Drilling highly depleted sands

Drilling through highly depleted sands may pose significant challenges, depending on the pore pressures and fracture gradients of other exposed formations, and the minimum allowable mud weight to avoid an influx and maintain wellbore stability (prevent hole collapse).

In most instances, fracture gradients in sands are reduced as a function of depletion. However, this is not a one to one relationship, as the reductions in minimum horizontal stress and fracture extension pressures are typically 30 to 60% of the reduction in pore pressure. Even so, in situations where initial drilling margins are low, such as in highly inclined wellbores in over-pressured environments, any reduction in the drilling margin may prove difficult to manage.

Since the minimum allowable mud weight for any wellbore is generally fixed by the maximum pore pressure of any exposed permeable formations or the minimum mud weight to prevent hole collapse, strategies for successfully drilling through highly depleted sands generally focus on maintaining a quality filter cake, reducing equivalent circulating density (ECD) and maintaining pipe movement to avoid differential sticking. In some cases it may also be necessary to alter the wellbore trajectory in order to increase the drilling margin.

In normally faulted environments, hoop stresses and fracture initiation pressures are reduced at high inclination angles, and industry wide wellbore strengthening efforts (e.g., stress caging) have often had mixed or negligible results. Maintaining a thin but tough filter cake, while establishing an optimal lost circulation material (LCM) concentration, is an important first step for ensuring that breakdown pressures in depleted sands are as high as possible, and that differential sticking is minimized. Too small a concentration of LCM will provide inadequate wellbore to formation isolation, while excessive LCM concentrations unnecessarily increase ECDs.

Furthermore, for many formations drilled at high inclination angles, the mud weight required to ensure wellbore stability is often greater than for a vertical wellbore. Since high inclination angles are often unavoidable, particularly for centralized offshore platform development drilling, a number of ECD reducing techniques have been developed. Managed pressure drilling (MPD) techniques, including "constant bottomhole pressure" drilling, allow for lower mud weights to be utilized in a closed system, with a portion of the total required mud column equivalent pressure held by the surface equipment. When drilling fluid circulation is established, the surface pressure can be reduced to account for all or most of the annulus friction pressure, which generates ECD above the static mud weight.

Drilling coalbed methane formations

Coalbed methane, or CBM, formations are comprised of a series of coal stringers that range anywhere from 1 ft thick to as much as 30 ft thick. Depending on the environment in which the coal was deposited, the interval can contain from one or two to as many as five to seven stringers. Coalbeds are normally bound by sandstone and shale stringers within the formation that contains the coal. Coal formations are considered to be a porous and "friable" (easily crumbled) formation. Although fracture gradients can be as high as 23 ppg, lost circulation situations can still occur when drilling through this formation because of the nature of its porosity. Depending on the area, coalbeds can be either overpressured or underpressured and different grades are encountered ranging in appearance anywhere from a bright luster to a dull gray. CBM wells are considered a non-conventional formation and typically produce higher volumes of water initially.

History

In the past, as other deeper formations were being sought, the coal was seen as just a formation to get through. Early on many saw extremely high pressures while going through the coal requiring very high mud weights. Some early coal wells produced as much as 20 mmscf/day.

The first coal wells drilled were completed using a slotted or perforated liner across the coal section and were allowed to free flow. The wells were typically vertical and later on the wells were either hydraulically fracture stimulated or completed by cavitation – pressuring up the formation with air and allowing it to surge back into a flow-back pit or tank causing the formation to crumble.

Drilling CBM wells

Today, CBM wells are drilled either vertically or horizontally and can be drilled with either roller cone or PDC type bits. Vertical drilling coal is in a practical sense no different than drilling any other vertical well. The main difference is that a drilling break will occur when the coal is encountered. The ROP will suddenly increase as the bit enters the coal with the same WOB as was applied through the shale and sandstone above it. Depending on the coal environment, it is possible to see minor gas kicks when drilling into the coal. Typically a standard low solids non-dispersed, or LSND, mud system can be used for drilling vertical wells.

The other form of drilling CBM wells that has been most recently adopted, especially in the US, is by directional and horizontal drilling. When drilling these wells, the operating parameters are much the same as any other vertical well when drilling to the kick off point and when drilling and landing the curve section. In a situation where the coal is over-pressured, a natural (unstimulated) completion is used. A clear drilling

