safe, economical, versatile, customised and practical Training solutions

Downhole simulation
OVERVIEW

It is fully recognized at ARI that a complete, comprehensive and realistic Downhole Simulator is the need of the hour in the highly demanding world of oil well drilling operations. Most seemingly small mistakes can have a cascading effect till they pose very significant dangers of blowout, damage of expensive equipment and not to mention environmental pollution. If nothing else, mistakes pose a heavy cost of machinery maintenance and repair. The ARI Downhole Simulation simulates real time drilling and is capable of being used for training over a wide range of scenarios including routine operations and emergencies with catastrophic potential. The simulator uses state of the art algorithms and provides the user with a wide range of modeling options.

MUD FLOW MODEL

The multiphase Mud flow model serves as the backbone of the drilling operation simulation. This model has evolved with inputs from experts in the field of drilling operations, fluid dynamics, applied physics & maths and draws on the work of numerous research scientists. The end result is a model which is robust, versatile, dynamic and above all completely relevant in every situation.

Rheology Model

The ARI Downhole Simulation is flexible in the selection of mud rheology, not only during the initialization of the simulation but also during run time. The following Rheological Models can be used:
- Bingham Plastic
- Power Law
- Herschel-Bulkley

Additionally custom models can be interfaced with the simulator.

Pressure Calculations

Complex algorithms are in place based on the rheology model to accurately calculate the frictional losses in the flow path of the mud, jet velocity of the mud passing through the bit and additionally takes into account factors such as variation in the geometry of the drill string, BHA combination and annular area at different depths.

Also includes
- Drill Cutting Transportation
- Filter Cake Formation
- Surge & Swab Effect

WELL PROFILE

The simulation is capable of designing and visualising well trajectory in both 2D and 3D geometry.

Well Planning View
Well Trajectory
Current Bit Position

Geological profile depicting various parameters such as hardness, permeability and porosity

Sample Faults
- Sensor/gauge failures
- Encoder failures
- Power failures
- Torsional stick slip
- Drilling break

Faults/User response may occur naturally based on drilling operation at a geological profile created by the instructor or orchestrated by the instructor at will.
Considerable attention has been given to model the drill string dynamics using non linear motion dynamics and the end result is evident in the simulation of drill string whirling, vibration, twist, stick slip, bit bouncing and other natural behaviour.

The system can be provided with the ARI WITSML Engine, allowing session data to be loaded and exported using the WITSML standard.

Geological Profiles

Geological profiles of rock hardness, rock porosity, permeability and variation of formation pressure etc. have been used to compute drilling parameters such as the rate of penetration, lost circulation of mud, well kicks.
DOWNHOLE SIMULATION FEATURES

• Can simulate the longest drill strings as exist in the real world
• Geological data such as rock hardness, abrasiveness, porosity, permeability, formation pressure and fracture pressure
• Flexibility in choosing the drilling and kick fluid type (including the combination of liquid and gas)
• Well trajectory planning
• Pressure losses in the entire system
• Downhole problems
  - kicks
  - stuck pipe
  - torsional stick slip
  - drilling break
  - drill string/bit wash out
  - broken pipe
  - weared out bit
  - bit bouncing
• Multiphase flow of fluids including combinations of salt water, drilling mud, hydrocarbon gases, CO₂, H₂S and mud additives
• Drill cutting transportation
• Mud cake formation around the periphery of the well bore
• Lost circulation model based on Darcey’s Law
• Case Based Fishing Operations
• Casing Run

Well Control during kicks
• Kicks while drilling/tripping in or out
• Scenarios of Kicks while running casing can be simulated
• Off bottom kicks
• On bottom kicks
• Various methods for controlling well kicks

Well Kill methods
• Drillers method
• Wait and weight method
• Volumetric method can be simulated

Well Planning
• 3D well trajectory creation
• Capabilities of assigning different well bore radii at different depths
• Selection from a range of drill pipes, collars and bit

Data Logging
• Logging while drilling
• Measurement while drilling

Sensors
• Proximity Detection Sensor (Sensor simulation by ray casting)
• Load Sensors (Sensor simulation by physics feedback)
• Torque Sensors (Sensor simulation by physics feedback)
• Pressure Sensors (Sensor Simulation by Fluid Flow model)

Surge & Swab Effect
• Calculated using the steady-state model developed by Burkhardt
• String Configuration
  - Closed Pipe
  - Open Pipe

EXTENDED ARI DRILL SIM FEATURES

In keeping with the training requirements of professionals working on modern drilling rigs, ARI drilling simulator helps train professionals not just in basic operations but the Simulator may be extended to drill against customized virtual well plans that include Managed Pressure Drilling, Through Tubing Rotary Drilling and HPHT Drilling scenarios. It also inherently as the framework for recreation of incidents, accidents and near miss scenarios.