

Schlumberger



PressureXpress-HT

Fast, accurate pressure and mobility measurements
in high-temperature environments



Successful completion design, production optimization, and field management depend on reliable measurements of reservoir pressure. Pressure data versus depth provides critical information on connectivity, differential depletion, pressure gradients for fluid densities, gas/oil/water contacts, and near-wellbore fluid mobilities and also aids sample point selection.



APPLICATIONS

- Accurate, fast pressure and mobility measurements from high-temperature and low-permeability environments on the first logging run
- Heat-management-optimized design for performing extended surveys at an industry-leading holding time of 14 h at 450 degF [232 degC]
- Pressure profiles and mobility measurements to combine with petrophysical, seismic, and conventional log data for developing a static reservoir model
- Identification of depleted zones in a wider mobility range
- Measurement of reservoir fluid density with gradients and gas/oil/water contacts

BENEFITS

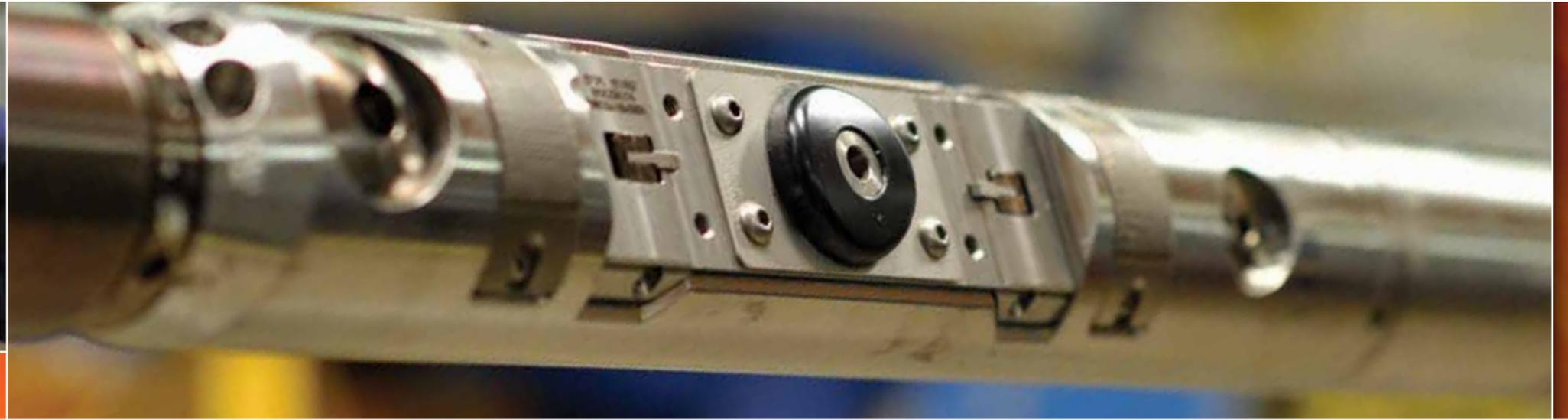
- Extends the measurement range to 450 degF [232 degC] and 20,000 psi in real time
- Acquires pressure measurements and fluid mobilities in a fraction of the time required by multifunction formation testers
- Increases survey efficiency by eliminating the wait time for gauge stabilization and by minimizing set and retract times
- Saves time and cost with the elimination of additional wireline runs solely for acquiring pressure measurement data
- Reduces risk of sticking

New PressureXpress-HT* service extends the efficiency and accuracy of PressureXpress* reservoir pressure while logging service to high-temperature environments. Because the PressureXpress and PressureXpress-HT tools are **specifically engineered for pressure and mobility testing**, as compared with conventional multifunction formation tester tools that also collect fluid samples, they significantly reduce the time and risk involved with multifunction testing operations. Highly accurate reservoir pressure and mobility measurements are typically made in **less than a minute**, a fraction of the time needed by multifunction formation testers. The tools are also **compatible with most openhole services** to deliver pressure measurements on the first logging run.

Innovative tool architecture enables the superior thermal stability of the quartz gauge and extended holding time. By combining these capabilities with the precision of electromechanical pretest control, the new PressureXpress-HT tool provides accurate gradients and overall data quality not achievable by either conventional standard or high-temperature formation tester tools. The tool design also eliminates the need for gauge temperature stabilization, thus significantly improving overall operational efficiency.

Specifically engineered for HT environments, the PressureXpress-HT tool precisely controls pretest volume and rate to efficiently and accurately measure reservoir pressure and mobility, even in low-permeability formations.

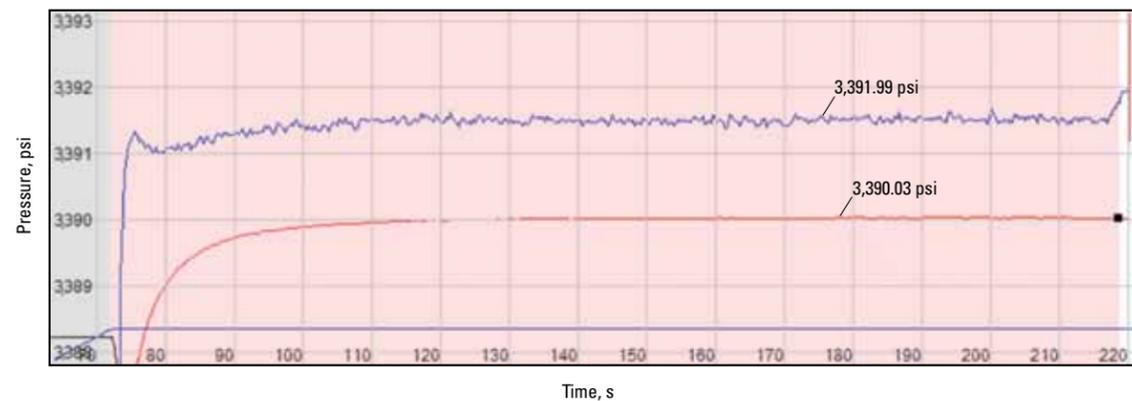
The streamlined profile of the flaked PressureXpress-HT tool minimizes the risk of sticking.



Effective design for accurate measurements at high temperatures

Two flasks, at the top and bottom of the PressureXpress-HT tool, protect the electronic components from high temperatures. The HPHT Quartzdyne[®] gauge is located in one of the flaked sections of the tool, isolating it from changes in borehole temperature. The flaked gauge does not require thermal stabilization, so it does not exhibit erratic pressure build-down behavior that leads to uncertainty in the final buildup pressure and pretests are completed in less time. To measure true formation fluid and borehole temperatures, a flowline temperature sensor is positioned outside of the flask. A temperature sensor in the toolhead provides an additional borehole temperature measurement.

These simple, effective design changes deliver exceptional tool performance in challenging conditions. Extended single-trip survey programs are possible with the industry's longest holding time: 14 h at 450 degF. The elimination of gauge thermal stabilization time further boosts the operating efficiency over that of conventional multifunction tools.



The performance of the HPHT Quartzdyne gauge (red) in the PressureXpress-HT tool shows no build-down behavior compared with an unflaked conventional gauge (blue).

Versatile enhanced pretest system for exceptional measurement accuracy

The dynamically controlled pressure-pretest system incorporated in the PressureXpress-HT tool enables precise, real-time control of volume and drawdown rates in a wide mobility range. A pressure limit can be set as necessary. The enhanced pretest system makes pressure testing possible in formations where conventional hydraulic technology cannot function because it allows ultrasmall pretest volumes and minimal flowline storage volume. The pressure differential for drawdown is up to 8,000 psi. A dedicated wellbore pressure gauge can be used to develop procedures and algorithms to overcome the supercharging effect that commonly occurs in many low-permeability applications.

Multiple pretests can be performed at a given depth to verify the accuracy of a pressure measurement without having to cycle the tool, or they can be performed at multiple depths to produce a profile of pressure versus depth. A reservoir pressure gradient can be established if the zone of interest is sufficiently thick, mud supercharging effects are not present, and the flow from the formation is confirmed by diagnostic plots. The resulting profile can be converted directly to the density of the formation's continuous fluid phase for use in defining fluid contacts. In extremely low-mobility formations, optional large-area packers effectively increase the probe's exposure to the formation.

Detailed pretest summaries in real time

PressureXpress-HT pressure profiles can be interpreted using proprietary software incorporating a variety of pretest analysis techniques. The PressureXpress Advisor[®] pretest quality indicator uses real-time data from the logging string that the PressureXpress-HT tool is run on

to determine which zones are good candidates for successful reservoir pressure and fluid mobility measurements. For pressure and gradient analysis, InSitu Pro[®] real-time quality control and interpretation can be performed. A concise PressureXpress-HT wellsite report is generated, along with an optional display of other log data.

Reduced possibility of sticking

Even with flaking, the slim-diameter, streamlined PressureXpress-HT profile greatly reduces the risk of tool sticking. The short probe section has an eccentric 4¹/₁₆-in diameter, and the remainder of the tool body has a diameter of only 3⁷/₈ in. The eccentric tool shape, combined with a slightly overbalanced setting force from the backup anchoring pistons, ensures an integral 1/2-in standoff from the formation during pretesting. The smooth tool profile also minimizes mudcake scraping when the PressureXpress-HT tool is run. There are no external tool angles over 20°.

Data integration for greater insight

PressureXpress-HT service provides accurate pressure profiles and mobility measurements for integration with petrophysical, seismic, and conventional log data. The combined data ensures a more comprehensive reservoir model for detailed reservoir simulation to optimize the value of the hydrocarbon asset. This integration of data can also improve the design of multilevel or stage fracturing operations in low-mobility formations and help identify zones to avoid during fracture stimulation, including depleted zones and thief zones. A thorough understanding of fluid movement within the reservoir helps in characterizing vertical and horizontal flow barriers, estimating permeability along the wellbore, delineating reservoir lenses, and monitoring flood performance.

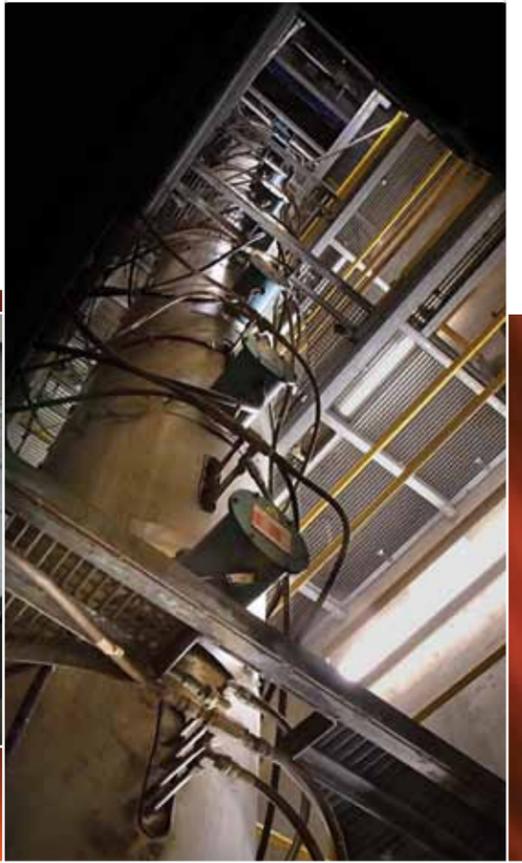
Using a heat-management-optimized design, the PressureXpress-HT tool can perform extended surveys for an industry-leading holding time of 14 h at 450 degF [232 degC].



Each PressureXpress-HT tool is subjected to pressure-temperature cycling in test wells at the manufacturing center before deployment for field operations.



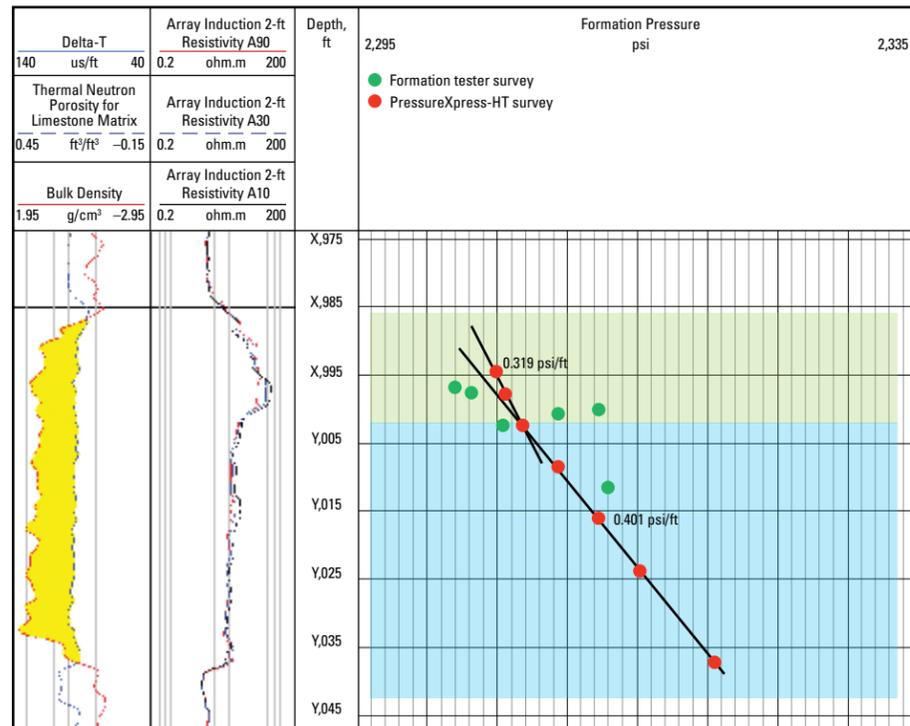
Shock and vibration testing of PressureXpress-HT tools is conducted using specially designed equipment.



Case study: Gulf of Thailand

The Gulf of Thailand is known for its high temperature gradient. One major operator's wells usually have bottomhole temperatures in excess of 320 degF [160 degC]. A slim conventional formation tester tool was being used to obtain crucial reservoir pressure measurements, with the selection of perforation intervals based on fluid type and mobility measurements. However, because conventional multifunction tools employ hydraulic control for pretesting, the resulting pressure data is usually not accurate enough for determining the pressure gradient, especially in low-permeability formations.

The precise control of pretest volume and rate provided by the enhanced pretest system of the PressureXpress-HT tool enabled performing pretests at multiple depths to produce a profile of pressure versus depth and accurately establish the reservoir pressure gradient.



The accuracy of PressureXpress-HT measurements that results from precise control over both the pretest volume and drawdown rate makes it possible to determine a valid pressure gradient and establish the fluid contact. The measurements from a conventional tool (green) are influenced by transient temperature effects. By using a flasked design to eliminate the need for gauge thermal stabilization, the PressureXpress-HT tool does not experience build-down effects.

Qualification process

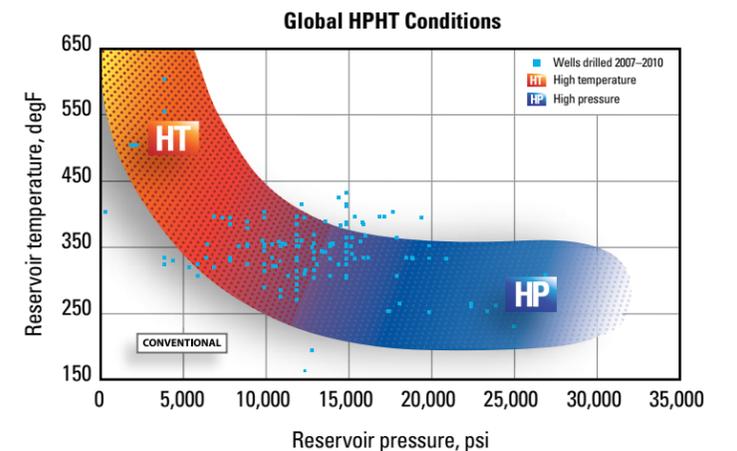
The extended qualification process for the PressureXpress-HT tool includes numerous tests conducted at a system level for the entire tool, as well as testing of individual components and subassemblies. The mission profile of the PressureXpress-HT design is reliable tool operation under the full operational and environmental load, including high-temperature operations at up to 450 degF [232 degC]. The qualification process simulates the harshest situations equipment may experience during field operations, including transportation.

The design qualification process of the PressureXpress-HT tool is performed in-house at the Schlumberger manufacturing center in compliance with the "Generic Mission Profile for Wireline Downhole Equipment" and includes

- shock
- pressure-temperature cycling of sonde and electronics: more than 600 h of testing at various operating conditions, including 450 degF [232 degC] and 20,000 psi
- thermal cycling: -15 to 400 degF [-26 to 204 degC] for sondes, -15 to 350 degF [-26 to 175 degC] for electronics cartridges
- thermal aging
- cold storage: -15 degF [-26 degC]
- low- and high-temperature operations: -15 to 450 degF [-26 to 232 degC]
- high-temperature life for 400 h: sonde at 400 degF [204 degC], electronics at 350 degF [175 degC]
- shock transmissibility.

The result of these exhaustive design qualification tests is high overall reliability and operating confidence at the maximum tool ratings.

The PressureXpress-HT design qualification process concludes with extended reliability testing, during which the tools are subjected to a lengthy operational test under cycles of temperature, power, functional load, and shock. An extensive database compiled from the reliability tests is used to predict system or component failure and define preventative maintenance events for the tool. Each PressureXpress-HT tool manufactured is similarly subjected to extremely rigorous temperature, pressure, shock, and vibration testing as part of the design criteria and again before each tool is sent to a field operating base.



Measurement Specifications

| | |
|--------------------------------|--|
| Output | Formation pressure, fluid mobility (permeability/viscosity), fluid density |
| Logging speed | Stationary Set and retract time: 15 s |
| Range of measurement | Max. measured overbalance: 8,000 psi [55 MPa] |
| Resolution | Quartzdyne gauge: 0.01 psi/s [69 Pa/s] Secondary Sapphire* gauge: 0.4 psi [276 Pa] at 1 Hz Flowline temperature: 0.18 degF [0.1 degC] |
| Accuracy | Quartzdyne gauge: $\pm 0.02\%$ of full scale + 0.01% of reading Secondary Sapphire gauge: ± 5 psi [34 kPa] + 0.01% of reading Flowline temperature: ± 3.6 degF [± 2 degC] |
| Depth of investigation | Probe extension beyond packer surface: 0.45 in [1.14 cm] |
| Mud type or weight limitations | None |
| Combinability | Combinable with SlimXtreme* platform and most openhole tools |

Mechanical Specifications

| | |
|---------------------------------|---|
| Temperature rating [†] | 450 degF [232 degC] for 14 h |
| Pressure rating | 20,000 psi [138 Mpa] |
| Borehole size—min. | 4¾ in [12.07 cm] |
| Borehole size—max. | 15.40 in [39.12 cm] |
| Outside diameter | Tool: 3.75 in [9.53 cm] Tool with bumpers or probe section without bumpers: 4.0625 in [10.32 cm] |
| Length | 30.2 ft [9.2 m] |
| Weight | 730 lbm [310 kg] |
| Tension | 50,000 lbf [222,410 N] |
| Compression | 22,000 lbf [97,860 N] |

[†] For operations > 400 degF [204 degC], contact your Schlumberger representative for information on required operating procedures.

