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Complex HPHT Fluid Phase Behavior and EOR Applications Resolved Using Versatile PVT System

University of Pittsburgh researchers successfully study phase behavior and viscosity to support valuable publications for hydrocarbon exploration and production

CHALLENGE

Improve university researchers' efficiency in performing a wide variety of routine and complex phase behavior measurements to obtain accurate PVT data for a large range of fluid types.

SOLUTION

Use adaptable, all-in-one Schlumberger PVT system with full cell visibility to reliably obtain HPHT phase behavior data without having to switch among multiple conventional PVT systems.

RESULTS

Successfully completed numerous studies using the versatile single PVT system, including observation of up to four fluid phases and determination of multiphase equilibrium conditions.

Increasing the efficiency of phase behavior research and PVT laboratory operations while saving capital expenditure

The renowned phase behavior research group at the University of Pittsburgh required an accurate and reliable PVT system for performing innovative studies of high-pressure, high-temperature (HPHT) fluid phase behavior and viscometry related to petroleum engineering, chemical engineering, and polymer synthesis and processing. Many phase behavior and PVT laboratories employ multiple PVT systems because of the systems' specific measurement ranges to acquire routine phase behavior studies on various fluid types, such as black oil, volatile oil, heavy oil, and gas condensate. Additional specialized PVT systems are usually necessary to perform complex studies, such as vapor-liquid equilibrium (VLE), vapor-liquid-liquid equilibrium (VLLE), and vapor-liquid-liquid-liquid equilibrium (VLLLE); the solubility of polymers, thickeners, and surfactants in liquid or supercritical CO_2, ethane, propane, or butane; and the solubility of high-pressure, high-temperature gases such as CO_2, H_2, H_2O, and N_2 in liquid solvents.

The modular design of the single PVT system streamlines employing various configurations for conducting a wide variety of fluid phase behavior investigations.

"I would highly recommend this resilient, robust, easy-to-operate, and easy-to-understand PVT system to anyone interested in long-term, creative studies of high-pressure phase behavior and viscometry related to petroleum, chemical engineering, and polymer synthesis or processing."

Dr. Bob Enick
Professor and Vice Chair for Research
Chemical and Petroleum Engineering
University of Pittsburgh

Instead of the expense of acquiring multiple systems, which would also entail an expanded maintenance program, the University of Pittsburgh research group wanted a single PVT system with a variable-volume, invertible, agitable, fully visual (axially) PVT cell in combination with positive displacement pumps and a temperature-controlled air bath for long-term HP projects.

Introducing a single system for all phase behavior and PVT studies

Schlumberger recommended installing its versatile single PVT system. This highly robust single PVT system is the most versatile system available and can be used to study many conditions, including

- multiple-phase behavior—bubblepoint, dewpoint, critical point, three-phase pressure, and density
- multiple fluid phases—water, oil, and CO_2-rich liquid and vapor related to enhanced oil recovery (EOR) applications
- solubility—of gas for precombustion carbon capture (e.g., CO_2 and H_2 solubility in hydrophobic solvents such as silicone oils); of CO_2, ethane, propane, and butane in oils for miscible and immiscible gas injection EOR applications; and of polymers, thickeners, dispersants, and surfactants in high-pressure gases such as CO_2 and propane
- polymer foaming upon immersion in CO_2 followed by depressurization
- formation and collapse of CO_2-in-brine foams, CO_2-in-oil emulsions, and CH_4-in-oil foams for EOR and waterless fracturing
- oil-water emulsions and water-in-CO_2 microemulsions
- dispersion of carbon nanotubes in liquid CO_2.

Efficiently conducting multiple studies on a versatile single PVT system

The phase behavior research group is using the single PVT system for a wide variety of studies. The modular configuration made it easy to modify the system to serve as a novel falling object viscometer with video recording system. The full visibility and invertibility of the PVT cell enables the researchers to verify the steady fall of objects through high-pressure fluids that are thickened by small molecules or polymers. By independently implementing this innovative modification, the University of Pittsburgh research group can accurately measure terminal velocity and viscosity.

The accurate data obtained for complex fluids with the single PVT system are the basis for numerous publications to the scientific literature by the research group. This information is greatly contributing to the E&P industry's understanding of fluid phase behavior and its applicability to EOR operations.

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