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Representative Reservoir Fluid Sampling: Challenges, Issues, and Solutions

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Abstract

Acquiring sufficient volumes of representative reservoir fluid samples is the first and foremost critical step in obtaining reliable PVT data and the resulting fluid characterization for efficient reservoir management. The fluid sampling challenges include appropriate selection of a sampling method, designing and customizing the sampling operation to the specifics of the reservoir rock and fluids, and implementing rigorous QA/QC procedures for a successful sampling program. Avoiding two-phase flow in the reservoir, minimizing fluid contamination from the drilling mud and the additives, maintaining sample integrity, and assessing the sample quality on-site are some of the serious issues that need careful attention during the sampling operation. Appropriate measures and techniques to resolve these issues will be discussed in detail with examples ranging from extra heavy oils through lean gas-condensates.

Introduction

Characterization of and understanding reservoir fluid properties are essential throughout the life of a field for effective reservoir evaluation and management. Studies can range from simple tests for the type of fluid in the reservoir to full compositional and PVT analyses including conventional depletion tests such as differential liberation or constant volume depletion studies, fluid viscosity measurements, and multi-stage separator tests to obtain gas-oil ratios or condensate gas ratios as well as EOR studies such as multi-contact experiments or swelling tests. Successfully obtaining accurate results from all of these tests hinges on obtaining representative reservoir fluid samples. The objective of reservoir fluid sampling is to collect a sample that represents the fluid in the reservoir at the time of sampling. Incentives for collecting representative fluid samples include:

- proper sizing of wells and design of surface facilities[1,2],
- ensuring compatibility of materials in contact with the fluids such as corrosion resistant materials for acid gases,
- accurate calculation of in-place volumes and recoverable reserves[3],
- appropriate input to software ranging from pipe flow modeling to complex reservoir simulation,
- developing accurate equation of state models,
- planning reservoir or depletion strategies.

Ensuring that the sample is representative of the reservoir fluids at actual reservoir conditions may be a difficult goal to achieve. Fluid properties can be position, structure, or time-dependent, requiring collection of multiple samples at different locations at different times in the reservoir[4]. Whether or not a sample is representative is also affected by how the sample is collected, transferred, and transported from the reservoir to the laboratory for analysis. Figure 1 illustrates some of the potential complications involved in the sampling process. Every step of the process involved in taking a sample could change the pressure, temperature, or composition of the small volume of reservoir fluid that is obtained. The changes result from a myriad of factors including:

- tool and hardware used in sample capture
- method by which the sample gets from the reservoir into the sample chamber
- location where the sample is taken
- experience and knowledge of the sample taker
- heat transfer or loss to the environment