Collision-Tolerant Rock Bit with Special Heel Technology for Crowded Offshore Platform Drilling Environment

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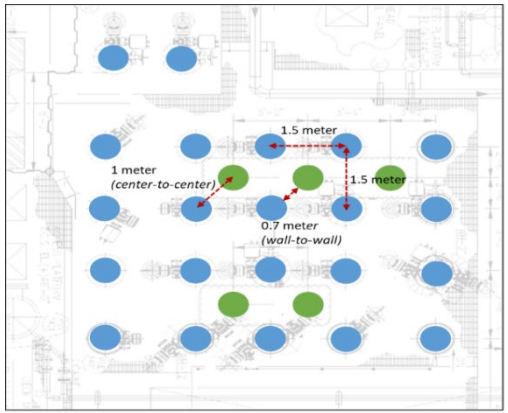
Crowded Offshore Platform Drilling Environment



Well	Minimum Separation Factor		Minimum Center-to-Center	
	Ratio	Depth (ft MD)	Distance (ft)	Depth (ft MD)
STA-27	0.29	689	3.6	503
STA-28	0.4	855	2.4	855
STA-29	0.561	649	2.2	649
STA-30	0.3	803	3.2	586

The high density of existing conductor pipes (blue dots) on this pad resulted in minimal available space for the 4 newly planned wells (green dots).
The minimum center-to-center separations ranged from 2.2 to 3.6 ft with minimum separation factors as low as 0.29.

Offshore platform in Santan field in East Kalimantan, Indonesia

- Extensive pre-job planning was required for these 4 wells due to the minimal available space between the high density of existing conductor pipes. The situation presented heightened HSE and operational concerns in the event of a downhole collision with one or more existing conductors.
- As part of their mitigation strategy, the operator requested a special collision-tolerant bit which would impart much less damage to a conductor in the event of a collision. The bit should still be able to drill the required distance with similar ROP and directional behavior as that of a conventional steel tooth rolling cone bit.

Risks Associated with Conventional Bit Designs

- PDC, ST or Hybrid bits would normally be used for drilling soft tophole applications, but are known to have the potential to cause significant damage to steel risers or casing in the event of a downhole collision
- TCI bits might cause incrementally less collision damage, but are not well suited for drilling such soft formations due to lower ROP potential.

PDC

Steel Tooth

Hybrid

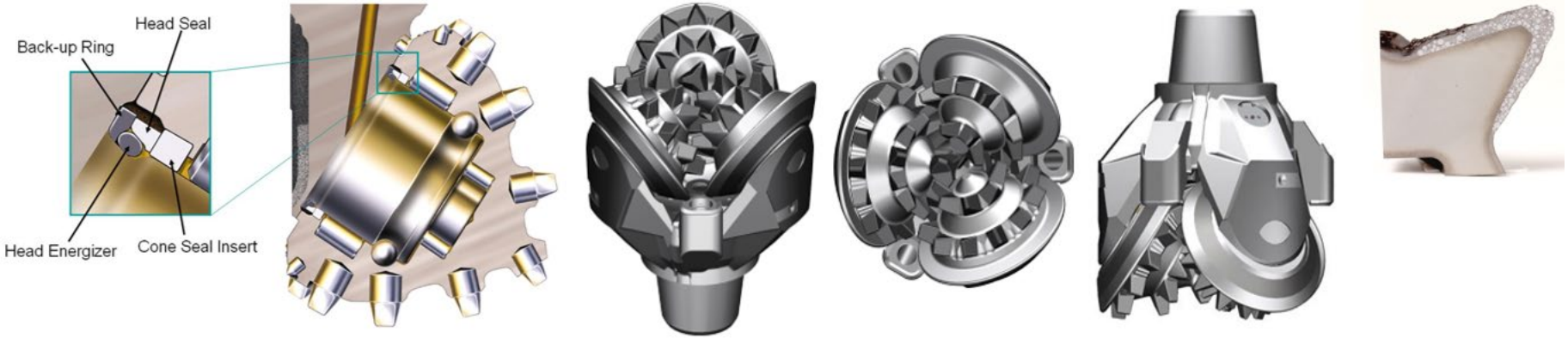
TCI

Collision-Tolerant Bit Design Concept

- A service company already developed a new 17.5 in. collision tolerant (CT) steel tooth (ST) bit design in 2017
- CT bit vs. conventional IADC 115 ST bit performance tests were conducted on atmospheric surface rig
- The CT bit was evaluated via two types of laboratory collision tests to quantitatively assess the damage imparted to 24 in. casing.

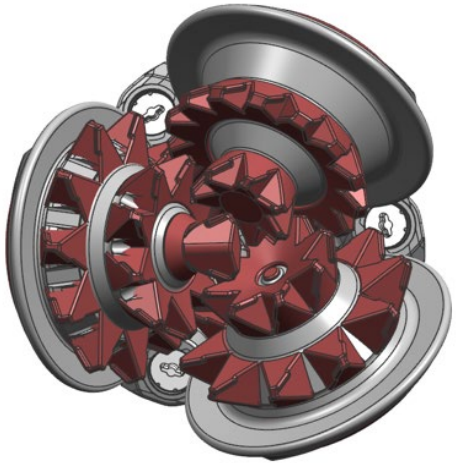
Additional Features of Collision-Tolerant Bit Design

- Proven premium single energizer metal face seals with precision roller bearing package for long life
- Three partially extended nozzles directed straight down which also provide 6-point gauge stabilization
- Carburized continuous disk heels with extremely smooth surfaces for high strength and wear resistance
- Three types of premium hardfacing materials were applied to the tooth crests, cone gauge surfaces, and shirttail hardfacing.

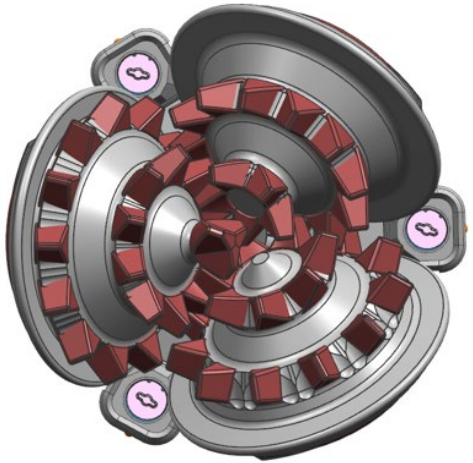


Other Sizes of Collision-Tolerant Bit Are Possible

- The CT bit development work being reported today was all for the 17.5 in. bit size
- The 16.0 in. size shown below was designed in late 2021, no field results available to report yet
- Larger sizes such as in the 20.0 – 26.0 in. range are also possible, depending on operator requirements.

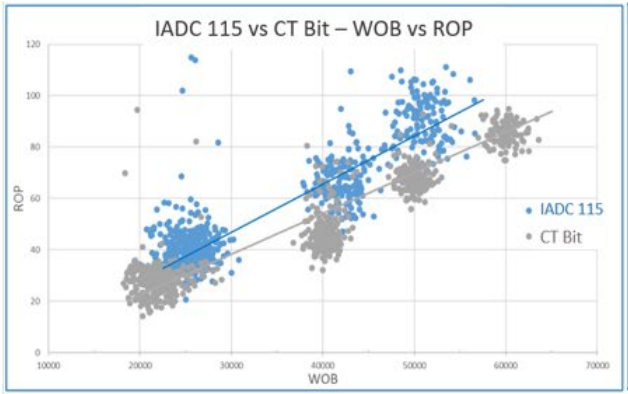


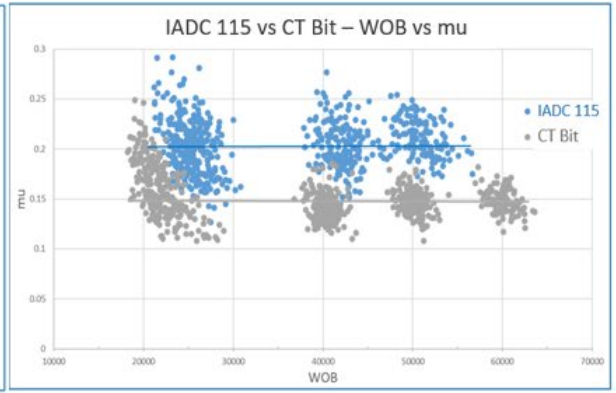
16.0 in. CT bit

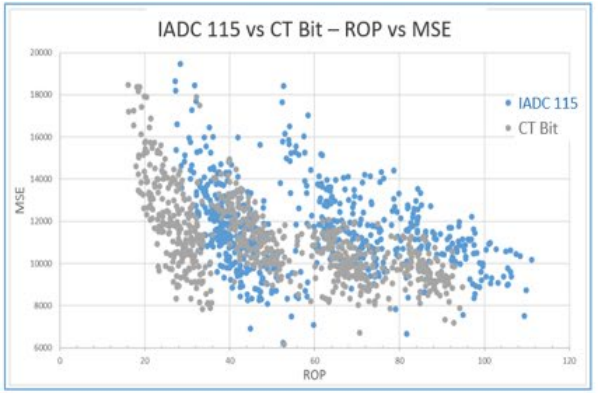


17.5 in. CT bit

Laboratory Test Results in Bedford Limestone (~ 6ksi UCS)





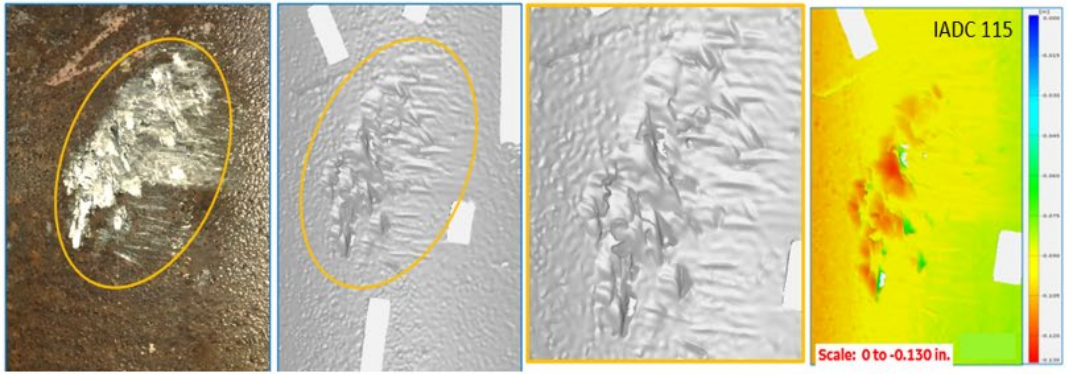


IADC 115 Bit

CT Bit

Laboratory Side Load Test Results – Casing Inclination 9°

Laboratory Collision Test Results – Casing Inclination 18°

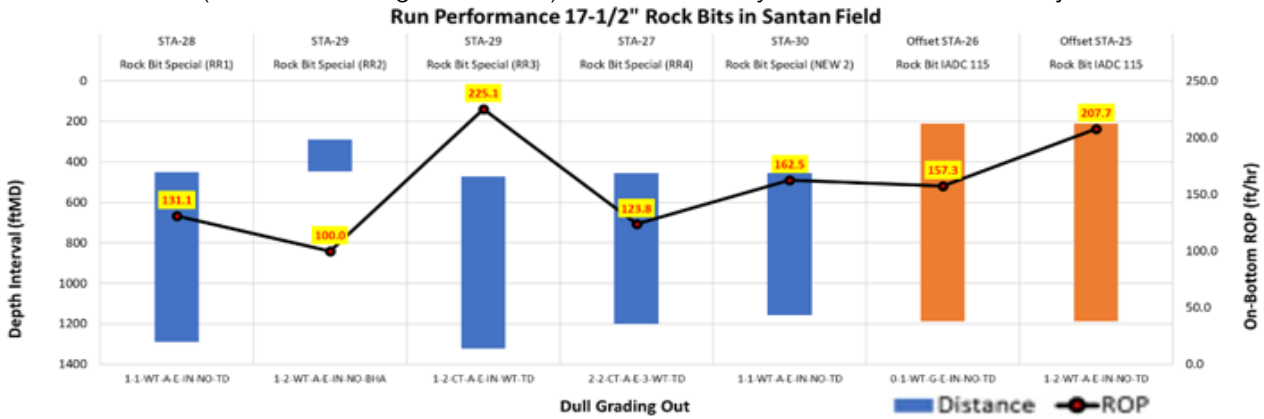


Test parameters: 48 ft/hr, 1 in. collision distance, 12 seconds duration

Summarizing:
The CT bit with disk shaped heels displayed a 70% to 80% reduction in damage to the surface of 24 in. casing in two types of laboratory casing collision tests based on scar depth and volume of material removed.

Performance Summary of CT Bit Field Trials

- Four wells were drilled with the Collision Tolerant (CT) bit between a measured depth of 440 to 1300 ft.
- One CT bit successfully drilled the first three wells, and a second CT bit drilled the fourth well.
- A CT bit on well STA-29 set the highest average ROP of 225.1 ft/hr, which was 7% faster than one of the fastest conventional bits on well STA-25.
- The first CT bit drilled a total of 2583 ft over four bit runs in three wells with a final dull grade of 2-2-CT-A-E-3-WT-TD.
- The second CT bit drilled the fourth well with a dull grade of 1-1-WT-A-E-NO-TD.
- No downhole collision was detected (no metal cuttings in returns) and no reliability issues observed on adjacent wells.



New vs. Dull CT Bit Condition Post-Run

- A new CT bit is pictured at the top
- The dull CT bit pictured at the bottom was after the 2nd run on well STA-29, its 3rd run overall for a total of 1838 ft drilled
- After these dull photos were taken this bit successfully drilled well STA-27, its 4th run overall
- Both CT bits were reported to be seals effective
- The steel tooth hardfacing and the carburized disk heels were still in good condition, which demonstrates their suitability for controlled drilling in this type of soft, unconsolidated formations.

Conclusions

The extensive laboratory test protocol results and the five trial runs over four wells for the Collision-Tolerant (CT) bits in the Santan field of Indonesia demonstrated the following:

1. The CT bit will impart 70% to 80% less damage to casing than a conventional IADC 115 bit in the event of a downhole collision. The rounded crests of the continuous disk heels tend to deflect from casing, rather than gouge into it as the numerous sharp chisel heel row teeth of conventional ST bits are prone to do.
2. The CT bit delivers excellent ROP and directional control while controlled drilling in very soft unconsolidated formations. Reduced drilling dynamics and improved borehole quality are also positive attributes for the CT bit.
3. All four wells in the subject field trial were drilled safely and economically with no indications of downhole collision. One CT bit drilled the first three wells, and a second CT bit was picked up to drill the fourth well, it was pulled in green (rerunnable) condition.
4. The CT bit is worthy of consideration as part of a holistic approach to minimize risk when planning additional wells on a densely populated offshore platform with critical well collision concerns for continued development of mature fields. Always conduct pre-job risk assessments and contingency planning.

Acknowledgements / Q&A

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