

InSitu Density

Reservoir fluid density and viscosity sensor

APPLICATIONS

- Determination of fluid gradients
- Identification and quantification of compositional grading
- Thin bed analysis
- Compartmentalization studies
- Equation-of-state (EOS) fluid modeling
- Contamination monitoring for representative downhole fluid analysis (DFA) and sampling

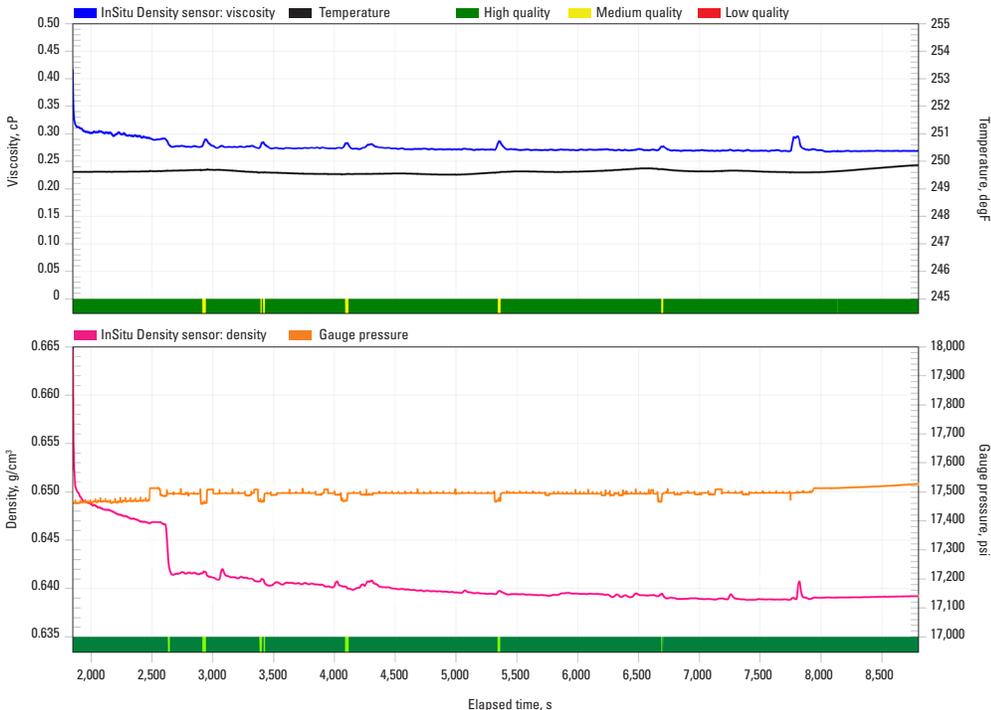
The density of reservoir fluid is a fundamental physical property that governs the distribution of fluids in the reservoir, including fluid contacts, capillary transition zone characteristics, and fluids in place. The viscosity of reservoir fluid is also important because it directly governs reservoir deliverability, injection, sweep efficiency and enhanced oil recovery (EOR) performance, and the ultimate recovery. Both density and viscosity commonly vary with depth and laterally within a field, which can significantly affect the commercial viability of the field.

Accurate real-time density and viscosity measurements at reservoir conditions

The InSitu Density* reservoir fluid density and viscosity sensor directly measures density and viscosity at reservoir conditions in real time without requiring pressure and temperature calibration. The miniaturized sensor fits the sensor slots of the InSitu Fluid Analyzer* real-time DFA system and Quicksilver Probe* focused fluid extraction to provide density measurements in a range of 0.5 to 1.2 g/cm³ and viscosity measurements in a range of 0.2 to 50 cP. These density and viscosity measurements are integral to the detailed fluid analysis conducted at reservoir conditions by the InSitu Fluid Analyzer system in real time, instead of waiting for discrete sample analysis from a laboratory.

Dual-resonance sensor rod

The InSitu Density sensor’s dual-resonance modes enable the direct measurement of density and viscosity at a 1-s frequency. The resonance frequency is related to the flowing fluid’s density, and the resonance damping is related to the viscosity. The characterization parameters incorporated in the sensor’s integrated electronics enable assessing the measurement quality in real time to ensure that the sensor’s response spectrum is with specification.



The dual-measurement modes of the InSitu Density sensor directly measure both density and viscosity.

InSitu Density

The sensor measures viscosity in miscible systems (oil sampling in oil-base mud). In higher-viscosity fluids or reservoir fluids with up to 10% water, the InSitu Viscosity* reservoir fluid viscosity sensor is used with the InSitu Fluid Analyzer system, with the required density input for the viscosity measurement provided by the InSitu Density sensor.

The InSitu Density sensor is qualified for corrosive environments, and both the InSitu Density and InSitu Viscosity sensors are high-pressure and high-temperature qualified. Employing both viscosity sensors in the InSitu Fluid Analyzer system not only provides redundancy and confidence in the measurements, but also mitigates possible downhole challenges such as the development of multiphase flow.

The outputs of both sensors are readily available in real time in Schlumberger InSitu Pro* real-time quality control and interpretation software. InSitu Pro software communicates with the Petrel* E&P software platform to enable direct use of the interpreted results in reservoir modeling to improve decision making.

Specifications

	InSitu Density Reservoir Fluid Density and Viscosity Sensor	InSitu Viscosity Reservoir Fluid Viscosity Sensor
Output	Live-oil density and viscosity	Viscosity of oil with up to 10% water
Physics of measurement	Dual-mode resonator	Vibrating wire
Measurement rate	1/s	1/s
Measurement range	Density: 0.05 to 1.2 g/cm ³ Viscosity: 0.2 to 50 cP	Viscosity: 0.2 to 300 cP Temperature: -67 to 375 degF [-55 to 190 degC]
Accuracy	Density: ±0.012 g/cm ³ Viscosity: ±12%	Viscosity: ±10% Temperature: ±1.3 degF [±0.7 degC]
Resolution	Density: 0.001 g/cm ³ Viscosity: 0.01 cP	–
Temperature rating	For InSitu Fluid Analyzer system: 350 degF [177 degC] High-temperature version for Quicksilver Probe extraction: 375 degF [190 degC] [†]	350 degF [177 degC]
Pressure rating	25,000 psi [172 MPa]	25,000 psi [172 MPa]
Mud type or weight limitations	Density: None Viscosity: Preferentially in oil-base mud for measuring miscible formation fluid	Measurement in oil- and water-base mud at up to 10% contamination
Special applications	NACE MR0175 compliant	

[†] Qualified for 8 h above 350 degF.

slb.com/insitu

Schlumberger