MPD helps to Make Problems Disappear

By Ken Smith, ConocoPhillips

"MANAGED Pressure Drilling" (MPD) is a frequently misused term. Some people equate MPD to underbalanced drilling, and others equate it to "Power Drilling." These associations are understandable, as all 3 practices share some key components: a rotating control head and a choke. Frequently, mud-gas separation equipment and a drill string float are used. However, the goals of these operations differ significantly.

Underbalanced operations are generally directed at reducing producing formation damage by encouraging inflow from the producing zone while drilling, thus keeping the drilling fluids out of the formation. Power drilling is generally associated with hard formations, and significant underbalance is sought to maximize penetration rate. In these wells, influx may or may not occur, but the goal remains to maximize penetration rate. These wells are frequently drilled with air or foam.

The IADC Underbalanced Operations & Managed Pressure Drilling Committee has defined MPD as "an adaptive drilling process used to precisely control the annular pressure profile throughout the wellbore." The objectives are to ascertain the downhole pressure environment limits and to manage the annular hydraulic pressure profile accordingly." MPD operations are directed at manipulating "windows" that exist between either formation pore pressures or wellbore stability pressures, and fracture pressures (Figure 1). In these wells, influx is absolutely avoided, just as in conventional drilling operations.

Perhaps it is easier to express these formation attributes in terms of pressure, rather than gradient. In this display, the "windows" are expressed as the red lines in Figure 2.

CONVENTIONAL DRILLING

In conventional operations, wellbore control is maintained by ensuring that the static and dynamic circulating pressure profiles are within these windows. Naturally, the bottomhole pressure increases by an amount equal to the annular friction pressure (AFP) while circulating. As the windows narrow, either well influxes or lost circulation can occur. The traditional response is to set casing and re-establish the windows.

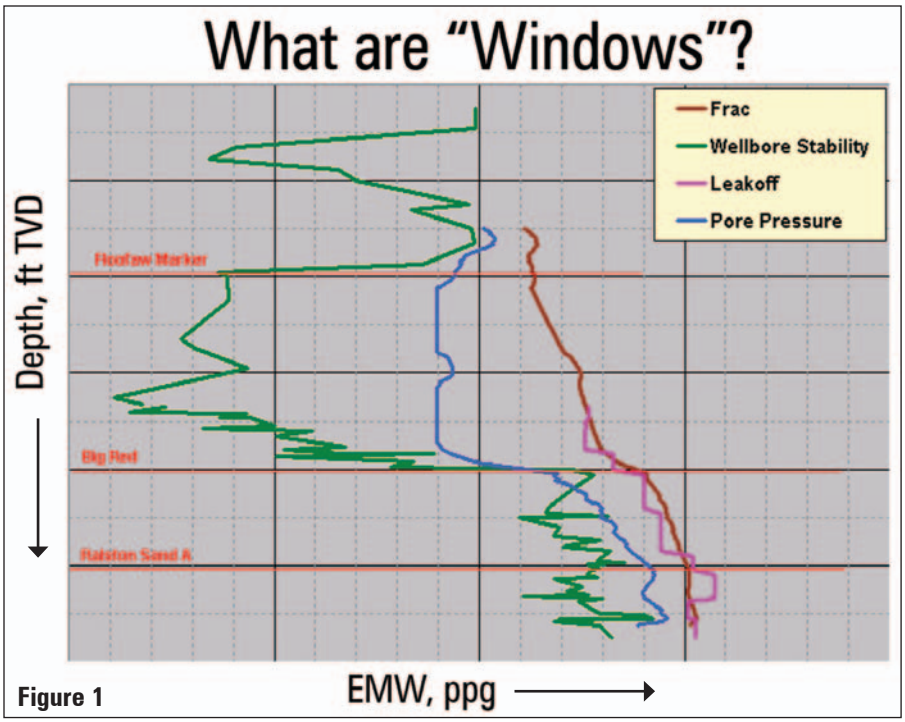


Figure 1

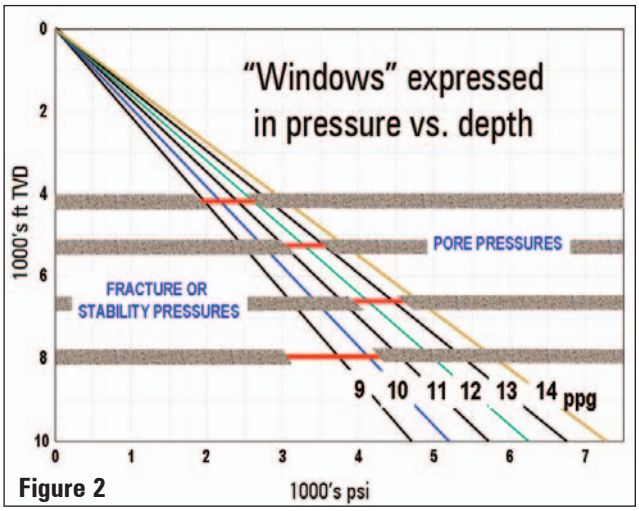


Figure 2

There are several variations of managed pressure drilling that offer alternatives to combat various downhole pressure challenges, however. In this article, 3 situations are offered where MPD can be used to avoid or defer setting casing.

The reason that these variations of MPD are even achievable is because the equipment allows us to keep the wellbore closed at all times. Once the wellbore becomes a closed and pressurizable container, any changes at all to the pressure conditions are immediately apparent on the surface in the form of a pressure change on the annulus. Therefore, influxes and losses are detected almost instantly. In this respect, safety is enhanced.

Constant bottomhole pressure profile MPD: In this situation, the well is stable while static, but once circulation commences, losses occur in a weaker zone up the wellbore due to the AFP. The conventional response would be to set casing. However, an alternative response could be to use a rotating control head, a surface choke and a drill pipe float, reduce the mud density and impose a surface pressure on the well while making connections.

Dual gradient MPD: In some wells, there is a rapid pressure gradient increase that cannot be controlled with a single fluid density without fracturing shallower formations. This is typically associated with deep water where the seawater column dominates the formation pressure in the shallower formations. Traditionally, this situation requires several casing strings to be set in the first few thousand feet of

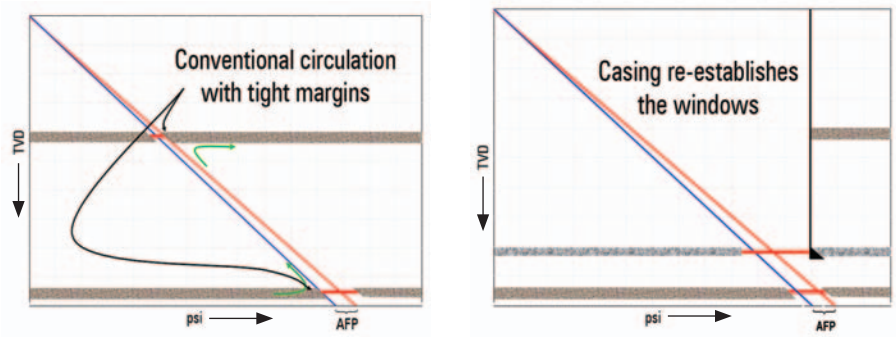
sediment. An alternative response can be dual gradient MPD, where a lifting mechanism is introduced in the wellbore. The mechanism can be mechanical. It can also be through the introduction and mixing of a lighter fluid or solid – for example, base oil, nitrogen or hollow spheres – into the wellbore. Onshore, this can be done through the introduction of a "parasite string," where air is injected into the wellbore at the casing shoe. Offshore, experience with dual gradient drilling is most frequently manifested as "pump and dump," where mud is circulated and discharged at the mudline during the top hole drilling operations before the surface casing, drilling riser and BOP are run.

Pressurized mudcap MPD: This variation of MPD is similar to dual gradient MPD, except that there is a rapid pressure gradient reversal. In this situation, the shallower formations will flow if the mud density is maintained such that losses do not occur in the deeper zones being drilled. Naturally, a solution is to set casing and seal off the high pressure zones. An alternative is to use the rotating control head and maintain a higher density fluid down to the weaker zones on top and drill with an expendable fluid, circulating all returns into the weak zones. This is effective in very vugular formations. The density of the upper fluid is dependent on how much surface pressure is acceptable on the surface.

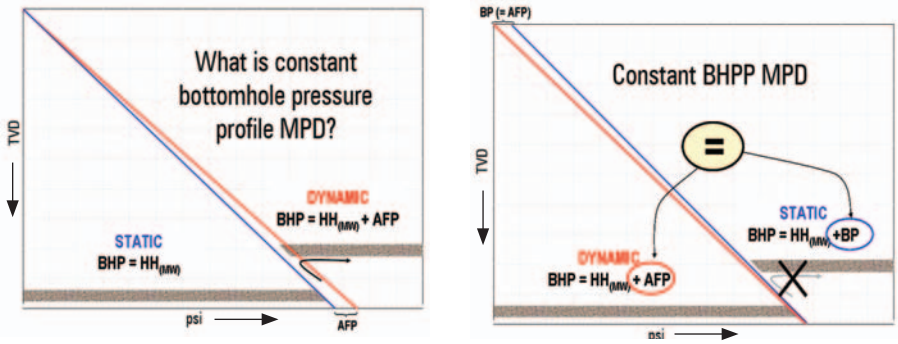
Health, safety and environment MPD: One more example of MPD is not really MPD at all. It is instead perhaps one of the more compelling motivations to utilize the equipment of MPD: the rotating control head and surface choke. Another tremendous benefit is realized with this equipment when it is used on production facilities, where any gas detected on the rig floor will cause a platform shut-in. With the surface control head, the rig floor is isolated from any gas escape from the mud at the top of the bell nipple. Instead, it is directed though the mud-gas separator, where it is vented harmlessly away from sensitive areas.

With these examples, it is evident that MPD is not a technique; it's a collection of techniques that can be used as alternatives in controlling difficult downhole pressure regimes. It's also clear why operators are adding these techniques to the arsenal of available tools.

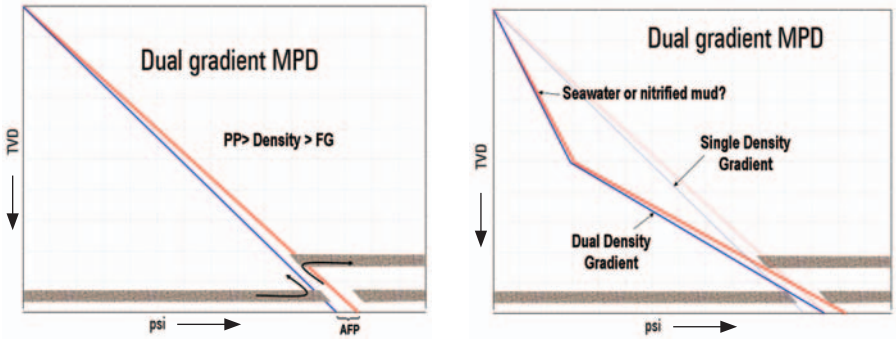
In essence, Managed Pressure Drilling is helping to Make Problems Disappear.



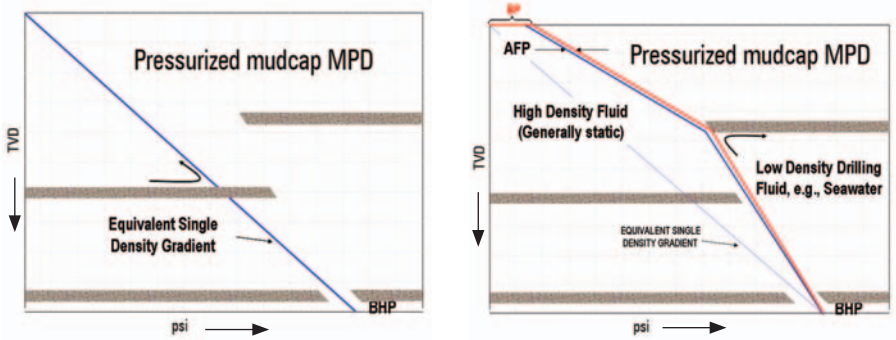
In tight margins (above left), wells can flow statically and lose returns when circulating. The traditional response (above right) is to set casing and raise mud density.



Situation (above left): Static OK, but HH+AFP exceeds formation strength and losses occur. Possible solution (above right): Use lower density and impose backpressure when static.



Situation (above left): Rapid pressure increase. Neither a static nor a dynamic column of single density fluid can be managed. Possible solution (above right): 2 density gradients in the wellbore, lower on top, higher on bottom.



Situation (above left): Pressure reversal can't be controlled with single gradient system. Possible solution (above right): Use rotating control head, heavier mud on top and inject all returns into weak zone.

Ken Smith is Manager, Well Operations, at ConocoPhillips. This article is based on a presentation made at the 2006 SPE/IADC Managed Pressure Drilling and Underbalanced Operations Conference & Exhibition, held 28-29 March in Galveston, Texas.