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Cased-Hole Cleaning: Do Annular Velocity, Annular Coverage and Contact Time Equal Mud Removal?

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Abstract

Mud-to-brine displacement efficiency can be difficult to quantify. Metrics to determine the success or failure of the displacement operation have traditionally been based upon the clarity of the completion brine that follows the spacers, the interface volumes of mud and completion brine, a visual determination of the cleanliness of the drillpipe pulled from the hole, and the time and materials required to filter the fluid. Despite their widespread use, however, these factors may not adequately characterize the quality of displacements in critical wells. Opportunities for improvement are largely affected by how well the displacement process can be understood. This can be difficult with the few direct and indirect parameters used to evaluate mud-to-brine displacement quality.

The authors initiated a study of samples captured during displacement circulations to examine the effects of spacer properties, volumes, pump rate, and chemical concentration on mud removal. The laboratory analyses inspected return samples of mud, spacers, and displacing fluids from 27 cased-hole wellbore displacements of oil-based and synthetic-based drilling mud in the Gulf of Mexico.

Results from this study suggest that criteria such as annular coverage, contact time, and annular velocity of the wash spacer(s), which have become the basis for most displacement programs, although critical to overall efficiency, are not the primary agents of mud removal during a wellbore cleanup.

Data correlations between the volume of mud observed in the samples analyzed and certain spacer characteristics suggest that cased-hole cleaning, when defined as mud removal, is a function of the size of a viscous spacer relative to hole size. This observation should simplify the displacement design process.

Introduction

The mud-to-completion brine displacement is an important operational component for most completions. A poor displacement can cause production impairment, problems with a gravel pack, loss of mud or brine, and loss of rig time, among other complications. However, unless these problems are encountered and identified, it is often difficult to determine the relative quality of a specific displacement. This is critical for avoiding problems on subsequent wells and for optimizing displacement operations.

The most common quality indicators include:

- the clarity of the brine measured in either Nephelometric Turbidity Units (NTU) or total suspended solids (TSS) immediately following the spacer circulation
- the number of filtration cycles (or quantity of filter media) required to achieve a target NTU level
- the total volume of mud/brine interface created during the displacement
- the presence or lack of drilling fluid on the drillpipe when it is pulled from the hole either on the short trip or after the displacement is completed

While these factors, either individually or collectively, are of significant value as overall indicators of efficiency, they lack the resolution necessary to adequately characterize the process, discriminate among different design techniques and to affect continuous improvement.

The current study combines laboratory analysis with field data to examine displacement technique. The purpose of the undertaking was to answer questions about claims to successful displacement design. Several dozen well displacements were analyzed for this study. Twenty-seven of them are described in this paper. From the fluid analyses and data gathered from field reports, the authors hoped to determine whether displacement fluids returning from the wellbore would reveal quantitative data about the relative success of removing mud from the hole.

Current Practices

Displacements are most often evaluated on data gathered in the field. Such data include:

a. ***The condition of the displacing fluid after the spacers have been collected.*** Several metrics derive as a result. Two of them are measured in NTU or TSS as discussed above. Two others are circulating time and volume circulated. In an indirect displacement, seawater (or lease water) can be circulated until an acceptable level of clarity is attained, usually 100 or 200 NTU, prior to the