# ADVANTAGE Engineering Software Updates

To provide efficient, holistic well planning for our customers, we have made several changes to the ADVANTAGE™ Engineering software. These changes provide us with better simulations and models, and are the result of in-depth research, parameter studies and Artificial Intelligence (AI) techniques. This will allow us to deliver even more valuable, consistent results.

## FRICTIONAL PRESSURE LOSS

release 2.5u4

We have improved how we measure frictional pressure loss. The new calculations consider string rotation and eccentricity for both laminar and turbulent flow. We have developed this based on a comprehensive parameter study of greater than 1 million computational fluid dynamics (CFD) flows, covering full operating ranges. This provides greater accuracy in predicted equivalent circulating densities (ECD), reducing the chance of a loss circulation or well control event.

**Why this matters:** More accurate prediction of ECDs allows for optimization of several drilling parameters, such as rate of penetration (ROP) and pumping rates. This leads to operational efficiency for our customers.

## HOLE CLEANING IMPROVEMENTS

release 2.6

We have updated the algorithm used to predict hole cleaning thresholds to account for string eccentricity and rotational velocity. This allows for more accurate predictions of where trapped cuttings occur.

**Why this matters:** Our customers are able to reduce friction and torque caused by trapped cuttings. This improves fluid flow and optimizes penetration rates, leading to faster well delivery and overall reduced costs.

## DYNAMIC TEMPERATURE EFFECTS

release 2.6

We are using measured fluid data and AI techniques to better predict downhole rheology and density. We have also made improvements to refine high temperature high pressure (HT/HP) data interpolation as well as extrapolation.

**Why this matters:** This enhanced accounting of drilling fluid viscosity and density allows us to provide a holistic model of well construction.

## DYNAMIC SWAB AND SURGE MODELING

release 2.6

We are now accounting for the pressure wave differential due to acceleration, deceleration, and movement of pipe throughout the wellbore to provide the maximum pressure seen at a local restriction.

**Why this matters:** Accounting for dynamic pressures seen while tripping allows for an optimized velocity profile. This results in reduced formation damage, shorter tripping times and overall safer operations.

| TYPICAL DRILLING SCENARIO RESULTS | | | | |
|---|---|---|---|---|
| | Legacy Model | | Improved Model | |
| | 60 rpm | 130 rpm | 60 rpm | 130 rpm |
| **ESD** (ppg) | 13.87 | 13.87 | 13.87 | 13.87 |
| **ECD** (ppg) | 14.13 | 14.09 | 14.10 | 14.06 |
| **SPP** (psi) | 5756 | 5708 | 5713 | 5661 |
| **Min. flow rate for cuttings transport** (gpm) | 1452 | 1378 | 1712 | 967 |
| **% Cuttings bed** | 28.57 | 25.69 | 37.84 | 0.00 |
| **% Cuttings load** | 18.50 | 16.05 | 25.15 | 0.80 |
| **Mud weight** (ppg) | 13.5 | | | |
| **Hole size** (in.) | 16.5 | | | |
| **Hole angle** (deg) | 44.72 | | | |
| **ROP** (ft/hr) | 45 | | | |
| **MD** (ft) | 26,000 | | | |
| **TVD** (ft) | 24,206 | | | |
| **Flow rate** (gpm) | 1,050 | | | |
| **ROP** (ft/hr) | 45 | | | |

These software updates will result in more accurate simulations when drilling and tripping operations are modelled and are backed by over 6 years of research. Listed below are the most relevant technical papers written with regards to the changes mentioned above.


An Integrated Thermal and Multi-phase Flow Model for Estimating Transient Temperature Dynamics During Drilling Operations
*SPE 194083 - 2019 SPE/IADC Drilling Conference*

Cuttings transport simulation in inclined large diameter borehole
*OMAE 2019 – 95228 - 2019 International Conference on Ocean, Offshore and Arctic Engineering (OMAE)*

Cuttings Transport Simulation in Annulus While Drilling
*OMAE 2018 – 77266 - 2018 International Conference on Ocean, Offshore and Arctic Engineering (OMAE)*

Drag and Lift Forces Acting on a Sphere in Shear Flow of Power-law Fluid
*Journal of Engineering Thermophysics - 2018*

Impact of Viscoelastic Characteristics of Oil Based Muds (OBMs) and Synthetic Based Muds (SBMs) on Cuttings Settling and Slip Velocities
*OMAE 2017 – 61131 - 2017 International Conference on Ocean, Offshore and Arctic Engineering (OMAE)*

Numerical Modeling of Cutting Transport while Drilling by Continual Model
*2017 All-Russian Seminar: Dynamics of Multiphase Media*

Systematic Simulation of flow in annuli using CFD to enable real-time applications
*2017 ADWELL Open Seminar*

About criteria of incipient motion and entrainment into suspension of particle from cuttings bed in shear flow of non-Newtonian fluid
*2017 Modern Problems of Continuum Mechanics and Explosion Physics*

Derivation of Drag and Lift Force Correlations for Spheres suspended in flowing non-Newtonian fluids
*OMAE 2016 – 54045 - 2016 International Conference on Ocean, Offshore and Arctic Engineering (OMAE)*

Modelling of Pressure Fluctuations in Wellbore While Tripping
*OMAE 2015 – 41370 - 2015 International Conference on Ocean, Offshore and Arctic Engineering (OMAE)*

Modeling and Evaluating Surge Pressure while Tripping in a Borehole
*European Oil and Gas Magazine - 2014*

Evaluation of Pressure Change While Steady-State Tripping
*OMAE 2014 – 23672 - 2014 International Conference on Ocean, Offshore and Arctic Engineering (OMAE)*

Detailed modeling of drilling fluid flow in a well bore annulus while drilling
*OMAE 2013 – 11031 - 2013 International Conference on Ocean, Offshore and Arctic Engineering (OMAE)*


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