

WELLCAT™ Software

DecisionSpace® Drilling & Completions

KEY FEATURES

Comprehensive suite of casing and tubing analysis tools that address a wide variety of challenges

Calculates precise downhole temperature and pressure profiles to improve well design

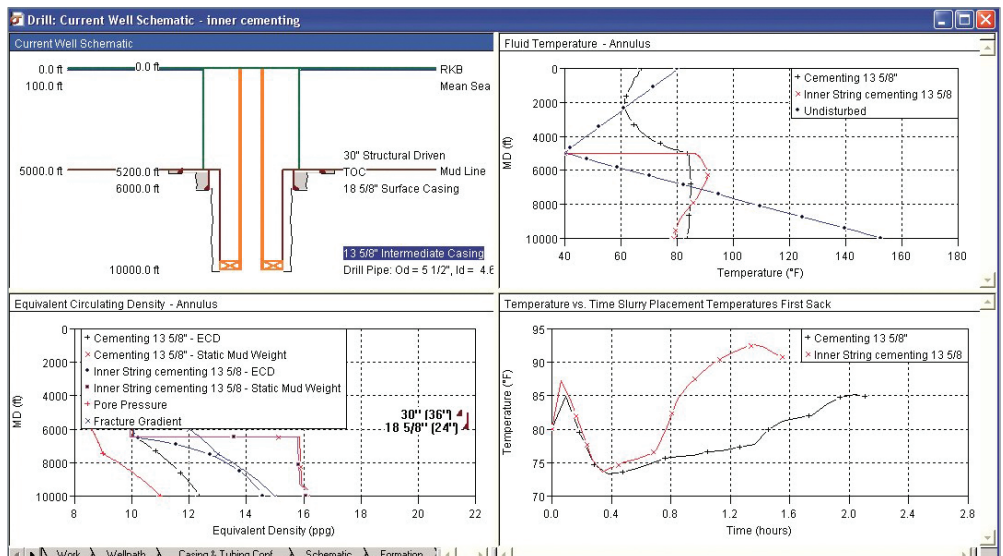
Essential for modeling complex loading conditions and trap annular pressure that can occur in High Pressure/High Temperature environments

OVERVIEW

WELLCAT™ software provides precise solutions for both wellbore analysis and integrated casing and tubing design. It calculates accurate downhole temperature and pressure profiles, which can be used for pipe-body movement and casing and tubing load analysis. WELLCAT software is an essential tool for companies operating in high-pressure, high-temperature (HP/HT) deepwater or heavy-oil drilling and production environments.

Five modules are integrated into a common environment to provide more accurate and reliable solutions to complex design problems. Thermal effects are modeled for drilling and production operations. A comprehensive analysis of loads and stresses on casing and tubing is provided, including service-life analysis. Detailed analysis of the entire casing system is provided to understand the effects of annular pressure buildup and the interaction in the casing and tubing systems within a well. Loads and their resulting wellhead movement are evaluated to determine the integrity of the well tubulars.

WELLCAT™ software is a comprehensive and modular suite of applications that work together to address a wide variety of casing and tubing challenges. It is integrated with the Engineer's Data Model™ (EDM™) software, which supports integrated operations reporting, drilling, and completions engineering, and well-planning workflows.



Display of an inner string cementing operation with well schematic and temperature results, which are compared against a normal cementing job.

BENEFITS

Comprehensive solutions

WELLCAT software provides powerful casing and tubing analysis for simple to complex well configurations, including tension leg platforms, in a single application.

Understanding of wellhead movement

Determines and redistributes loads in the casing system for critical well design.

Reduces casing and tubing costs

Efficient and accurate designs based on user-defined load conditions can help lower casing and tubing costs.

Helps design safely

WELLCAT software helps engineers design safer, higher-quality designs for complex HP/HT wells. Understanding thermal expansion of annular fluids can help engineers design casing that can manage thermally induced wellhead movement, eliminate buckling, and reduce casing collapse of inner strings or casing bursts of outer strings during production operations.

FEATURES

Drilling Design

The Drill Design module simulates flow and heat transfer during drilling operations, providing full transient analysis. The software offers linked analyses with the Casing Design module.

The Drill Design module is useful for:

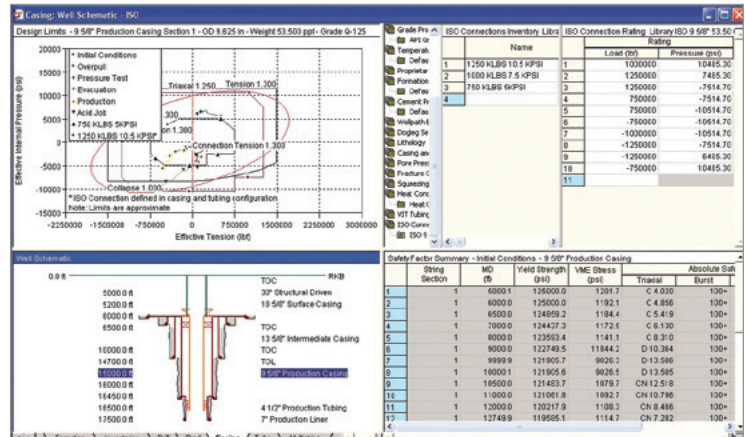
- Cementing operations temperature modeling, including complex cement job schedule, spot cement plug in cased and open-hole, and inner string cementing.
- HP/HT hydraulics
- Downhole tool temperatures
- Subsea wellhead and BOP temperatures
- Hydrate inhibition program schedule
- Casing service loads during drilling
- Undisturbed temperature profile from log and drilling data
- Multi-string initial and final conditions, annular pressure buildup, and WHM (wellhead movement) load history

Casing Design

The Casing Design module analyzes casing loads, design integrity, and buckling behavior under complex mechanical, fluid pressure, and thermal-loading conditions with standard and automatic load-case generation. Analyses may be performed in conjunction with the Drill Design and Production Design modules (including tubingless configurations).

The Casing Design module is useful for:

- Comprehensive casing design and analysis
- Installation and service loads
- Multi-string load transfer (initial conditions)
- Buckling stability and post-buckling analysis with and without centralizers.
- Displaying the ISO (International Standards Organization) ellipse with user-defined connection performance curves (ISO 13679). ISO service load safety factors and temperature deration of connection performance curves.
- Support new collapse load, issued by Bureau of Safety and Environmental Enforcement (BSEE), Well Containment Screening Tool (WCST).



New collapse load (Bureau of Safety and Environmental Enforcement (BSEE), Well Containment Screening Tool (WCST).

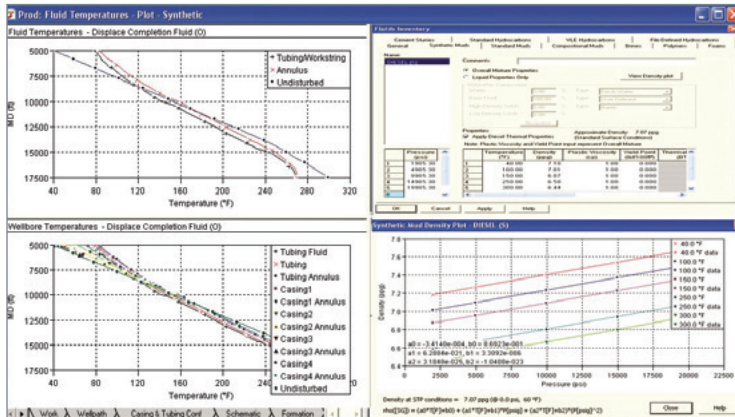
Production Design

The Production Design module simulates fluid and heat transfer during completion, production, stimulation, testing, and well-servicing operations. The software allows transient and steady-state analysis for single-phase and multiphase flow in addition to providing initial conditions linkage with thermal results from the Drill Design module. It also offers linked analyses with the Tube Design and Casing Design modules.

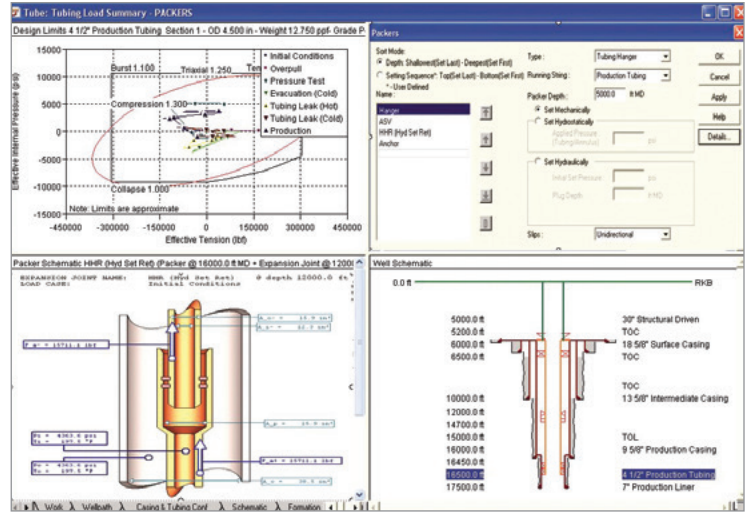
The module includes VLE (vapor-liquid equilibrium) phase diagrams with definition of temperature- and pressure-critical points.

The Production Design module is useful for:

- Analysis of temperatures and pressures for flowing and shut-in well streams
- Analysis of temperatures and pressures during forward and reverse circulation
- Gas-lift operations
- Tubingless well discharge thermal flow scenario modeling
- Multi-string final conditions annular pressure buildup and WHM load history
- Thermo-setting resin and gel treatments
- Insulation requirements and permafrost thaw assessment
- Fracture and acid-stimulation jobs
- Modeling steam injection (saturated or superheated)
- Modeling a diversity of fluid-type inventory including:
 - » Standard (water/oil-based) and compositional muds
 - » Standard (black oil), VLE and file-defined hydrocarbons properties linked to third party fluid characterization tool
 - » Brines, polymers, and foams
 - » General and synthetic muds (PVT fluid definition)
 - » Cement slurries
- Mechanistic models for improved pressure-drop calculations:
 - » Zhang model (deviated wells, upward/downward flow)
 - » Kaya model (deviated wells)
 - » Ansari model (near-vertical wells less than 15 degrees)



Display Wellbore temperatures and Synthetic Fluid input dialog, with Pressure Temperature Density plot overlapping the Fluid Temperature results.



Expansion joint schematics and Packer Dialog with capabilities for multiple packer setting sequence overlapping other Tube Schematics.

Tube Design

The Tube Design module analyzes tubing loads and movements, buckling behavior, and design integrity under complex mechanical, fluid-pressure, and thermal-loading conditions with standard and automatic load-case generation. Offers linked analyses with the Production Design module.

The Tube Design module is useful for:

- Comprehensive tubing design and analysis
- Installation and service loads
- Mechanically, hydrostatically, and hydraulically setting mechanisms
- Packer setting sequence
- Tubing movement
- Tubing-to-packer and packer-to-casing forces
- Multiple string and multiple packer completions
- CRA (Corrosion and Erosion Resistant Alloy) tubulars with yield anisotropy
- Displays the ISO ellipse along with a user-defined connection performance curve (ISO 13679) and ISO service load safety factors
- Packer operating envelope load check
- Packer and expansion joint schematics make it easy to visually review and check forces associated with different packers and expansion joints

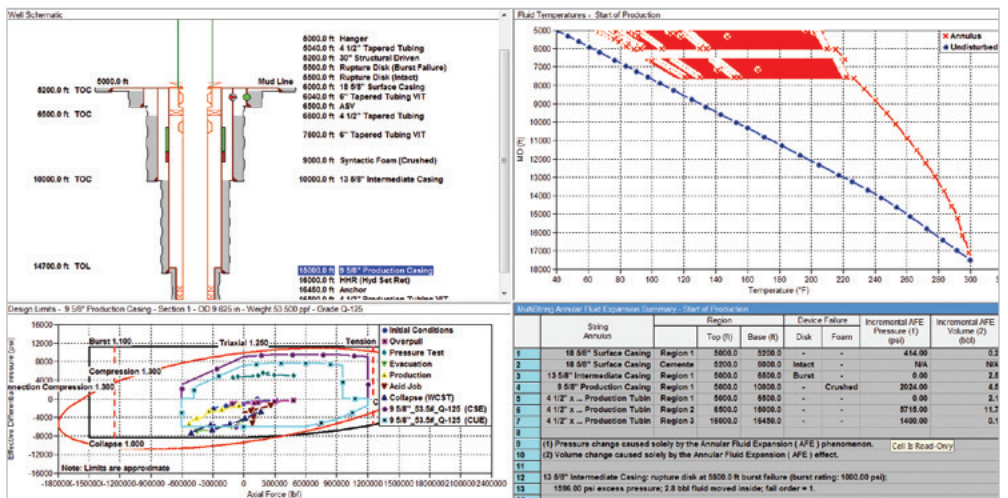
Multi-string Design

The Multi-string Design module predicts pressure and volume changes due to annular pressure buildup (APB) when the well system heats up as a result of drilling or production operations or the injection of hot fluids into the well.

The Multi-string Design module determines the movement that occurs to the well-head during the life of the well. Movement is calculated due to strings being run and cemented, static loads being added or removed from the well (nipple-up BOP, hang-off drillstring during a drive-off situation), and pressure or thermally induced loads applied to each individual string in the well. Analyses are linked to Drill Design, Production Design, Tube Design, and Casing Design modules.

The Multi-string Design module is useful for:

- Trapped annuli in subsea operations for determination of tubular burst and collapse loads due to APB. Evaluate APB mitigation option by applying nitrogen and other noble gases and U-Tube effects.
- Structural integrity of uncemented (unsupported) conductor/structural casing in platform operations due to wellhead movement and load redistribution
- Wellhead movement analysis also includes; Point of Fixity, Lock-Ring Rating, Wellhead Load Compensator, Lift-Off Analysis, and Progressive Failure Analysis features
- Combined modeling of tubingless well discharge flow trapped annuli and wellhead movement of uncemented production casing scenarios
- Comprehensive well-soil interaction modeling for multi-string well-stress analysis. This model predicts wellhead movement and determines the integrity of the foundation.



VIT modeling is integrated with multiple WELLCAT software capabilities, including temperature and flow simulation, stress, and Multi-string Analysis.

Deepwater license

The additional deep water license capabilities include temperature flow modeling using VIT (vacuum-insulated tubing) thermal flow and tubing analysis of production operations with Electrical Submersible Pump (ESP); Rupture Disk, Syntactic Foam trap annular pressure mitigation techniques, and wellhead-movement progressive-failure analysis.

VIT modeling

The VIT enhancements add critical technology to the WELLCAT modules aimed specifically at solving VIT applications for deepwater and heavy-oil design problems. The heavy-oil capabilities are designed for high-temperature steam-injection scenarios.

The VIT option is used to model thermal flow and stress analysis of vacuum-insulated tubing within the WELLCAT application. VIT is used to mitigate the risks of APB, cold startups, and heavy-oil production when using the latest VIT systems.

Annular pressure buildup

In deep water, high temperature and high annular pressure can cause casing strings to burst or collapse. Operators use VIT to mitigate these risks. VIT temperature-flow modeling using the deepwater license feature in combination with the WELLCAT Multi-string Design module helps model these possible scenarios.

Cold startups

In some subsea completions, a cold startup (initial flow) can be hampered or made impossible because of temperature losses and hydrating near the seabed mudline. VIT minimizes this problem by maintaining wellbore temperatures to prevent hydrate formation. The modeling of these temperature and pressure conditions for VIT can now be analyzed using the deepwater license feature.

Heavy-oil production

In heavy-oil production scenarios, VIT helps maintain lower viscosity levels in steam flooding, "huff and puff," and steam-assisted gravity drainage (SAGD) projects, reducing the need for artificial lift techniques and increasing total ultimate recovery (reservoir draw down).

Using the deepwater license feature in combination with the WELLCAT steam-injection modeling license feature, it is possible to model temperature and pressure for vacuum-insulated tubing in heavy-oil production scenarios.

Electrical Submersible Pump (ESP)

Extreme to ultra-deep HPHT reservoirs present the challenges of having low natural flow ability, the use of sub-sea system such as (ESP) would help to increase production rates and increase well recovery. WELLCAT software includes production thermal flow simulation and tubing analysis of production operations with ESP.

Rupture disk

Among the current trap annular pressure mitigation techniques to prevent annular pressure build up, engineered rupture disk are designed to vent annular pressure in excess to protect outer or inner strings. WELLCAT multi-string module allows users to specify the location of rupture disk in the well mechanical configuration, verify survival initial conditions and solve annuli pressure and volume change due to disk failure.

Syntactic foam

WELLCAT multi-string module supports trap annular pressure analysis including the presence of syntactic foam. This trap annular pressure mitigation technique is designed to crush at a specified pressure and temperature creating additional volume for fluid expansion.

Wellhead-movement progressive-failure analysis

Wellhead-movement progressive-failure analysis enables a user to obtain axial loads and contact forces of the entire system once the hanger rating is exceeded. The WELLCAT software will distribute the loads through the system once the hanger ratings are exceeded, and only stop reporting once the rating equals the loading condition.

The VIT and Progressive-Failure Analysis features are licensed separately to be used in conjunction with the Production Design, Tube Design, and Multi-string Design modules.

Steam license

The WellCAT Steam-modeling option is used to model multiple steam circulation-injection scenarios in single tube circulation, including circulation and reverse circulation, injection through tubing, injection down the tubing annulus, and simultaneous injection through both tubing and annulus.

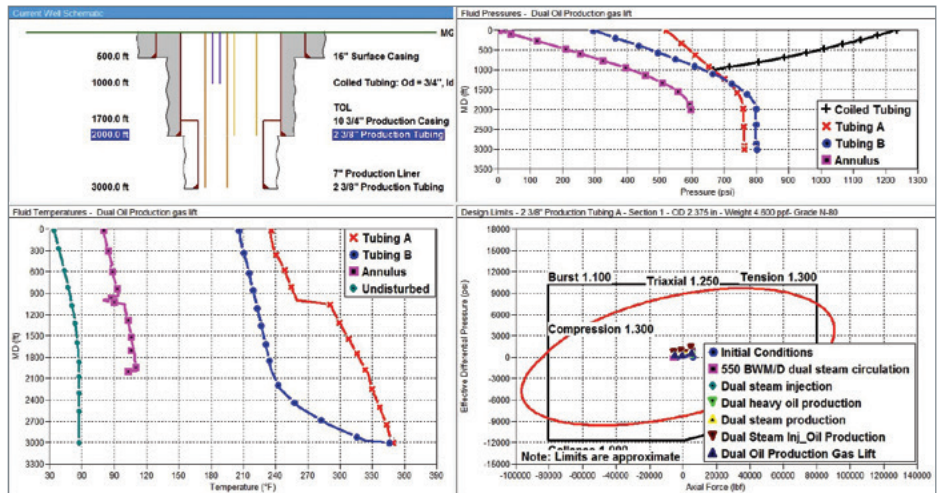
Dual-tube completion modules:

- Tube-to-tube
- Tube-to-annulus steam circulations
- Reverse circulation
- Dual-steam injection
- Dual-steam production
- Dual-oil production with coiled tubing
- Dual long-string injection / short-string production

The modeling handles super-heated steam or saturated steam with a given quality. The technology uses the rigorous PVT model for steam and water developed by the National Institute of Standards and Technology (NIST).

Transient or steady-state calculations output steam quality versus depth, and fluid temperature and pressure versus depth analysis. In addition, the calculations output steam quality versus time at a specified depth to help determine the steam breakthrough at the perforations.

Temperatures calculated for the wellbore or wellbore components can be used within WELLCAT for stress analysis, annular pressure buildup analysis, and wellhead-movement calculations.



Steam thermal-flow modeling and stress analysis of single and dual completions.

System and Software

SOFTWARE REQUIREMENTS

*Engineers Data Model (EDM)
Oracle® ODBC Driver*

OPERATING SYSTEMS

*Microsoft® Windows® 7 Enterprise
64-bit with SP1
Microsoft Windows Vista Enterprise
64-bit with SP2
Windows 2008 Server 64-bit R2 with SP1
Citrix XenApp 6.0
Oracle 11.2.0.2
Oracle 10.2.0.4
SQL Server 2008 R2 SP1*

Detailed results presentation

Presentation of calculation results on-screen allows user-configurable, multi-pane spreadsheet and plot formats with user-defined and preconfigured display tabs. Presentation of print results is in both standard and user-configurable formats. Template features for setting standard default configurations are included.

Multiple unit systems

English, metric, and custom unit systems are provided along with a comprehensive online help system.

Easily transfer or export data

Links to DEX™ software, Landmark's data exchange software, permits easy transfer of relevant data to other DEX-compliant applications. Also, send data from any WELLCAT spreadsheet to Microsoft® EXCEL (input and output results). Import pore-pressure or fracture-gradient data from an ASCII file or EXCEL spreadsheet.

WELLCAT Packaging

- Tubulars Drilling Package—Includes WELLCAT Drill Design and Casing Design modules
- Tubulars Production Package—Includes WELLCAT Tube Design and Production Design modules
- Tubulars Advanced Package—Includes WELLCAT Tube Design, Production Design, Drill Design, Casing Design, and Multistring Design modules
- Steam Package—Includes WELLCAT Steam features. These technologies are licensed to be used in conjunction with the Casing Design, Production Design, Tube Design, and Multi-string Design modules
- Deepwater Package—Includes WELLCAT VIT, Electrical Submersible Pump (ESP), annular fluid expansion mitigation techniques rupture disk, syntactic foam, and Wellhead-Movement Progressive-Failure Analysis features. These technologies are licensed for use in conjunction with the Drill Design, Casing Design, Production Design, Tube Design, and Multi-string Design modules.

Precise modeling of fluid flow and heat transfer during drilling and completions and the buildup of trapped annular pressure is essential in the proper design of well tubulars or catastrophic consequences can occur. This is particularly serious in complex high pressure/high temperature (HP/HT) conditions.

Landmark offers solutions to help you deliver on your business strategies. For questions or to contact your Landmark representative, visit us at landmarksoftware.com.

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