M-I SWACO
A Schlumberger Company

Offshore Malaysia: Total Losses in Subnormal Pressured Wells – @balance Services Mud Cap Drilling (MCD) with Continuous Annular Injection

The Challenge

The team faced the challenge of introducing Continuous Annular Injection as the safest method for drilling subnormal pressured carbonate reservoirs and maintaining well barrier requirements of the client and M-I SWACO.

Gas migration control was crucial to avoid total losses while:

- Drilling
- Tripping
- Running a slotted liner

More than 25,000 bbls of drilling fluid were lost due to control issues on previous wells in the area.

The Solution

Based on experience with operators in different regions, M-I SWACO proposed @balance Services Continuous Annular Injection to the client as the safest and most efficient method to drill into a subnormal pressured carbonate reservoir.

The Results

The Continuous Annular Injection technique was initiated once losses were encountered. Subsequently, no kicks or well control issues were experienced, and the well barrier requirement was met with overbalanced fluids in the annulus at all times.

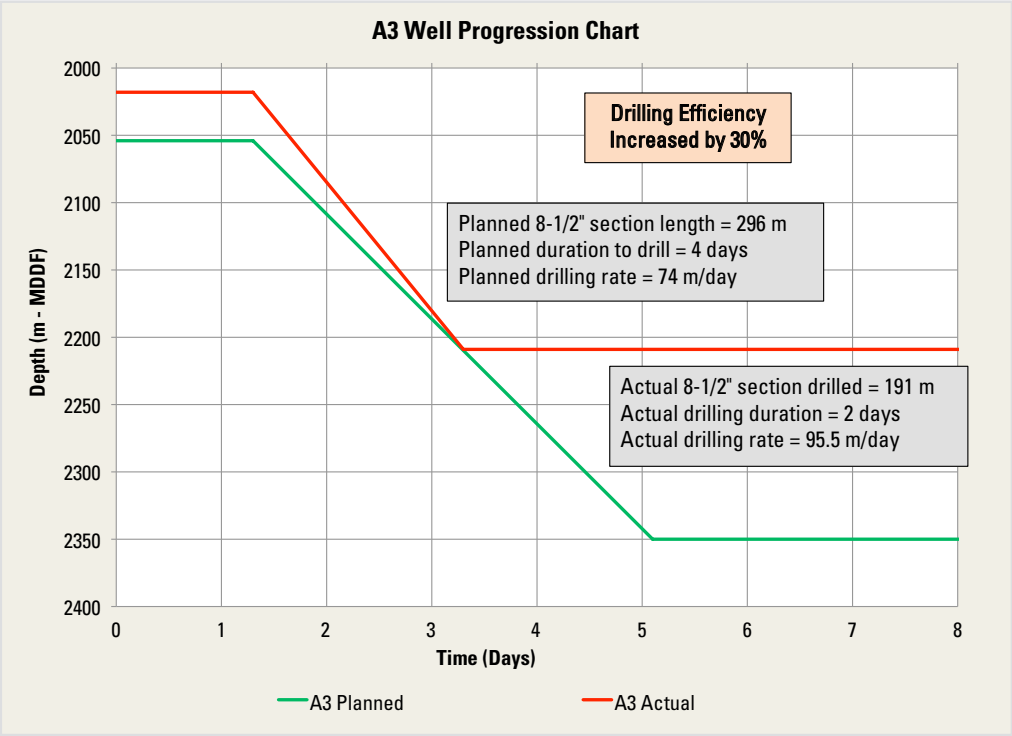
Drilling time was reduced by over 50%. A pre-drilled/slotted liner was run with an inner string to facilitate CBP dress-out and then run to TD with Continuous Annular Injection. Although successful, additional time savings could be realized by eliminating the CBP and running a conventional liner using Continuous Annular Injection or a barefoot completion. Fluid cost was reduced to almost zero since seawater was used as the sacrificial and annular fluid. No NPT was experienced and safety was greatly improved.

Offset Well – Exploration Well

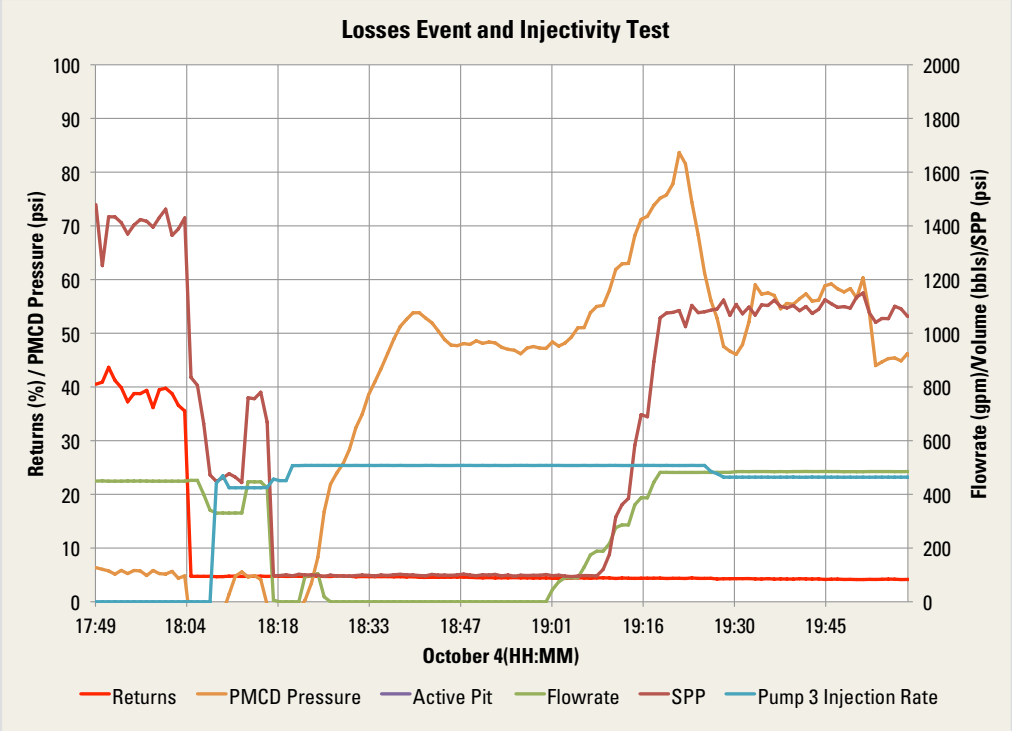
When drilling the initial well, A-1, the team encountered total fluid losses at the top of the carbonate in the 8½-in openhole section during the exploration phase. Total fluid losses were approximately 10,000 bbls. The team attempted to cure losses with KMC lift, LCM pills, EZ squeeze cement and gunk plugs. TD of the 8½-in section was called earlier than anticipated and an unplanned 7-in liner was set. The 6-in hole was drilled, where losses were once again encountered after drilling approximately 20 m. Total mud losses were an estimated 15,000 bbls. The team attempted to cure losses once again utilizing the same methods as in the 8½-in section, but achieved positive results only with cement plugs. Finally TD was called at ±360 m above the planned TD. Plug and abandon operations were then conducted. Over 25 days were spent achieving subpar results.

Mud Cap Drilling – Continuous Annular Injection

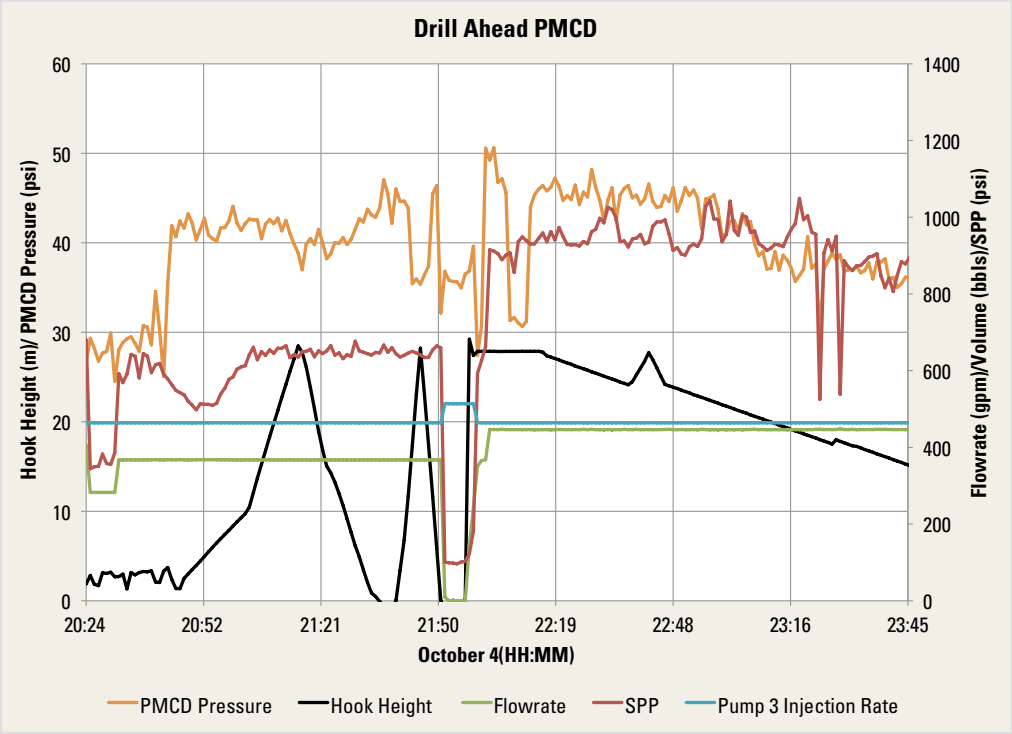
Two wells were drilled during the first development phase. Only one of the wells, A-3, encountered total fluid losses and required MCD. Due to the subnormal formation pressure, seawater was injected continuously down the annulus to maintain a full hole while ensuring that no formation fluid or gas entered the wellbore. By injecting at a rate higher than the loss rate, an artificially induced surface pressure was created to allow for wellbore monitoring while drilling. Upon reaching TD, the BHA was stripped out of the hole while seawater was continuously injected down the annulus. A CBP was set to isolate the wellbore from the openhole loss zone. After the liner was run and set, and the completion isolation valve was closed, the MCD operation was concluded. Total drilling time to reach TD utilizing the @balance Services MCD technique required only two days.



Plot 1: This figure shows a comparison between the planned A3 well progress versus the actual A3 well progress. From the chart, it can be seen that the drilling rate was increased by approximately 30% in the actual well, which encountered total fluid losses before MCD was performed. Note that the time axis shown in the plot was simplified for illustration purposes; actual values might vary.



Plot 2: This figure shows the total fluid losses and the subsequent injectivity test prior to converting the well to MCD and continuing to drill.



Plot 3: This figure shows the ability to monitor the continuous induced MCD pressure while drilling. This helps the team determine if the hole is full while maintaining the primary well control barrier.

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