Tensor Elite™ in the Haynesville - Case Study

Recognized as the leading provider of predictable and reliable MWD performance in high temperature, 175 °C/ 347 °F environments Tensor Drilling Technologies was invited to develop and deploy a highly ruggedized system to survive the extreme temperature and vibration suffered in the Haynesville formation in Louisiana, U.S.A..

The Bayou San Miguel field presents unique challenges in the harshness of its drilling environments. Wells are typically landed at ~12,000 ft TVD with a further 5-6000 ft of tangent being drilled. A series of MWD operators suffered multiple failures of their downhole systems due to circulating temperatures in excess of 330 °F/ 165 °C and high intensity axial and lateral shocks.

Tensor Drilling Technologies was invited to design and deploy a system that could successfully complete the wells in the area.

The solution was Tensor Elite™, a system which surpasses all existing HT tools in its class allowing operators and service companies to drill with greater confidence through less frequent bit trips and lower cost of operations. Coupling Tensor's proven success in high temperature operations with market leading solutions to counter the expected high shock and vibration the development team provided a system capable of delivering in field where all other competition had failed.

Drilling Parameters			
Bit Size	6.75"/ 171 mm	Measured Depth	12,000 - 17,600 ft/ 3,650 - 5,350 m
Temperature	255 - 330 °F/ 125 - 165 °C	True Vertical Depth	12,600 ft/ 3,840 m
Flow Rate	250 gpm/ 15.77 L/s	Mud Weight	15.45 ppg/ 1.86 s.g.
Total Solids	33%	High Gravity Solids	26%

Over 5 runs the new system proved resistant to both the high levels of shock and the extreme temperature. Runs of up to 3,330 ft/ 1,100 m delivered the well to TD to the satisfaction of the customer.

Key Upgrades

Rotary Connectors

High Temperature Rotary Connectors are used between all tool modules delivering improved performance at high temperature and under high vibration. Easier, and more reliable, tool assembly at the rigsite minimizes risk of operator error and electrical damage to the tool.

Integral Centralizers

Standard Centralizers are replaced with one-piece sleeves over the Rotary Connectors. This shortens the tool length bringing sensor measurements closer to the bit while also reducing toolstring harmonic vibrations. The simplified design also helps reduce maintenance time and cost.

Pulser

The Tensor 175 °C Solenoid Pulser is upgraded to provide better mechanical performance and improved reliability:

- Sealing - redesign of key components ensures perfect sealing across the entire operating envelope.
- Elastomers - Industry leading elastomers maintain performance in the harshest of drilling fluids at 175 °C.
- Wash Resistance - Redesign of housings offer greater resistance during high flow in imperfect drilling fluids.

Bottom End

The upgraded Bottom End delivers outstanding and reliable performance in the toughest of environments. Key components have been replaced to improve internal sealing and wear resistance, while other modifications improve Poppet seating force.

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Muleshoe

The Muleshoe is upgraded to offer improved resistance to wash and wear in high flow rates through the use of market leading coatings and inserts. Together with the Bottom End, a locking mechanism ensures the toolstring cannot unseat during high-inclination operations.

Snubbers

Snubbers are used in all modules to isolate electronics from downhole vibration. By upgrading to market leading Snubber assemblies Tensor Elite removes a major cause of system failure. In accelerated endurance testing the new Snubber assemblies demonstrate over 2000 hour service life without maintenance and prove to considerably reduce the amount of vibration related downhole failures.

Toolstring Axial Isolator

An additional module is positioned between the Bottom End and the Pulser to isolate the toolstring from the axial shock and vibration. The system utilizes a nonlinear elastomer spring and damper elements, which improve reliability and shorten maintenance cycles. A reduction of 70-80% in axial shock events is achieved.

Wiring Assemblies

The manufacture of all wiring harnesses, including the Directional Module Uphole Snubber Pigtail (Transorb) has been revised for improved performance at elevated temperatures and sustained vibration.

Seals

Industry leading elastomers are used on all tool modules, ensuring performance at temperature limits.

Sensor Specifications

Directional	Tri-axial fluxgate magnetometers and Q-flex accelerometers	
Measurement	**Range**	**Accuracy**
Inclination	0 - 180º	+/- 0.1º
Azimuth	0 - 360º	+/- 0.25º
Toolface - Magnetic	0 - 360º	+/- 0.5º
Toolface - Gravity	0 - 360º	+/- 0.5º
TMF	0 - 100 µT	+/- 0.075 µT
Dip	-90 - 90º	+/-0.15º
GT	0 - 2.000 g	+/- 0.001 g
Temperature	-35 - 200 ºC	+/- 0.5 ºC
Peak Shock	0 - 250 g	+/- 1 g

Gamma	NaI Scintillation
Parameter	**Specification**
Memory Update	18 samples/ m at 20 m/hr
Real Time Update	9 samples/ m at 20 m/hr rotating 6 samples/ m at 20 m/hr sliding
Resolution	1 API
Sensitivity	2.5 counts per API
Memory	32 Mb.
Sampling Period	Programmable 1-60 seconds

Technical Specifications

Probe OD	1.875 in./ 47.6 mm	Max. Pressure	20 kpsi/ 137.9 MPa	Max. Sand	0.5 %
Max. Temperature Operating	175 ºC	Max. Temperature Survival		175 ºC	
Max. LCM Tolerance	40 ppb/ 114 kg/ m^3 evenly mixed medium nut plug				

2418 North Frazier St. | Suite 100
Conroe, TX 77303, USA
P: +1 346.353.5130

www.Tensordt.com

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