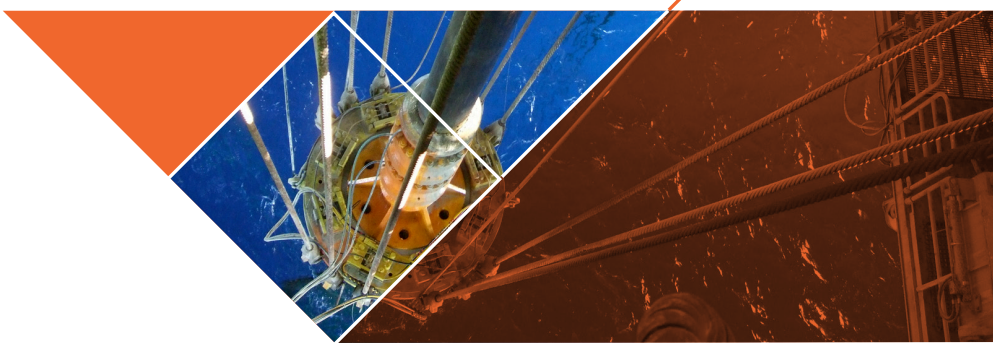
EXEBENUS

SPOTTER™



ROP AGENT

Optimize ROP in real time and increase drilling and operational efficiency

Rate of penetration (ROP) is a major contributor to drilling time and cost. The Exebenus Spotter ROP Agent uses multi-parameter machine learning to advise and help crews make informed decision to improve drilling speed and efficiency.

RATE OF PENETRATION IS A MAJOR FACTOR IN CONTROLLING DRILLING COSTS

In general, optimizing the ROP in drilling is achieved by adjusting the weight on bit (WOB), RPM, and flow rate. The allowed ranges for these parameters are typically obtained prior to the operations using complex, time consuming simulation models.

Simulation models depend on the input of configuration parameters that cannot be predetermined accurately. In addition, there are many uncontrollable factors such as bit dulling, vibration, buckling, and variable formation strengths, all of which need to be considered when trying to optimize ROP. Consequently, the ability to plan and make effective drilling adjustments to enhance ROP is largely dependent on the experience of the rig crew.

MACHINE LEARNING OFFERS BETTER, MORE RELIABLE ADVICE IN REAL TIME

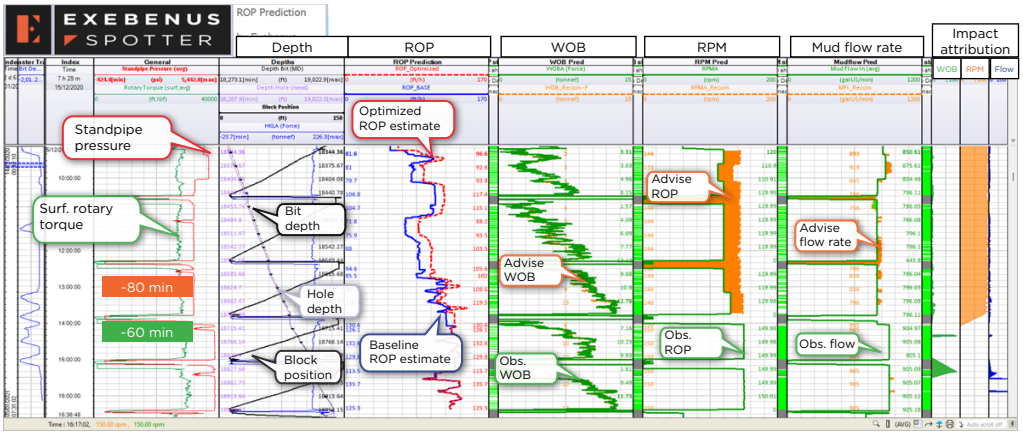
Exebenus Spotter ROP Agent is unique its ability to decipher the relationships between controllable and uncontrollable drilling parameters. Using machine learning, the agent provides parameter recommendations for the drilling crew in real-time. No complex mathematical models and hard-to-get configuration data are required. Just plug the agent into your WITSML data stream and be amazed at the output.

Machine learning is the perfect tool for the job of interpreting and seeing the relationships between multiple parameters. The Exebenus ROP optimization agent adapts to well formations, mud flow, BHA and bit type, and identifies combinations of factors and changes to parameters than may not be obvious to the human operator relying on traditional routines.

The real-time advice provided by the Exebenus **ROP Agent** has been shown in field operations to increase ROP and reduce drilling time significantly.

EXCEPTIONAL BENEFITS

- Real-time multi-parameter optimization
- Integrates with safeguards against stick-slip and poor hole clearning
- Parameter boundaries settings are flexible and changeable
- No pre-training of models required
- Reduce risk of human error
- 10-30% improved ROP overall



Exebenus Spotter estimates optimized ROP and a baseline ROP (no changes to drilling parameters). When these coincide, ROP is optimal. If they do not coincide, the WOB, RPM and flow recommendations shown (orange) are used to further optimize ROP. In this operation, the rig crew implemented the advice at the starred point, resulting in increased ROP.

25% LESS TIME TO COMPLETE STAND AFTER IMPLEMENTING DRILING PARAMETER, COMPARED TO PREVIOUS STAND (60 VS 80 MIN)

Supported by ROP Agent	
Well trajectory	0-90 deg
Operation types	Rotary drilling, sliding, CWD, MPD
Hole sizes	6” - 30”
Bit types	PDC (fixed cutter), roller cone, diamond bits
Depth range	0-10000 m
Formation type	Clay, evaporites, marl, marine clay, paleozoles, sandstone, shale, silt

Supported by ROP Agent	
Input	**Output**
Bit depth	Baseline ROP estimate
Hole depth	Optimized ROP estimate
Surface RPM	Calculated ROP (observed)
Surface torque	ROP % difference between baseline and optimized
Weight on bit (WOB)	Recommended WOB
Standpipe pressure	Recommended RPM
Mud flow rate in	Recommended mud flow
Mud density in	Impact attributions

OUT-OF-THE-BOX AND INTO PLAY

The **Exebenus Spotter ROP Agent** is an out-of-the-box solution, adaptable to any field or well type using standard WITSML setups and familiar WITSML viewers. Because it adapts to well formations, BHA, bit type and mud flow, the solution reduces the risk of human error by removing the need to manual configuration.

The **ROP Agent** provide additional logs to be visualized in the WITSML viewer showing recommended RPM, WOB and mud flow rates to obtain the optimal ROP. As the recommended parameters are implemented, the agent updates in real-time, reflects the new situation, and continues to give advice.

POWERFUL INDIVIDUALLY. STRONGER TOGETHER.

The Exebenus Spotter suite includes three targeted AI/ML agents.

Stuck Pipe Agent
including supporting models for

- Differential sticking
- Mechanical sticking
- Hole cleaning

ROP Agent

Vibration Agent

Exebenus Spotter agents are available as standalone or bundled solutions. When working together, they support each other's predictions or recommendations.

Combined, the agents address interconnected challenges, leading to even better results than any can achieve alone.

INTELLIGENT DRILLING WITH EXEBENUS SPOTTER AGENTS

Exebenus Spotter is a cloud-based, standalone software as a service (SaaS) solution. The agents can be hosted on any public cloud, installed on your corporate cloud or on your premises.

Exebenus Spotter agents are designed based on our deep understanding of drilling and completion operations and data sciences.

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