CoilCADE

Coiled tubing design and evaluation software

APPLICATIONS

- CT operations
- Vertical, deviated, or horizontal wells
- Open and cased holes

ADVANTAGES

- Better-designed CT jobs
- Accurate simulations and predictions
- Job design verification
- Twelve complementary modules
- Ability to simulate all aspects of CT operations, even workover and CT drilling

To better understand the low cycle fatigue behavior and limits of CT pipe, Schlumberger developed CoilCADE* coiled tubing design and evaluation software. CoilCADE software simulates all aspects of CT operations from start to finish, even including workover and CT drilling. Using modules created from intense research and development, CoilCADE software determines

- forces and stresses expected during operation
- force and pressure windows for safer operations
- design jobs requiring specific pulls or slackoffs at the bottom of the well
- CT reach in highly deviated wells
- optimal CT string design
- expected low-cycle fatigue during well intervention
- expected pressures while pumping liquid, nitrogen, or nitrified fluids.

Tubing Forces module

As the main CoilCADE software module, the Tubing Forces module simulates the forces acting on a CT string as it is run in and pulled out of a well. It models buoyancy, friction, string and tool weight, wellhead pressure, and various CT strings to predict operational parameters such as weight indicator readings and helical buckling and lockup points. These predictions are particularly important for extended-reach wells because CT size, wall thickness, BHA size, and wellbore geometry all determine the depth to which CT can be conveyed.

CoilLIMIT module

CoilLIMIT* coiled tubing pressure and tension limit module determines the differential pressure (burst or collapse) and the axial force (tension or compression) limits that can safely be applied to a CT section in the wellbore. Von Mises stress criteria for pressure, tension, and bending reveal the conditions under which the CT will begin to yield. This module also calculates the collapse pressure of oval CT and the maximum compressive load before corkscrewing and lockup. It defines an operational envelope that the user will follow during the live intervention.
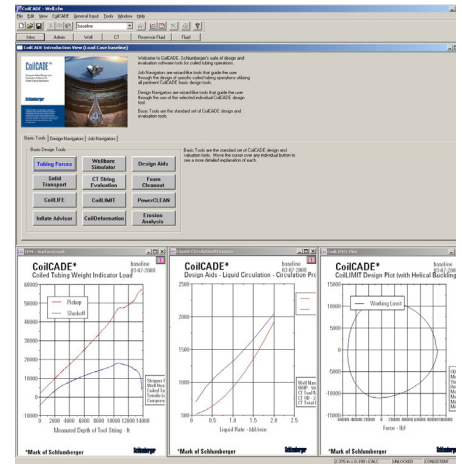
CoilCADE software introductory screen and output plots.

CoilLIFE module

CoilLIFE* coiled tubing life prediction model mathematically tracks the life of a CT string to minimize the risk of fatigue failure by forces imposed on the coil. This module was developed from an extensive laboratory and field fatigue testing program.

Wellbore Simulator module

In CT fluid circulation operations, a sequence of fluids is pumped through the tubing while it is lifted or lowered into the wellbore. At any given time, there can be three regions of flow: (1) inside CT, (2) wellbore below CT, and (3) annulus between CT and wellbore. Each region can have different cross-sectional areas along the depth, and the length of each region may change with time.

Using the equations for mass conservation and momentum, the Wellbore Simulator models the transient multiphase transport and wellbore hydraulics that occur during fluid circulation. It also models the pickup and transport of solids to determine required circulation rates and pressures. Possible formation leakoff or inflow is calculated to model the mixing and flow of all solids, liquids, and gases in the annular flow stream. Treatment feasibility during sand fill removal, nitrogen kickoff, and CT drilling interventions can be evaluated in this module, both in horizontal and deviated wells. Solids and fluids return at surface can also be quantified with this module.

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The Wellbore Simulator includes CT movement, sand pickup, sand bedding in deviated and horizontal wells, reservoir inflow and leakoff, fluid tracking, pressure drops, and the choke on the return line. Given this information, engineers can verify job design and investigate uncertain situations before actually mobilizing equipment and material.

Design Aids module

The tools in the Design Aids module complement the previously listed CoilCADE software capabilities by allowing better-designed wellbore fluid circulation treatments performed by CT. The output from this module is a series of sensitivity plots that show the effects of altering job execution parameters. These plots help when studying the effects of input parameters, such as pressures, rates, and fluids on the output parameters that are critical to operations. From these plots, appropriate treatment parameters can be determined.

This module supports circulation of liquid, foam, nitrified fluid, liquid-plus-gas lift, and nitrogen lift. It also supports calculations of solids concentration, annular velocities, wellhead pressures, and flow patterns for given inputs.

CT String Evaluation module

The CT String Evaluation module is used to optimize CT string design or to evaluate an existing CT string for a given set of operating and well completion conditions. The module is used to ensure that mechanical limits of the CT are not exceeded.

CT cleanout

Removing sand or other fill from a wellbore using CT involves fluid circulation through CT to the sandface, where the sand is picked up by the jetting actions of the nozzles. Fill is then transported to the surface through the annulus between the CT and production tubing or casing.

The Wellbore Simulator aids in modeling this process, including multifluid pumping, reservoir interaction, CT movement, and sand transport in deviated wells. Also, the Design Aids module provides more guidelines for the design of cleanout operations. For specific cleanout purposes though, CoilCADE software offers three modules:

Solids Transport module

For solids transport out of the wellbore, the Solids Transport module enables selection of the optimal fluid, minimum pump rate, and CT penetration rate. It is particularly effective in predicting the movement of solids beds in deviated well sections.

Foam Cleanout module

To achieve the desired bottomhole foam quality and surface choke pressures required to maintain wellbore conditions, the Foam Cleanout module determines rates and volumes of liquid and gas needed.

In addition to the aforementioned modules, CoilCADE software also offers

- Inflate Advisor module for design guidance for the CoilFLATE* coiled tubing through-tubing inflatable packer
- CoilDEFORMATION* coiled tubing elongation and ballooning prediction model for elongation and ballooning due to fatigue loading
- Erosion Analysis module to predict CT wall thickness changes as a function of job parameters.

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