Schlumberger

PowerSTIM

Well optimization service

find the approach that works >>

The oil and gas industry is constantly evolving; we are always looking for a better way to get the job done. The best tools and methods are the ones that fit your business needs. That is why we develop solutions with you—not just for you. Your local knowledge is combined with our multidisciplinary industry expertise and the most advanced technologies in the business. Together, our combined team develops workflows that fit wherever you need them, anywhere in the world, resulting in decisions that work for your bottom line.

>> together we can

PowerSTIM

Well optimization service

Turning reservoir specifics into stimulation solutions

Need for stimulation optimization

Stimulation is a major expense in many well completions. Each year more than 20,000 wells worldwide are hydraulically fractured. At a cost exceeding $2 billion—an average of $100,000 per well—the results often barely justify the expense.

It is estimated that two-thirds of these wells do not respond as expected and fail to meet objectives, and that fewer than 1% of fracturing treatments are optimized to maximize production and recovery. Instead, the tendency is to rely on acid or proppant fracturing treatments that have always been performed the same way in a particular area—the one-size-fits-all approach—or to base treatments on estimates of average reservoir properties, which may result in hydraulic fractures of insufficient length and width with excessive vertical height.

Service optimizes treatments

The PowerSTIM* well optimization service takes a fit-for-purpose solution-oriented approach that has proved effective in a broad range of reservoir types. Stimulation treatment design and execution are customized to the specific conditions in the well or field, based on detailed, accurate formation evaluation and modeling by a multidisciplinary team of client and Schlumberger experts. Based on the PowerSTIM team's analysis, treatment options such as acid treatments, fracture treatments, or sand management will be considered. The knowledge gained from each stimulation treatment is used to improve the next, in a continuous, closed-loop process that reduces costs, maximizes production and increases recovery.

Applications

- Optimizing profitability in both high-productivity conventional reservoirs and low-permeability heterogeneous, layered reservoirs
- Improving performance of marginal fields
- Overcoming completion problems or failures
- Reengineering completions to maintain or exceed past production at economically justifiable costs

Benefits

- Increased production
- Improved profitability
- Greater return on stimulation investment
- Reduced completion and production costs
- Shorter learning curve over fewer wells
- Greater understanding of well performance
- Access to Schlumberger experts worldwide
- Knowledge gained for improving future wells

Features

- Proprietary workflow process
- Multidisciplinary team
- Real-time monitoring and communication
- Integration of best-in-class Schlumberger services
- Value creation through collaboration
- Continually updated informed decision report (IDR)
- Basin-specific reservoir and completion models
- Advanced software programs for stimulation optimization

The PowerSTIM process >>

The first step in the PowerSTIM process is forming the team, which normally is made up of geoscientists, reservoir and production engineers, and stimulation designers. Initially, the team concentrates on a small group of wells—typically three to five, depending on field and reservoir complexity.

After collecting and analyzing all available data, the team uses the information to build a customized model that describes geology and reservoir dynamics. This model, which accurately predicts key parameters and forecasts production, is used to design optimized treatments for the first group of wells.

PowerSTIM elements

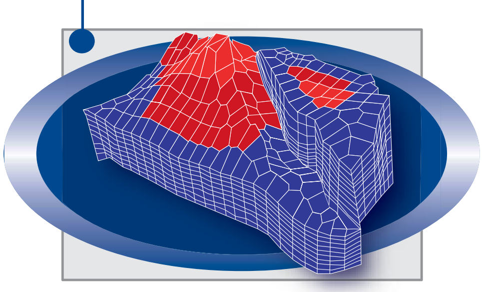
Field data review

Geologic considerations

- Review depositional environment
- Review structure and stratigraphy
- Review geological model
- Develop local interpretation models

Reservoir considerations

- Review offset well data
- Understand reservoir performance
- Improve reservoir profiles (e.g., stress, permeability)
- Develop Mechanical Earth Model (MEM)



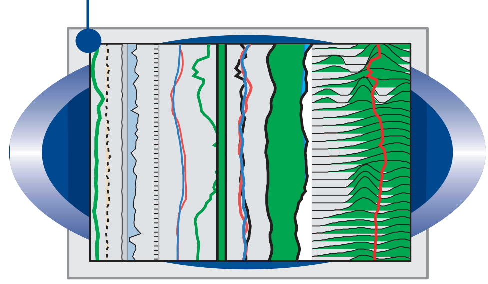
Well analysis

Geologic considerations

- Review log and core data
- Understand effects of depositional, structural and stratigraphic models

Reservoir considerations

- Apply improved reservoir profiles (e.g., stress, permeability, oil, gas, water)
- Provide improved 3D data set for stimulation design
- Finalize prefracture reservoir characterization
- Design and analyze pressure buildup test
- Analyze production data (pressure and rate)
- Material balance
- Make performance forecasts



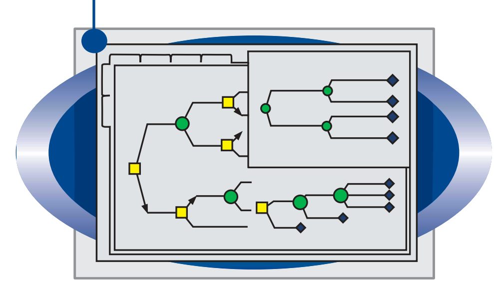
Treatment selection and completion design

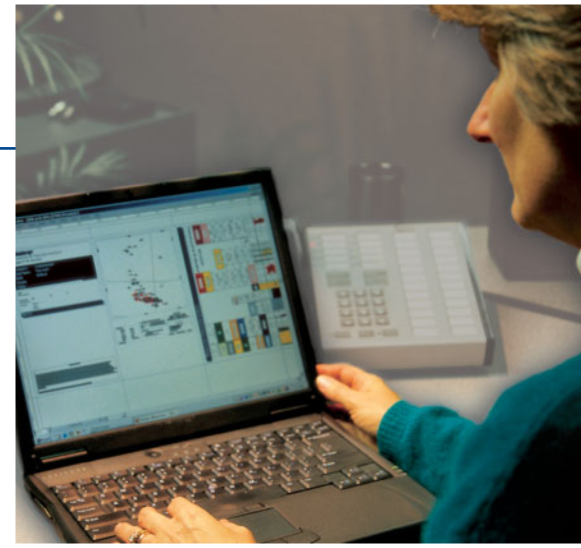
Select treatment

- Perforation optimization
- Matrix acid
- Acid or proppant fracture
- Sand or water management
- Well architecture

Completion design

- Recommend perforation interval
- Design DataFRAC* services
- Optimize casing and tubulars
- Revise performance forecast
- Design production or artificial lift systems
- Evaluate technology options





After these treatments are executed according to design, the PowerSTIM team evaluates the results and uses them to update the model, which is then used to optimize the next group of completions. The updated model often is available to decision-makers within a few hours after the evaluation is finished.

Performance driven >>

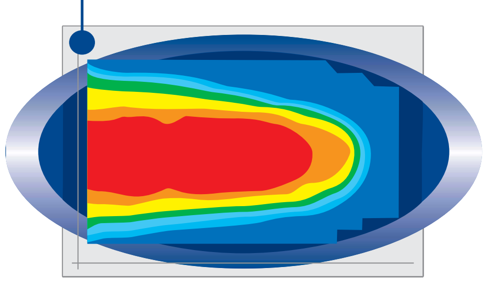
Stimulation design and execution

Treatment design

- Run appropriate laboratory tests
- Use improved reservoir profiles
- Use CADE software suite
- Calculate net present values (NPVs) of design options
- Optimize stimulation
- Use interpretation models and expertise

On-site execution

- Perform quality assurance and quality control
- Ensure design criteria are met
- Supervise implementation of pumping schedule
- Analyze diagnostic tests
- Monitor job in real-time



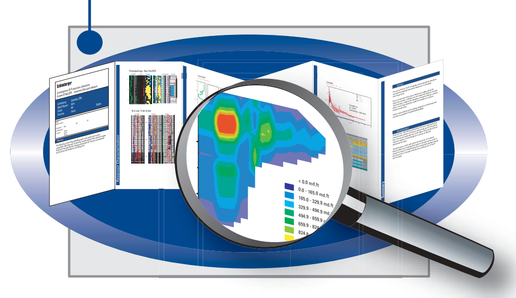
Analysis and optimization

Treatment analysis

- Analyze post-treatment data
- Perform post-treatment production data analysis
- Design and analyze post-treatment pressure transient test
- Update reservoir and completion model

Optimization

- Incorporate results into next completion design
- Improve reservoir and completion model accuracy
- Reduce cycle time and well costs
- Optimize production



Innovations facilitate process >>

Schlumberger innovations are major contributors to the timeliness, efficiency and success of the PowerSTIM process. One of these innovations is the PowerSTIM "in-time" report, or IDR, which documents the PowerSTIM solution and provides a complete, historical record for each well treated. Another is the InterACT* real-time monitoring and data delivery, which facilitates collaboration and allows real-time monitoring of treatments.

InterACT system

The InterACT system promotes teamwork by providing Web-based data delivery with secure real-time, two-way communication at all stages of the project—from initiation to post-job analysis. Files of all standard data types and formats can be exchanged and shared, and stimulation operations can be monitored and supervised in real time from remote locations, resulting in better well treatments. Integration of the InterACT system with the FracCAT* fracturing computer-aided treatment system provides a powerful platform for the PowerSTIM process.

Updated report

The comprehensive IDR is built dynamically on a personal computer desktop. As the project proceeds, the PowerSTIM team continually updates the report, which begins with the initial reservoir characterization and progresses through completion design and execution to postjob evaluation, recommendations and summary.

At any stage in the project, the report can be viewed via the InterACT system or printed as a hard-copy snapshot, similar to a well log, for quick access to well information. Whether viewed on paper or on screen, the report facilitates collaboration. It is a tangible representation of the value inherent in the PowerSTIM process and is usually delivered cumulatively in three stages:

- well and reservoir characterization
- design
- execution, evaluation and summary.

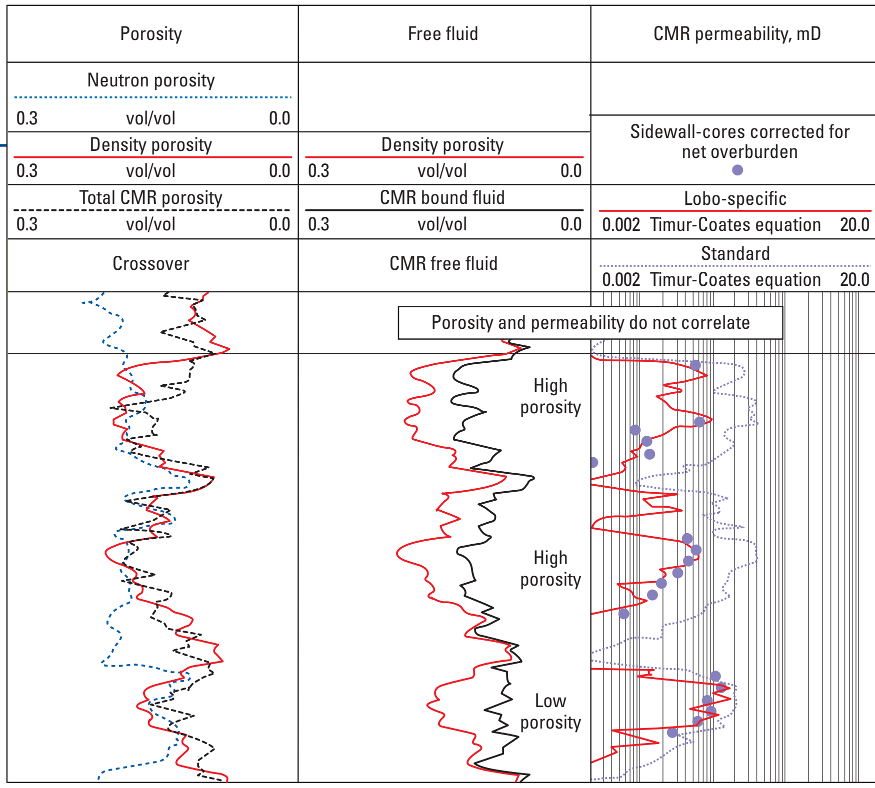
Comprehensive data set

PowerSTIM optimization is based on a comprehensive data set and complete reservoir characterization—not standard correlations, averages, estimates or assumptions about reservoir performance parameters. The data set, which includes rock mechanical properties, hydrocarbon-resource profiles and sand-prediction models, is used for well-performance forecasting, reservoir simulation and well-completion design.

At any stage in the project, the report can be viewed via the InterACT system…

Basin-specific models

The PowerSTIM team builds basin-specific petrophysical and completion models to predict and optimize the effects of stimulation treatments. These models provide key parameters such as net pay, producible fluids, permeability, porosity, fluid saturation, magnitude and direction of tectonic stresses, and other rock mechanical properties.



Accurate and reliable permeability log profiles are key to production optimization. A Timur-Coates equation modified specifically for the Lobo formation provides a better core-log correlation in this example. It provides an improved permeability profile for stimulation design in the Lobo formation.

Initially, the models are developed from local knowledge, data from previous completions in offset wells and existing reservoir models. The models are updated with new information as it becomes available, and additional data required to ensure model accuracy are acquired by logging, testing or sidewall coring of the candidate wells.

Geological model for planning

Petrophysical and mechanical properties are usually merged in a geological model, which is used to plan initial strategies for the completion design. ELANPlus* software for elemental log analysis is used to develop this model, and some parameters may be calibrated against existing core data or sidewall cores. Analyses from offset wells also are used in finalizing the geological characterization.

Formation evaluation technology

The PowerSTIM team uses a wide range of technology to collect data needed to quantify reservoir parameters and improve models. Porosity and permeability measurements from a CMR-Plus* Combinable Magnetic Resonance logging tool with high-logging-speed capability, along with mechanical properties from DSI* Dipole Shear Sonic Imager logs, are used to improve stimulation candidate selection.

Permeability derived from CMR-Plus measurements also can be used to determine leakoff and design fracture stimulations, and DSI compressional and shear data are used to derive Young's modulus and Poisson's ratio. The CHFR* Cased Hole Formation Resistivity tool can identify fluid saturations in cased wells, and FMI* Fullbore Formation MicroImager microresistivity images help identify fault planes and preferred fracture plane orientation.

Completion and treatment design

The PowerSTIM team designs a customized completion based on all available well data. This design is focused on maximizing production for the lowest cost and includes recommendations on perforation interval, tubular optimization and stimulation treatment. Integration of all available basin, field, reservoir and well data for better evaluation of formation characteristics facilitates optimization of fracturing fluids, proppants and volumes.

Stimulation design technology

The stimulation design is optimized using advanced software programs. Petrophysical data are distributed into reservoir layers for fracture modeling with a zone-by-zone layering program or FracCADE* fracturing design and evaluation software. FracCADE software also predicts fracture geometry, using formation parameters such as shear modulus, Young's modulus, Poisson's ratio, permeability, overburden stress and pressure.

Visualization software provides a "picture" of fracture geometry, orientation and barriers. In-situ tests, including minifracture treatments using the DataFRAC fracture data determination service, provide correlations to complement and verify empirically derived values.

The PowerSTIM team designs a customized completion based on all available well data.

The Production Data Fracture Interpretation Tool determines fracture half-length and conductivity and the effective permeability of stimulated formations. Production is correctly allocated to each completed interval using production log data, and NODAL* production system analysis evaluates well productivity, taking the completion design into account.

The OrientXact perforating system is an important component of the perforation optimization part of the PowerSTIM process.*

Perforation strategy

The PowerSTIM team devises a perforation strategy that helps achieve the desired fracture properties. This strategy may include using high-performance UltraJet* deep penetrating shaped charges to increase formation penetration and orienting the perforations to encourage hydraulic fractures to follow the direction of natural stresses. Orienting the perforating guns with the Wireline Oriented Perforating Tool allows fracture design to be focused on fracture placement instead of proppant transport. Oriented perforations minimize the risk that near-wellbore complexities or tortuosity will cause premature screenout.

Stimulation execution and evaluation

PowerSTIM treatments are executed with an emphasis on diagnosis, quality assurance and quality control, and reducing cycle time. Following the treatments, production logs, temperature logs, tracer logs and other data are acquired and analyzed.

Actual production is compared with the forecast made prior to treatment. If there is a gap, all available mechanical and petrophysical data are used to refine the fracture designs and update models to improve results from the next treatment.

Closing the loop

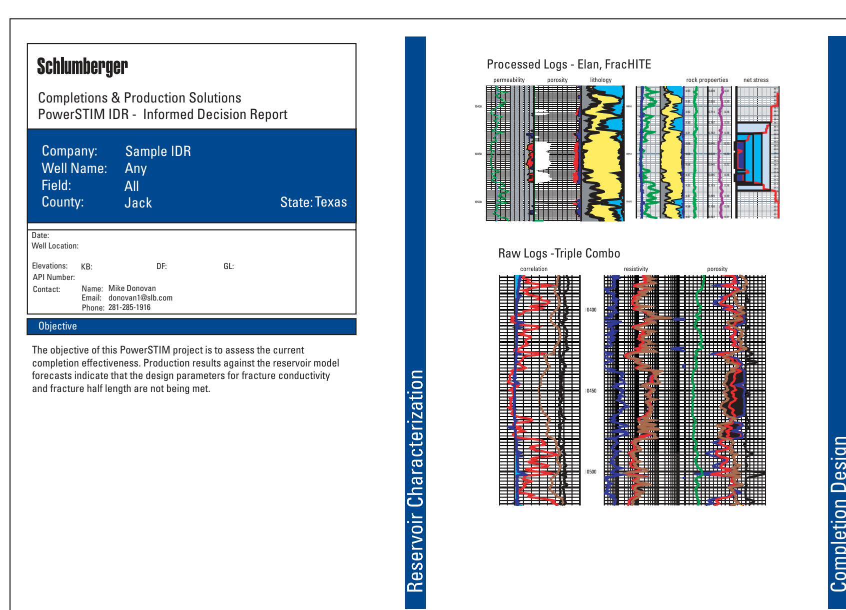
The last step of the PowerSTIM process is closing the optimization loop by presenting a complete job summary, which is documented in the IDR. This summary includes recommendations and a go-forward plan for future wells.

Collaboration creates value

In the PowerSTIM process, client reservoir knowledge and field experience and Schlumberger technology and expertise work together to create value. This close collaboration reduces engineering cycle time by expediting the learning process and results in selection and application of the best stimulation technologies and completion solutions.

Reservoir snapshot >>

The PowerSTIM IDR is a presentation of logs and graphics that depicts a total picture of the process of gathering and interpreting the data, generating an appropriate solution, implementing the solution and evaluating the results. The optimization loop is closed by presenting a complete job summary including recommendations and a go-forward plan for future wells.



Schlumberger

Completions & Production Solutions
PowerSTIM IDR - Informed Decision Report

Company: Sample IDR
Well Name: Any
Field: All
County: Jack State: Texas

Date:
Well Location:
Elevations: KB: DF: GL:
API Number:
Contact: Name: Mike Donovan
Email: donovan1@slb.com
Phone: 281-285-1916

Objective

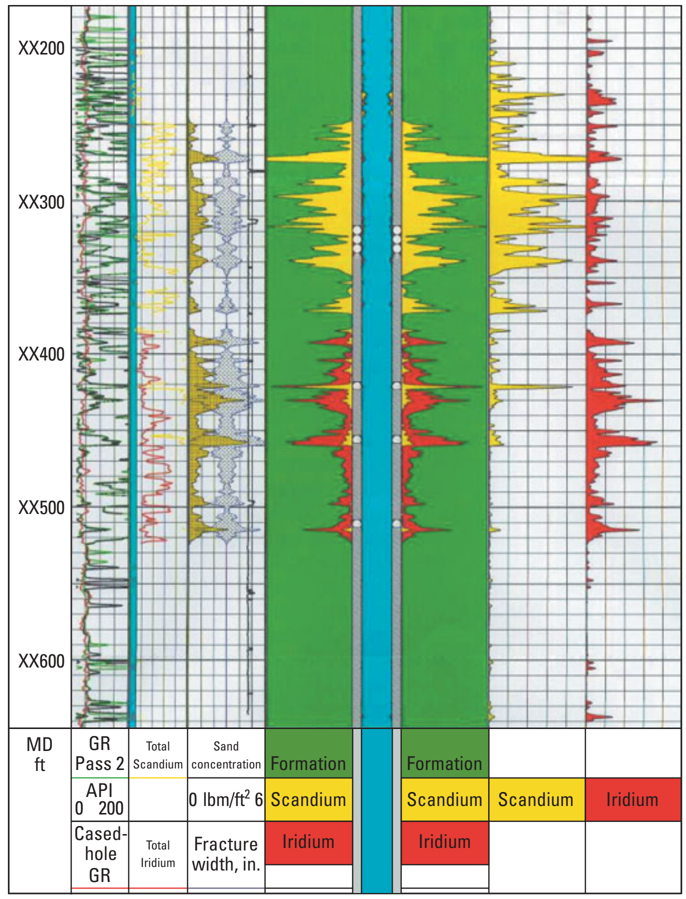
The objective of this PowerSTIM project is to assess the current completion effectiveness. Production results against the reservoir model forecasts indicate that the design parameters for fracture conductivity and fracture half length are not being met.

Transforming data to decisions

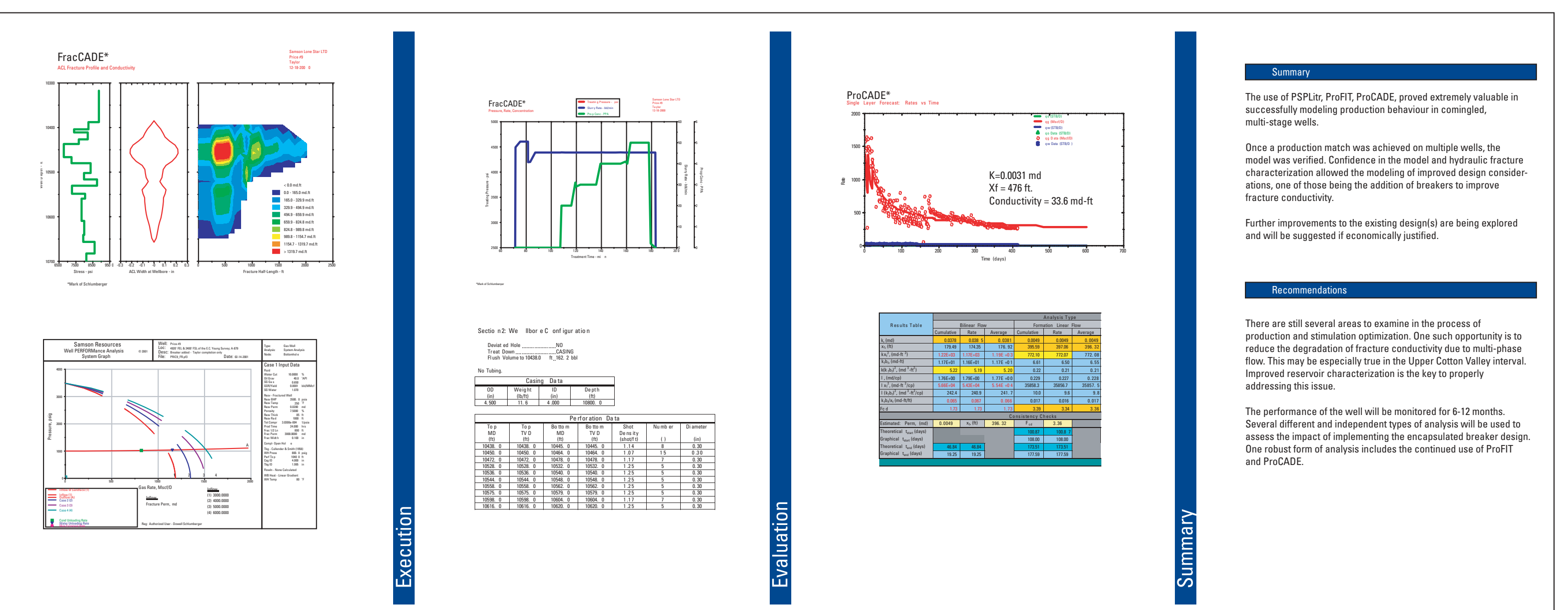
The PowerSTIM service helps improve well-by-well financial performance by capturing and taking advantage of all the downhole information already being collected.

…client reservoir knowledge and field experience and Schlumberger technology and expertise work together to create value.

Instant Web-based access to cross-disciplinary expertise and worldwide data exchange gives decision-makers the timely information they need to balance improved well performance against treatment cost.



PowerSTIM teams often have to evaluate multiple zone scenarios to determine which strategy results in maximum production for the lowest cost. This radioactive survey indicates successful placement of two separate fractures less than 100 ft apart.



Transform data to decisions >>

IDR

The hard copy of the IDR is made up of 8½-in. by 14-in. pages that fold out. Well location and relevant background data are shown on the cover. Inside, a section of mud log or openhole log, core analysis and other test data identify pertinent zones. A wellbore configuration shows the completion design and perforation record.

The execution section documents the stimulation design and implementation and often includes prefracture diagnostics plots and the three-parameter plot of the treatment. Additional sections present stimulation designs, productivity analyses, production forecasts and logs, and actual production data.

Reservoir profiles

Nuclear magnetic resonance (NMR) technology is used in the CMR-Plus tool, which excites hydrogen nuclei in formations by setting up a magnetic moment, relaxing it and measuring the time it takes atoms to realign. This NMR relaxation time is dependent on pore size and porosity, which is related to permeability.

Stress profiles

The DSI sonic tool excites formations with acoustic waves and measures the resulting compressional and shear transit times. Transit times are converted into rock properties such as shear modulus, Young's modulus and Poisson's ratio.

Shear modulus is an elastic material constant that is the ratio of shear stress to shear strain. Young's modulus is an elastic material constant that is the ratio of longitudinal stress to longitudinal strain. Poisson's ratio is an elastic constant that is the ratio of latitudinal to longitudinal strain, or a measure of material compressibility perpendicular to applied stress, that can be expressed in terms of measured properties, including compressional- and shear-wave velocities.

FracCADE and StimCADE software

FracCADE and StimCADE* software allows evaluation of different strategies to better understand how they will impact fracture geometry. Issues such as connectivity to the perforations, height growth, fracture length, bridging and conductivity are considered in this evaluation.

Schlumberger visualization software allows the PowerSTIM team to "see" the impact of fracture geometry and its relation to reservoir size and orientation. This visualization is useful in building a strategy to optimize the completion and overall production.

FracCADE LG Zones module

A unique zone-by-zone layering routine identifies and evaluates individual zones in a layered formation. This analysis tool is a critical link between formation evaluation data and the FracCADE program.

ProFIT* software

Production-data analysis using the Production Data Fracture Interpretation Tool program determines fracture half-length and conductivity and the effective permeability of stimulated formations without shutting wells in for analysis. Schlumberger is the only company that provides this evaluation service.

Production allocation program

Production log data are used as input to correctly allocate production to each completed interval in commingled, multilayer reservoirs. This allocation program allows determination of maximum permeability, minimum fracture length and conductivity for each zone.

NODAL analysis

NODAL analysis is used to evaluate well productivity, taking perforations, tubulars and surface facilities into consideration. Each pressure interface is treated as a node with several variables.

To learn more about stimulation solutions and PowerSTIM well optimization services, visit www.slb.com/oilfield and select Stimulation or e-mail powerstim@slb.com.

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