



Predict stuck pipe events using Exebenus Current ML agents

Increase productive time by predicting and preempting stuck pipe conditions

Exebenus Current ML machine learning agents use data that is readily available in all well operations to provide real-time, dynamic predictions and trends, enabling operators to avoid undesired events.

PREVENTING HIGH-RISK CONDITIONS

Exebenus Current ML Stuck Pipe agents predict, in real-time, high-risk conditions such as pressure differentials, hole cleaning conditions and wellbore geometry issues that, without intervention, typically result in stuck pipe situations.

When used on historical data as part of offset well analysis, the agents can identify unreported near misses and provide guidance for optimizing performance in the future.

Machine Learning (ML) agents are designed for engineers to

- ▲ Optimize pre/post job offset well and investigative root cause analysis
- ▲ Perform real-time predictive, situational awareness and performance analysis throughout operations.

ML agents consume real-time or historical WITSML data and provide WITSML data output. To minimize user training, they integrate with existing real-time WITSML viewers and operations center workflows to monitor, analyze and advise rig crews.

SUCCESSFUL DEPLOYMENT AND EXPERIENCES

For new deployments, ML agents are trained using historical data from one or two wells, preferably from the area in which they will be used, or from wells sharing a similar trajectory design. Data showing historical stuck pipe events is beneficial, but not required.

Exebenus Current ML Stuck Pipe agents are supplied in one package. They work independently to solve different stuck pipe scenarios.

Exebenus Current ML Stuck Pipe agents

- ▲ Differential sticking
- ▲ Hole cleaning
- ▲ Wellbore geometry

SMART USE OF REAL-TIME DATA

To create easily understandable and trustworthy predictions, the ML agents use parameters that are familiar to engineers. The agents have easy-to-read color coding and text information. As the agents provide predictions, their analysis is presented in the monitoring display as trends, warnings and alarms related to the predicted problem.

The sensitivity level of each agent's warning and alarm setting is configurable to provide engineers with the best possible situational awareness. An agent's predictive time depends on the nature of the operation, the sensitivity configuration, and the type of look-ahead, predictive signs that exist. A typical setup gives the engineer three warnings prior to raising the alarm.

In addition to the Stuck Pipe agents, the software issues alarms when data is missing or the connection to the rig is lost.

THE POWER OF EXEBENUS CURRENT ML AGENTS

Exebenus Current ML agents comprise a cloud-based, stand-alone software as a service (SaaS) solution. The agents can be hosted on a public cloud (e.g. Microsoft Azure) or installed on your in-house, private cloud.

Exebenus has partnered with IBM and has embedded the IBM Watson technology in the ML agents.

The design of the Exebenus ML agents is based on our deep understanding of drilling and completions operations and the associated data. Exebenus machine learning experts continue to work closely with domain experts to ensure that the agents are robust and highly predictive.

Prior to deploying **Exebenus Current ML agents**, our experts will work with your organization to recommend the optimal configuration and setup for managing any number of well operations, including connectivity, IT infrastructure and hardware.

STUCK PIPE ML AGENTS	WARNING/ALARMS	PREDICTIVE TIME	INPUT DATA
Differential sticking (DS)	The warning is triggered by a decreasing or increasing drag trend in combination with extended (more than 10 minutes) stand-still or connection time.	½ hour – 4 hours ahead	Time, bit depth, hole depth, hookload, flow rate, RPM, block position
<p><i>Example shows a tripping-in scenario. The red prediction ahead of time is dropping because we have a buoyancy effect in the mud. A low to medium differential sticking warning is issued as every joint goes in the hole. Data courtesy of PETRONAS.</i></p>			
Wellbore geometry (WG)	The warning is triggered when there is a predicted increased in drag at depths where high dog-leg severity is planned and/or drilled.	½ hour to one run ahead	Time, bit depth, hole depth, hookload, flow rate, RPM, trajectory, block position
<p>Warnings from previous runs in the same section are remembered.</p>			
Hole cleaning (HC)	The warning is triggered when there is an increased predicted ECD trend in combination with a diverging pressure vs flow relationship.	½ hour – 4 hours ahead	Time, bit depth, hole depth, hookload, flow rate, RPM, trajectory, mud density in, ROP, stand-pipe pressure
<p><i>Example shows a yellow warning is issued as predicted ECD is increasing (black) and the relationship between flow and standpipe pressure. Once the flow rate has been changed the ECD prediction (magenta) decreases and situation goes back to normal. Data courtesy of PETRONAS.</i></p>			

EXEBENUS PULSE

The **Exebenus Pulse** solutions digitalizes the information exchange between planning and operations. Bridging the digital footprint of past and current operations, the solution automatically generates validated, digital operating procedures for drilling and completions operations. Exebenus Pulse facilitates dynamic interaction between planner and crew, validates actions, flags deviations in real time and captures best practices for future implementation. The **Exebenus Pulse ML agents** pre-empt well conditions and increase situation awareness and operational productivity.

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