[PS]Underbalanced MPD technology Proved to be Effective in Drilling of Fractured Granitic Basement*

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Abstract

The basement hydrocarbon reservoirs have been discovered in many places over the world. The remarkable characteristics of the basement reservoirs are their low pressure with narrow density windows and well developed fractures, which usually resulted in probably massive losses. A case study on drilling of fractured granitic basement with application of UBD in Chad and MPD in Indonesia is presented in this paper.

To tackle the common problems of drilling in narrow density windows and potential problem of losses, an underbalanced drilling (UBD) technology with a micro-foam drilling fluid was used in Chad. The pore pressure coefficient of the basement of Chad was predicted as between 1.02-1.06, and the density of the micro-foam drilling fluid was designed to be 8.7ppg. While an under-balanced managed pressure drilling (MPD) technology with a synthetic based gas-to-liquid (GTL) drilling fluid was utilized in Indonesia. The formation pressure coefficient of the basement of Indonesia was estimated to be 1.04, and the density of the GTL drilling fluid was designed to be 7.4ppg.

Losses or severe losses existed in previous conventional near-balanced drilling in fractured granitic basement of buried hills of Chad. The problem of losses also encountered even UBD was later used. Losses and kicks continued almost all the time during drilling, coring and wireline logging in some wells. Losses happened as soon as pump started while overflow occurred no sooner than pump stopped. However, the potential problem of losses and kicks was completely controlled by utilization of under-balanced MPD technology in fractured granitic basement of Indonesia.

The under-balanced MPD technology, a precisely pressure controlled drilling system, is able to accurately control the annular pressure profile throughout the wellbore, therefore it could effectively achieve safe drilling in narrow density window and cut non-production time. It is proved effective in drilling of fractured granitic basement.

Underbalanced MPD Technology Proved to be Effective in Drilling of Fractured Granitic Basement

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Abstract

The basement hydrocarbon reservoirs have been discovered in a lot of places over the world. The remarkable characteristics of the basement reservoirs are their low pressure with narrow density windows and well developed fractures which usually resulted in probably massive losses. This paper presents a case study on drilling of fractured granitic basement with UBD in Chad and underbalanced MPD in Indonesia.

Introduction

Losses or severe losses existed in previous conventional near-balanced drilling in fractured granitic basement of buried hills of Chad. The problem of losses also encountered even UBD was later used. Losses and kicks continued almost all the time during drilling, coring and wireline logging in some wells. Losses happened as soon as the pump started while overflow occurred no sooner than the pump stopped. However, the potential problem of losses and kicks was completely controlled by utilization of underbalanced MPD technology in fractured granitic basement of Indonesia.

Predicted basement pore pressure:

- Pressure coefficient, Chad = 1.02-1.06
- Pressure coefficient, Indonesia = 1.04

Drilling fluid system and density:

- Density of the micro-foam drilling fluid, Chad = 6.25-7.90ppg
- Density of the gas-to-liquid (GTL) drilling fluid, Indonesia = 7.35-7.40ppg

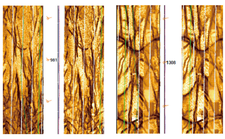

Figure 1. Imaging log of granitic basement, Chad

UBD in Chad

Typical case of one well:

- Losses out of effective control
- Total volume of losses = 17,395bbls
- Maximum rate of losses=220bbls/hr
- Maximum amount of single overflow = 190bbls
- Occurrences of overflow during POOH = 14 times
- Total amount of LCM and HV drilling fluid added to avoid losses and overflow = 2262bbls
- Total oil produced = 2380bbls
- Daily produce of oil = 40-50bbls
- Time effect:
  Drilling = 57%
  Tripping = 24%
  Treatment of drilling fluid = 9%
  Others = 10%

Common:

- Losses occurred in some wells; some other wells no
- losses happened
  The wells where losses happened produce oil; no losses no oil

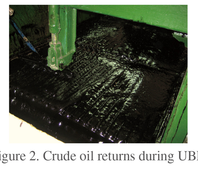

Figure 2. Crude oil returns during UBD

MPD in Indonesia

Typical case of one well:

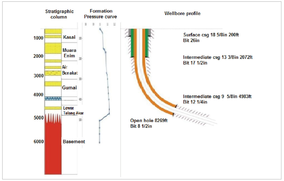

Figure 3. Casing program and wellbore profile

Required to use 8 1/2in bit to drill in the basement hole section from 4,993ft to 8,269ft.

- Total volume of losses = 0bbls
- Losses or kicks under complete control
- Longest time period of continuous flare = 75hrs
- Total time length of flare = 240hrs
- Total time of MPD operations = 300hrs
- Time effect:
  Drilling =32%
  Tripping = 46%
  Treatment of drilling fluid = 0%
  Circulation = 10%
  Maintenance of RCD = 1%
  Others = 11%

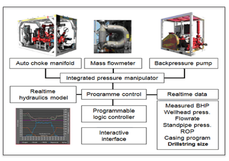

Figure 4. Underbalanced MPD philosophy

Underbalanced MPD

- Underbalanced MPD = Automatic control software + Automatic control system
- BHP control = Outlet flow control + Backpressure control

Figure 5. Auto choke control system

Figure 6. Backpressure pump system

Flow surveillance

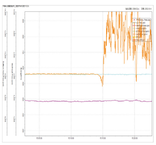

Figure 7. Overflow

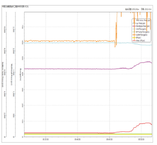

Figure 8. Return of CO2

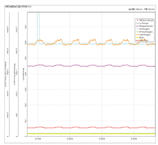

Figure 9.After CO2 blown off

Backpressure control

Table 1. Backpressures during MPD

Bit run	Hole section (ft)	Density of drilling fluid (ppg)	BP during drilling (psi)	BP during tripping (psi)
1	5003-5033	7.3	80-105	350
2	5033-5446	7.4	80-120	360
3	5446-5590	7.4	60-110	350-360
4	5590-5880	7.4	60-100	350-360
5	5880-6512	7.4	60-100	350-360
6	6512-6770	7.4	60-135	350
7	6770-7184	7.4	60-100	350
8	7184-7972	7.4	50-130	350
9	7972-8269	7.4	50-80	350-400

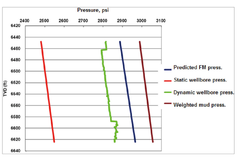

Figure 10. A specific hole section pressure profile

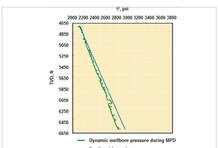

Figure 11. Overall wellbore pressure profile

Figure 12. Flare during MPD

Figure 13. Flare aftereffect

Figure 14. Flare with black smoke

Figure 15. Flare with white smoke

Conclusions

The under-balanced MPD technology, a precisely pressure controlled drilling system, is able to accurately control the annular pressure profile throughout the wellbore, therefore it could effectively achieve safe drilling in narrow density window and cut non-production time. It is proved to be effective in drilling of fractured granitic basement.