Understanding heavy oil fluid properties is fundamental for deciding the best extraction, production, and processing methods for an asset. Studies may include heat or solvent addition to reduce oil viscosity or examining emulsions and emulsion breakers.

Schlumberger offers standard and specialized services for investigating the thermodynamic and physical properties of live and stock-tank heavy oils.

Successful analysis and characterization of heavy oil require the collection of representative reservoir fluid. Schlumberger provides a collection of homogeneous, single-phase heavy oil samples in both openhole and cased hole environments. The Oilphase-DBR* single-phase multisample chamber (SPMC) can collect multiple samples in one wireline run in open hole. The SCAR* inline independent reservoir fluid sampling system can be run on tubing to collect multiple samples in cased hole during well testing. Clients can choose to sample at various depths to study the fluid gradient. All systems use pressure-compensating technology to assure sample integrity and no loss of gas.

Once samples are received and reconditioned to ensure the reservoir fluid is monophasic and homogeneous at reservoir conditions, live heavy oils are tested to verify sample quality. Sample quality testing may include free-water check; water content; compositional analysis including saturates, aromatics, resins, and asphaltenes (SARA); and simulated distillation.
Heavy Oil Testing

Schlumberger has designed a state-of-the-art, mercury-free, heavy oil PVT cell. The fully visual cell is equipped with a high-power mixer to ensure fluid equilibrium and improved data quality.

PVT studies include
- constant composition expansion (CCE) for bubblepoint pressure, compressibility, and density measurements
- differential liberation for two-phase fluid behavior and properties
- separation tests
- compositional analysis
- viscosity measurements.

The capillary viscometer is used to measure viscosity of both live and stock-tank oils as a function of temperature and pressure. It is capable of generating reproducible experimental results for either cleaned samples or samples containing small amounts of emulsified water or entrained solids. For samples heavier than 200,000 cp, a high-pressure rheometer is used that can measure viscosities up to 1,000,000 cp.

Transportation studies may also include screening for asphaltene precipitation during the blending of heavy oil with light hydrocarbon fluids. Screening tests are performed with the Schlumberger solids detection system (SDS), which works in conjunction with the high-pressure microscope (HPM).

Schlumberger also provides a suite of specialized heavy oil services, such as
- single-phase heavy oil sampling in openhole and cased hole wells (see SPMC and SCAR product sheets)
- solvent studies—miscibility, swelling, and PVT analysis
- vapor-liquid equilibria of live oil with solvent and/or water at high temperatures
- solids detection of asphaltenes with HPM and SDS
- live-oil and dead-oil rheology (see high-pressure, high-temperature rheometer technical sheet for more information)
- porous media flow studies using sandpacks or etched-plate micromodels
- live oil emulsion generation and demulsifier chemical testing
- live foamy oil studies and defoamer chemical testing
- apparent viscosities and kinetics of gas bubble formation in foamy oils
- hydrate formation conditions.

The high-pressure, high-temperature (HPHT) capillary viscometer can be used to study apparent viscosity versus emulsions with various water cuts.

<table>
<thead>
<tr>
<th>Equipment Specifications</th>
<th>Heavy Oil PVT Cell</th>
<th>Capillary Viscometer</th>
<th>High-Pressure Rheometer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. pressure rating, psi [MPa]</td>
<td>15,000 [103]</td>
<td>10,000 [69]</td>
<td>5,900 [41]</td>
</tr>
<tr>
<td>Max. viscosity rating, cp</td>
<td>1,000†</td>
<td>200,000</td>
<td>1,000,000</td>
</tr>
</tbody>
</table>

† At test temperature