RDT

Brief

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Engineering Evaluation of Polymer-Based Drilling Fluids for Applications in Missouri Shale

Research Development and Technology

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Polymer-based drilling slurries have emerged in recent years as attractive alternatives to conventional mineral-based slurries for drilling in a wide range of soil and rock types (Figure 1). Polymer-based slurries, which are considered to be non-particulate, non-hazardous, and are often disposable directly on-site, retain environmental advantages over traditional drilling fluids while in many cases providing effective inhibition of swelling and slaking processes that commonly occur along uncased borehole walls.

Figure 1. Application of polymer-based drilling fluid (PDSCo, El Dorado, Arkansas).

Investigators from the University of Missouri – Columbia have conducted a laboratory experimental program to evaluate the general performance of partially hydrolyzed polyacrylamide (PHPA) drilling slurries for applications in Missouri shale. The experimental program includes drum slake, jar slake, linear swell, and hardness testing for representative Missouri shale specimens allowed to interact with a variety of commercially available PHPA slurries. Slurries are prepared at concentrations ranging from 25% (under-concentrated) to 150% (over-concentrated) of manufacturer-recommended mixing ratios to examine the associated effects on performance.

Indices used to quantify slurry performance in terms of slaking, swelling, and softening inhibition are shown to be relatively insensitive to polymer manufacturer and form (granular or emulsified) but significantly sensitive to concentration. Each performance index generally improves with increasing slurry concentration and appears to reach an optimum at the manufacturer's recommended slurry mixing ratio. Over-concentration does not enhance, and may diminish, slurry performance.

Figure 2 (next page), for example, shows slake durability index (measured using a drum slake apparatus) as a function of slurry concentration for shale specimens from the Bevier Formation, Lafayette County Missouri. Indices equal to 100 indicate highly durable (rock-like) behavior while lower indices indicate materials having relatively high sloughing

and erosion susceptibility. Optimum durability is reached near 100% of the manufacturer recommended slurry concentration. Figures 3 and 4 show similar trends evident in indices measured to quantify shale swelling potential (Figure 3) and shale hardness (Figure 4). Additional observations drawn from the work include the following:

- Complete realization of polymer slurry viscosity requires at least 5 hours and as much as more than 48 hours
- Solid-based slurries develop full viscosity more rapidly than liquid-based (emulsified) slurries
- Solid-based slurries develop consistently higher viscosity than liquid-based slurries
- Shale durability is only slightly enhanced relative to baseline values for distilled water and not enhanced relative to baseline values for tap water
- There is no significant dependence on the type (manufacturer) or form (solid or liquid) of polymer in terms of slurry performance

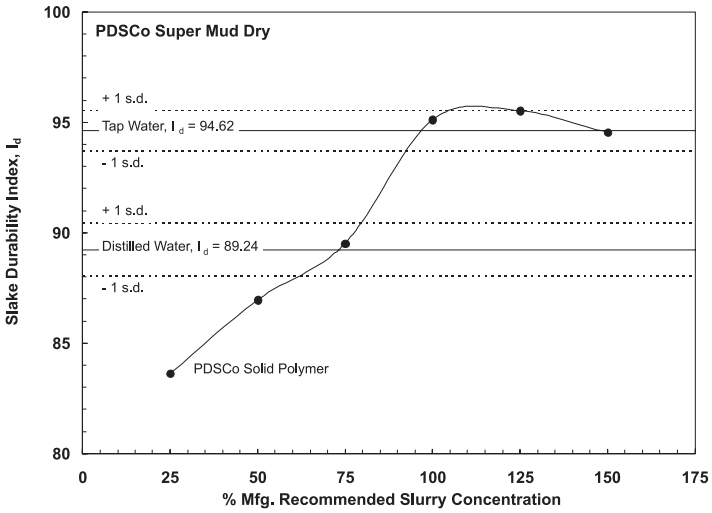

Figure 2. Slake durability index as a function of polymer slurry concentration.

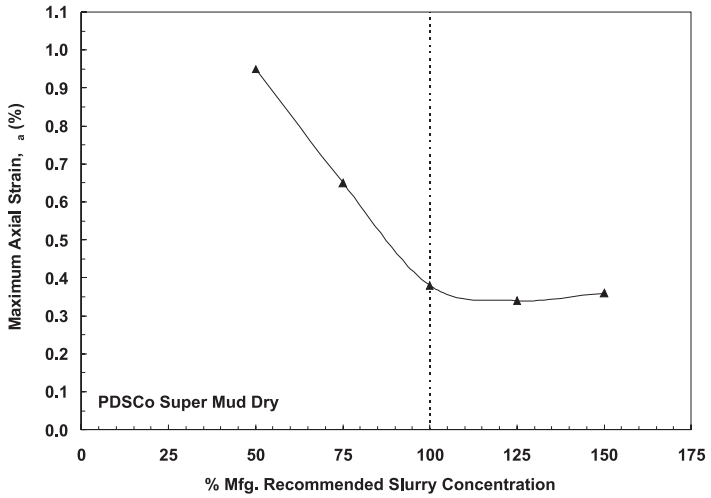

Figure 3. Maximum axial strain (swelling) as a function of polymer slurry concentration.

The research provides quantitative evidence regarding the impact of slurry concentration to its performance in commonly encountered Missouri shale formations and a basis for subsequent tests that may be conducted to develop evidence-based specifications for quality control variables related to slurry concentration (e.g., viscosity). A framework for implementing a site-specific slurry specification procedure is suggested.

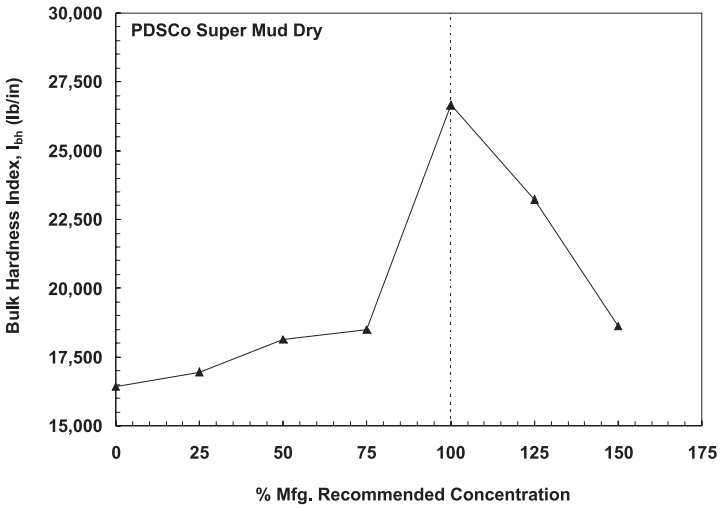

Figure 4. Bulk Hardness Index as a function of polymer slurry concentration.

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