StraighTalk

Why Bentonite Hurts Well Production:
The Case for Biopolymer Drilling Fluid

Bentonite is a naturally-occurring clay material, largely composed of the mineral, sodium montmorillonite. The dominant property of bentonite is that it swells to many times its dry volume when hydrated by water, forming a viscous fluid with high gel strength. This makes bentonite an excellent product when used as a sealant, for preventing the influx of surface water into a well, sealing abandoned wells, or building slurry walls to contain contaminated groundwater.

Bentonite is also frequently used as the base for drilling muds, including drilling fluids for horizontal wells. In this application, the characteristics that make it such a great sealant also make it a great choice for a drilling fluid, but bad for the ultimate well performance.

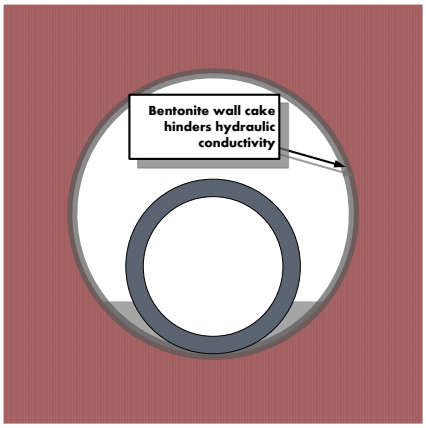
The swelling property of bentonite is known as "yield." Premium quality bentonite (usually from Wyoming) provides the best yield for a given weight of bentonite powder. When cost is the only concern, high yield is an excellent characteristic, since less powder makes a thicker mud. However, it takes time for bentonite to yield, from hours to days for the individual particles to fully swell to their maximum expansion. Drilling operations seldom have the time to wait for days for mud to fully yield, so the bentonite is injected into the bore before it is fully hydrated. Since bentonite particles are colloidal in size; once mixed in water and introduced into a borehole, the bentonite particles can penetrate into the soil surrounding the borehole. Once there in the presence of water, the bentonite continues to swell, sealing off the borehole.[1]

Why Bentonite is Bad

At first analysis, this seems like a good thing. A wall cake that penetrates into the soil, supports the borehole, and seals against mud loss appears to be an advantage. This is true for many types of drilling projects, but has a negative effect on the performance of horizontal environmental wells. The reasons are manifold.

1. Bentonite is a clay mineral that doesn't break down. Once hydrated in a subsurface borehole environment, it is very difficult to remove. The only effective way to restore the soil to its original hydraulic conductivity is to physically remove the bentonite from the bore. This is typically done by mechanical or hydraulic agitation, i.e., surging, jetting, or other means.

2. Horizontal borings are typically large compared to the screen size. In order to successfully install the well screen and casing, the typical horizontal boring is about 1.5 times the diameter of the well materials. If the native soil tends to cave, or presents other drilling difficulties, the bore size may be larger yet. The final installation is a large-diameter bore, filled with drilling mud, with the wall screen placed off-center within the bore. Development techniques performed inside the screen have little effect on most of the borehole wall surface (see figure).[2]



3. Horizontal wells generally have very limited open area. A typical soil vapor extraction or chemical injection well may only have 0.5% - 2% open area, with widely spaced slots that are only 0.010 inches wide and a few inches long. Mechanical agitation performed inside the well screen generally does not extend to a significant distance outside the well screen, meaning that the wall cake, or "filter cake" that was carefully built during drilling cannot be removed. A well installed in such a manner will never perform to its optimum capacity, due to the formation damage that occurs by using a bentonite drilling mud.

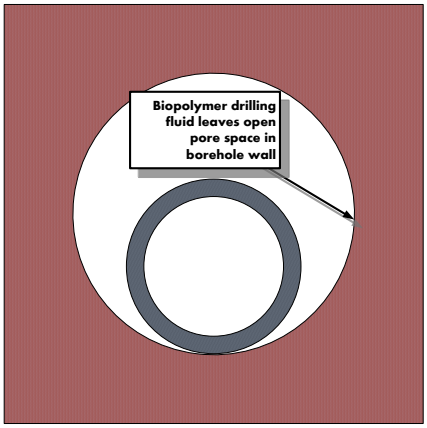
Directed Technologies Drilling Incorporated

There is a Better Way

Fortunately, drilling fluid technology has advanced considerably in recent years. Biodegradable polymer drilling fluids were introduced in the 1970's, with the Johnson Well Screens' product, Revert, among the best known. Most of these drilling fluids are a mixture of natural resins and gums, derived from plants or bacteria. Xanthan and guar gum, and various plant starches are the most common constituents. These same food grade ingredients are commonly found as thickeners and emulsifiers in foods and beverages.[3]

Biodegradable polymers (biopolymers) provide similar characteristics as bentonite in a drilling fluid: drilling tool cooling and lubrication, cuttings removal, and borehole stabilization. However, biopolymers provide a significant advantage over bentonite during well development — they break down to the viscosity of water, leaving only simple nutrient sugars and salts. This breakdown process occurs naturally within a few days of well installation, or can be accelerated to a 24 hour process through the introduction of an enzyme.[4]

Since biopolymer drilling fluids leave no inert residue in the formation, they cause no permanent damage and leave the pore spaces in the borehole wall open and hydraulically conductive. Wells drilled with biopolymer mud are much less likely to suffer formation damage and can provide as much as 40 times the flow rate of wells drilled with bentonite.[5]



One notable physical disadvantage to biopolymer drilling fluids is that their breakdown products can support microbial life. For this reason, products like Revert are sometimes disallowed in wells that are intended for potable water production. However, in most environmental remediation wells, enhancement of native microbial communities is generally considered a benefit, if not the actual intent of the remediation program. In these applications, biopolymers provide a better well and a headstart to site cleanup.

Biopolymer drilling fluids are also more considerably more expensive than bentonite. However, considering the extra expense required to fully develop a well drilled with bentonite, with little assurance that the well will ever be fully developed, the initial cost of biopolymers is mitigated.

DTD has exclusively used biopolymer drilling fluids in environmental wells for the last 15 years. Our experience as groundwater geologists and environmental scientists reinforces our belief that we best serve our clients needs by providing the highest performing wells possible for treatment of contaminated soil and groundwater. This experience, combined with ongoing research, has confirmed that biopolymer drilling fluids are the best, if not only, choice for producing wells that are optimized for the wide array of current remediation technologies.

[1] Remedial Wells Reap 40-Fold Benefit from Horizontal; Hoy, Ed, Dow Chemical Company.
[2] Drilling Fluids for Monitoring, Vapor Extraction and Remediation Wells; Berry, John H., P.G., Product Manager, CETCO Drilling Products.
[3] ibid
[4] Hoy, op. cit. and Berry, Personal Communication
[5] Hoy, op. cit.

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