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Best Practices for Formation Testing in Low Permeability Reservoirs

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Abstract

The data provided by wireline formation testers (WFT) is critical to the evaluation and understanding of petroleum reservoirs. Pretest pressures, gradients and mobilities are generally regarded as essential inputs to the reservoir evaluation model. However, acquiring this data in low permeability reservoirs can prove challenging. There is no stable flowing pressure during the pretest, build-up times can be long and the confidence level of the final pressure is often uncertain. These issues are painted on the ever-present backdrop of supercharging that can limit the data's utility or, in some cases, invalidate the results.

New generation formation testing tools that extend the range of pretest rates and volumes have greatly improved the quality of WFT data acquired in low permeability reservoirs. Job design and planning has always been important for the proper acquisition of formation test data. Several new options, made available through the enhanced capabilities of the new generation of tools, makes packer/probe and parameter selection even more critical. Additionally, the challenges of the low permeability environment require specific attention to real time quality control and evaluation of the test data as it is acquired.

In this paper we discuss best practices for formation testing in low permeability reservoirs with examples from the US Land area and an offshore carbonate formation in West Africa. We show the pitfalls that can arise with incorrect test design as well as the improvements brought by the latest tools when correctly configured.

While there is usually confidence in the mobility data from high permeability reservoirs the numbers generated from low permeability reservoirs is often suspect: pretest volumes are typically very low and there is no stable flowing pressure. In the examples the WFT probe results are compared and validated with subsequent mobility measurements made with inflatable dual packers.

Introduction

All probe type formation testing tools utilize the same principles to measure sand face pressure:

1. The tool, with a probe and packer assembly connected to a pressure measurement gauge via a flowline, is positioned at the depth to be tested.
2. The tool is "set":
 - a. The probe/packer assembly is pushed up against one side of the borehole while hydraulic pistons provide anchoring on the opposite side.
 - b. The rubber packer makes a seal against the borehole wall isolating the center probe area from the mud column therefore allowing hydraulic communication between the flowline and the formation without influence from the mud's hydrostatic pressure.
 - c. All internal valves in the tool are closed creating a fixed flowline volume sealed at near hydrostatic pressure.
3. A pretest is performed:
 - a. A piston is pulled back to expand the flowline volume, thus reducing the pressure in the flowline.
 - b. Once pressure drops below sand face pressure fluid from the formation will flow into the flowline
 - c. Once the pretest piston stops expanding the flowline the pressure will build-up to sandface pressure
4. Multiple pretests may be performed on the same set and when complete the tool is retracted exposing the gauges back to hydrostatic pressure.