-1/2	6.500	6-1/2	6.500
	8.500	39.00	6.625	6.500	6-1/2	6.500	6-1/2	6.500
8-5/8	9.625	24.00	8.097	7.972	7-7/8	7.875	7-7/8	7.875
8.625	9.625	28.00	8.017	7.892	7-7/8	7.875	7-7/8	7.875
	9.625	32.00	7.921	7.796	6-3/4	6.750	6-3/4	6.750
	9.625	36.00	7.825	7.700	6-3/4	6.750	6-3/4	6.750
	9.625	40.00	7.725	7.600	6-3/4	6.750	6-3/4	6.750
	9.625	44.00	7.625	7.500	6-3/4	6.750	6-3/4	6.750
	9.625	49.00	7.511	7.386	6-3/4	6.750	6-3/4	6.750

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API Casing Dimensions (continued)

Casing OD (in.)	Coupling OD (in.)	Weight (lb/ft)	Inside ID (in.)	API drift ID (in.)	Roller OD (in.)	Roller OD (dec.)	Fixed OD (in.)	Fixed OD (dec.)
9-5/8	10.625	29.30	9.063	8.907	8-3/4	8.750	8-3/4	8.750
9.625	10.625	32.30	9.001	8.845	8-3/4	8.750	8-3/4	8.750
	10.625	36.00	8.921	8.765	8-3/4	8.750	8-3/4	8.750
	10.625	40.00	8.835	8.679	8-1/2	8.500	8-1/2	8.500
	10.625	43.50	8.755	8.599	8-1/2	8.500	8-1/2	8.500
	10.625	47.00	8.681	8.525	8-1/2	8.500	8-1/2	8.500
	10.625	53.50	8.535	8.379	8-3/8	8.375	8-3/8	8.375
10-3/4	11.750	32.75	10.192	10.036	9-7/8	9.875	9-7/8	9.875
10.750	11.750	40.50	10.050	9.894	9-7/8	9.875	9-7/8	9.875
	11.750	45.50	9.950	9.794	9-1/2	9.500	9-1/2	9.500
	11.750	51.00	9.850	9.694	9-1/2	9.500	9-1/2	9.500
	11.750	55.50	9.760	9.604	9-1/2	9.500	9-1/2	9.500
	11.750	60.70	9.660	9.504	9-1/2	9.500	9-1/2	9.500
	11.750	65.70	9.560	9.404	8-3/4	8.750	8-3/4	8.750
11-3/4	12.750	42.00	11.084	10.928	10-5/8	10.625	10-5/8	10.625
11.750	12.750	47.00	11.000	10.844	10-5/8	10.625	10-5/8	10.625
	12.750	54.00	10.880	10.724	10-5/8	10.625	10-5/8	10.625
	12.750	60.00	10.772	10.616	9-7/8	9.875	9-7/8	9.875
13-3/8	14.375	48.00	12.715	12.559	12-1/4	12.250	12-1/4	12.250
13.375	14.375	54.50	12.615	12.459	12-1/4	12.250	12-1/4	12.250
	14.375	61.00	12.515	12.359	12-1/4	12.250	12-1/4	12.250
	14.375	68.00	12.415	12.259	12-1/4	12.250	12-1/4	12.250
	14.375	72.00	12.347	12.191	11	11.000	10-5/8	10.625
16	17.000	65.00	15.250	15.062	14-3/4	14.750	14-3/4	14.750
16.000	17.000	75.00	15.124	14.936	14-3/4	14.750	14-3/4	14.750
	17.000	84.00	15.010	14.822	14-3/4	14.750	14-3/4	14.750
18-5/8	—	87.50	17.755	17.567	17-1/2	17.500	17-1/2	17.500
20	21.000	94.00	19.124	18.936	17-1/2	17.500	17-1/2	17.500
20.000	21.000	106.50	19.000	18.812	17-1/2	17.500	17-1/2	17.500
	21.000	133.00	18.730	18.542	17-1/2	17.500	17-1/2	17.500
	21.000	169.00	18.376	18.188	17-1/2	17.500	17-1/2	17.500

NOTE: Above information is for API casing data, refer to Toolpusher's Manual or specific manufacturer's specifications.

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API Standard Bit Diameter Tolerance

O.D. TOLERANCE (IN.)		
BIT SIZE (IN.)	ROLLER CONE BIT	FIXED CUTTER BIT
6-3/4 and smaller	-0.0 to +1/32	-0.015 to +0.00
6-25/32 to 9	-0.0 to +1/32	-0.020 to +0.00
9-1/32 to 13-3/4	-0.0 to +1/32	-0.030 to +0.00
13-25/32 to 17-1/2	-0.0 to +1/16	-0.045 to +0.00
17-17/32 and larger	-0.0 to +3/32	-0.063 to +0.00

Conversion Factors

Multiply	By	To Obtain
Barrel [bbl]	0.158984	Cubic Meter [m^3]
Barrel [bbl]	42	Gallons (US) [gal (US)]
Barrels per Day [bbl/d]	0.0066243	C. Meters p. Hour [m^3/h]
Feet [ft]	0.3048	Meter [m]
Feet Pounds-Force [ft·lbf]	1.3558	Newton Meter [Nm]
Inches Pounds-Force [in·lbf]	0.1129848	Newton Meter [Nm]
Cubic Feet [ft^3]	28.302	Liter [l]
Gallon (US) [gal (US)]	3.7854	Liter [l]
Gallon (US) [gal (US)]	0.02380952	Barrel [bbl]
Horsepower [hp]	0.7457	Kilowatts [kW]
Inch [in]	2.54	Centimeter [cm]
Square Inch [in^2]	6.4516	Square Centimeter [cm^2]
Cubic Inch [in^3]	16.3871027	Cubic Centimeter [cm^3]
Ton (metric) [t]	2204	Pounds [lbs]
Pounds [lbs]	0.453592	Kilogram [kg]

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Recommended Make UP Torque

Connection	Max. Pin ID	Bit Sub OD	Min. Make-Up Torque [ft-lbs]
2 3/8" API Reg.	1"	3"	1,800
		3 1/8"	2,450
		3 1/4"	3,100
2 7/8" API Reg.	1 1/4"	3 1/2"	3,100
		3 3/4"	4,650
		3 7/8"	4,700
3 1/2" API Reg.	1 1/2"	4 1/8"	5,200
		4 1/4"	6,350
		4 1/2"	7,650
4 1/2" API Reg.	2 1/4"	5 1/2"	12,500
		5 3/4"	16,500
		≥ 6"	17,500
6 5/8" API Reg.	2 13/16"	7 1/2"	37,200
		≥ 7 3/4"	42,700
	3"	7 1/2"	37,200
		≥ 7 3/4"	40,600
7 5/8" API Reg.	3 1/4"	8 1/2"	48,350
		8 3/4"	57,750
		≥ 9"	67,400
	3 1/2"	8 1/2"	48,350
		8 3/4"	57,750
		≥ 9"	63,650
8 5/8" API Reg.	3 1/2"	≥ 9 3/4"	94,900

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TFA Values of Common Nozzle Sizes

NOZZLE SIZE	NUMBER OF NOZZLES									
IN.	1	2	3	4	5	6	7	8	9	10
7/32	0.0376	0.0752	0.1127	0.1503	0.1879	0.2255	0.2631	0.3007	0.3382	0.3758
8/32	0.0491	0.0982	0.1473	0.1963	0.2454	0.2945	0.3436	0.3927	0.4418	0.4909
9/32	0.0621	0.1243	0.1864	0.2485	0.3106	0.3728	0.4349	0.4970	0.5591	0.6213
10/32	0.0767	0.1534	0.2301	0.3068	0.3835	0.4602	0.5369	0.6136	0.6903	0.7670
11/32	0.0928	0.1856	0.2784	0.3712	0.4640	0.5568	0.6496	0.7424	0.8353	0.9281
12/32	0.1104	0.2209	0.3313	0.4418	0.5522	0.6627	0.7731	0.8836	0.9940	1.1045
13/32	0.1296	0.2592	0.3889	0.5185	0.6481	0.7777	0.9073	1.0370	1.1666	1.2962
14/32	0.1503	0.3007	0.4510	0.6013	0.7517	0.9020	1.0523	1.2026	1.3530	1.5033
15/32	0.1726	0.3451	0.5177	0.6903	0.8629	1.0354	1.2080	1.3806	1.5532	1.7257
16/32	0.1963	0.3927	0.5890	0.7854	0.9817	1.1781	1.3744	1.5708	1.7671	1.9635
17/32	0.2217	0.4433	0.6650	0.8866	1.1083	1.3300	1.5516	1.7733	1.9949	2.2166
18/32	0.2485	0.4970	0.7455	0.9940	1.2425	1.4910	1.7395	1.9880	2.2365	2.4850
19/32	0.2769	0.5538	0.8307	1.1075	1.3844	1.6613	1.9382	2.2151	2.4920	2.7688
20/32	0.3068	0.6136	0.9204	1.2272	1.5340	1.8408	2.1476	2.4544	2.7612	3.0680
21/32	0.3382	0.6765	1.0147	1.3530	1.6912	2.0295	2.3677	2.7059	3.0442	3.3824
22/32	0.3712	0.7424	1.1137	1.4849	1.8561	2.2273	2.5986	2.9698	3.3410	3.7122
24/32	0.4418	0.8836	1.3254	1.7671	2.2089	2.6507	3.0925	3.5343	3.9761	4.4179
26/32	0.5185	1.0370	1.5555	2.0739	2.5924	3.1109	3.6294	4.1479	4.6664	5.1849
28/32	0.6013	1.2026	1.8040	2.4053	3.0066	3.6079	4.2092	4.8106	5.4119	6.0132

Hydraulic Calculations:

Annular Velocity:

$$V_A = \frac{24.5\ Q}{d_h^2 - d_s^2}$$

Surface Equipment Pressure Losses:

$$\Delta P = c\rho \times (Q/100)^{1.86}$$

Drill Stem Bore Pressure Losses:

$$\Delta P = \frac{6.1 \times 10^{-5}\ \rho L Q^{1.86}}{d_i^{4.86}}$$

Jet Nozzle Pressure Losses:

$$\Delta P = \frac{\rho Q^2}{10858\ A_N}$$

Annular Pressure Losses:

$$\Delta P = \frac{(1.4327 \times 10^{7})\rho L V^2}{d_h - d_s}$$

Jet Velocity:

$$V_N = \frac{0.32086\ Q}{A_N}$$

Jet Impact Force:

$$I_N = 5.16 \times 10^{-4}\ \rho Q V_N$$

Hydraulic Horsepower:

$$H_{hp} = \frac{PQ}{1714}$$

Nomenclature:

V_A ... Annular Velocity [ft / min]
Q ... Circulation Rate [gpm]
d_h ... Borehole Diameter [in]
d_s ... Drill String Outer Diameter [in]
d_i ... Drill Stem Inner Diameter [in]
ρ ... Mud Weight [lb / gal]
c ... Friction Factor
P ... Pressure [psi]
ΔP ... Pressure Drop [psi]
L ... Length [ft]
A_N ... Nozzle Area [in^2]
V_N ... Jet Velocity [ft / sec]
I_N ... Jet Impact Force [lbf]
H_{hp} ... Hydraulic Horsepower [hp]

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