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Performance Comparison of Managed Pressure Drilling (MPD) and Conventional Drilling in the Delaware Basin

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Abstract

This study presents a comparative analysis of drilling performance metrics from 10 Delaware Basin wells, including 3 conventional wells and 7 utilizing Managed Pressure Drilling (MPD) technology. Conventional wells reached total depth (TD) in an average of 9.96 days at 21,088 feet, achieving a rate of penetration (ROP) of 144.2 ft/hr. In contrast, MPD wells reached TD in 8.15 days at an average depth of 22,076 feet with an ROP of 164.18 ft/hr—reflecting a 13.85% improvement in ROP and an 18.2% reduction in time to TD over conventional drilling.

The performance improvements were particularly evident in challenging formations:

- Wolfcamp A: MPD wells showed a 9.4% increase in ROP (169.72 ft/hr) compared to conventional drilling (155.07 ft/hr).
- Wolfcamp B: MPD wells demonstrated a 29.8% increase in ROP (159.27 ft/hr) versus conventional methods (122.74 ft/hr).

These results indicate that MPD technology delivers substantial efficiency gains in Delaware Basin drilling, reducing the time to TD while significantly enhancing ROP, particularly in challenging formations such as Wolfcamp A and B. The study highlights MPD's potential to optimize wellbore integrity and performance in complex drilling environments.

Introduction

The Delaware Basin is one of the key components of the broader Permian Basin, representing one of the most productive hydrocarbon regions in the United States. In June 2022, the Permian Basin accounted for 43% of U.S. crude oil production and 17% of U.S. natural gas production (EIA 2022). However, its geological complexity, namely in the Wolfcamp A and B formations, poses some significant challenges to drilling operations in the area. Narrow pressure windows, unstable formations, and needing to precisely control wellbore pressures have hindered efficiency and safety in operations, leading to days lost to NPT and with that cost overruns through well control events and additional time spent on wells. Many of these issues arising from the Wolfcamp formation in the area exhibiting overpressure conditions, which post significant challenges which need to be overcome and mitigated (GeoScienceWorld 2022). Utilization of Managed Pressure Drilling in the area offers a solution to many of these problems by letting operators dynamically manage bottomhole pressure and adapt quickly to real-time drilling conditions, without the need for costly and long mud circulations. MPD is particularly beneficial in wells with highly uncertain or very narrow drilling windows, and unstable formations (Petrowiki 2025). This paper will compare the performance of conventionally drilled wells and those drilled using MPD in the Delaware basin, focusing on critical key performance indicators such as rate of penetration, time to total depth, and overall operational efficiency. The findings will underscore MPD's potential to optimize drilling performance in challenging formations, enhancing both economic outcomes while also enhancing operational safety.

Methodology…..

Data was collected from 10 wells drilled in the Delaware Basin and was then analyzed to identify possible performance patterns. The dataset included 7 wells drilled with the help of MPD, as well as the 3 most recent conventional wells drilled before implementing MPD. The data was further broken down based on formation into Wolfcamp A and Wolfcamp B wells. Wolfcamp A wells accounted for 2 of the wells drilled utilizing MPD, as well as 2 drilled conventionally. Wolfcamp B wells made up the remaining 5 MPD wells and 1 conventional well. The key metrics to be compared across this data set includes:

1. Days to Total Depth
2. Average Total Depth
3. Rate of Penetration
4. 100' Moving Average of Rate of Penetration

To ensure consistency in geological and operational conditions, all wells were selected from the same timeframe and general location. Furthermore, some data cleaning and normalization was performed to address some of the outliers and ensure accuracy. This data clean up was mainly performed for the Rate of Penetration values, in which we omitted values below 0 or above 1000 ft/hour.

Results and Discussion

1. Days to Total Depth Comparison.

Wolfcamp A

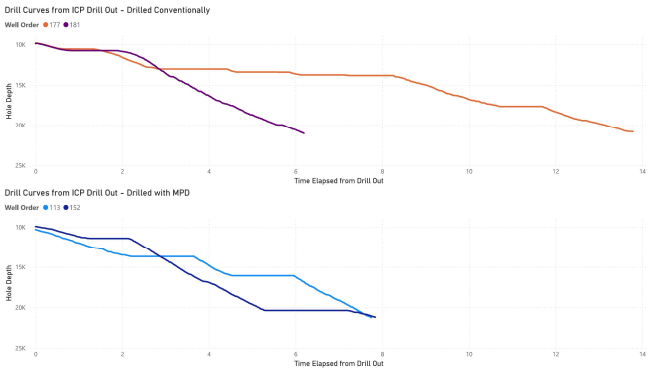

Figure 1: Time Elapsed Comparison Drill Curves - Wolfcamp A

Plotting the drill curves for the Wolfcamp A formation reveals the differences in operational efficiency between conventional drilling and MPD. Wells that were drilled conventionally (pictured in the top half of figure 1, exhibit much longer times to reach total depth, with frequent pauses in the drilling intervals evident in the curve, indicative of challenges such as lost circulation and multiple trips. In contrast, the lower half of figure 1 depicts the wells drilled with MPD which demonstrated a much more consistent and accelerated progression while drilling, reflecting a reduction in the non-productive time. The smoother curves of the MPD wells suggests enhanced control of the bottomhole pressure enabled steady drilling through the challenging intervals when compared to the conventional drilling curves. Overall, MPD reduced the days to total depth compared to conventional drilling by 22%, from an average of 9.99 days to TD to an average of 7.80 days to TD. This confirms its effectiveness in optimizing drilling performance in the Wolfcamp A formation.

Wolfcamp B

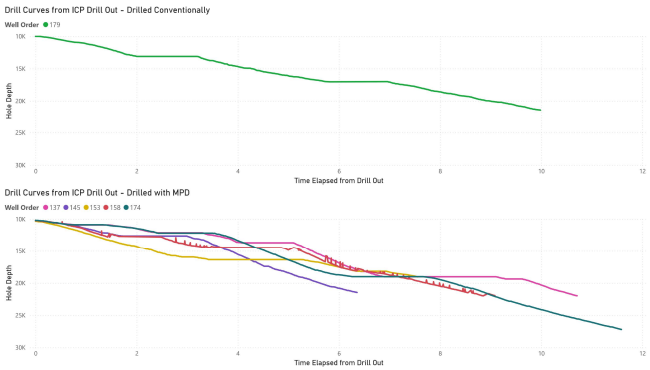

Figure 2: Time Elapsed Comparison Drill Curves - Wolfcamp B

When we take a look at the drill curves for the Wolfcamp B, they only further emphasize the performance improvements achieved through the use of MPD. The conventionally drilled well in this case shows a fairly stead, although fairly prolonged drill curve in comparison to the MPD wells. The MPD wells showed faster overall progression with more variability in the curves maximum depth, indicating MPD has the ability to manage and adapt to dynamic drilling conditions and allows us to plan more complex wells with longer laterals. In this case again we see that MPD was able to significantly reduce the time to reach total depth, dropping the total days to TD from 9.99 days to 9.06 days, or a reduction of 9.3%.

This analysis of time elapsed to total depth across both the Wolfcamp A and B formations highlights the substantial impact of MPD on drilling efficiency. In the Wolfcamp A formation, MPD reduced the average time to TD by 22%, from 9.99 days to 7.80 days, demonstrating its ability to significantly mitigate delays caused by common drilling challenges. Similarly, in the Wolfcamp B formation, MPD reduced the average time to TD by 9.3%, brining it down from 9.99 days to 9.06 days. These results emphasize the advantages of MPD in reducing the non-productive time, optimizing well delivery, and enabling more efficient drilling operations in both formations.

2. Average Total Depth Comparison

Wolfcamp A

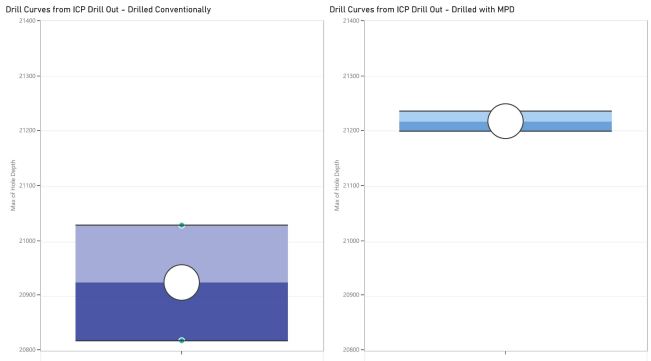

Figure 3: Total Depth Comparison - Wolfcamp A

The analysis of the total depth reached in the Wolfcamp A formation further highlights the effectiveness of drilling with MPD. Wells drilled with MPD achieved longer and more consistent TDs compared to conventionally drilled wells, which could point to issues of wellbore instability and lost circulation issues. The conventional wells in this formation reached TDs of 20,819’ and 21,030’, whereas the MPD wells were able to extend further to depths of 21,237’ and 21,199’. MPD’s ability to dynamically manage bottomhole pressure played a vital role in mitigating drilling challenges, reducing the occurrence of reaming and NPT events. This precision worked to minimize any operational delays and also ensured strict adherence to well plans, which is critical for maintaining formation integrity and minimizing cavings. The average TD

improved across these wells was 294’ or an additional 1.4%, which although may seem minimal when combined with the previous sections investigation that we reached this point 22% faster, affirms MPDs value in achieving both operational efficiency and geological stability.

Wolfcamp B

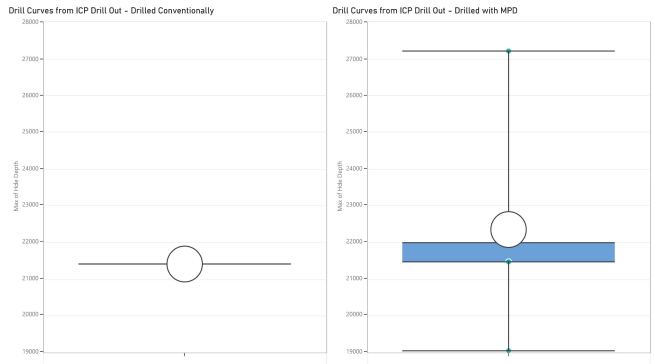

Figure 4: Total Depth Comparison - Wolfcamp B

Moving on to the Wolfcamp B formation, the advantages of MPD are even more pronounced when comparing the total depth performance. Conventional wells in this formation reached a TD of 21’414’, while MPD wells consistently achieved longer TDs, ranging from 19,060 to 27,213’. This demonstrates MPD’s ability to get over the various geological challenges and considerations required when drilling much longer lateral sections. MPDs dynamic control of bottomhole pressure was instrumental in mitigating challenges like differential sticking and wellbore ballooning, which can often limit a wells total depth in conventional drilling. Additionally, MPD allowed for the successful drilling of longer lateral sections, maximizing reservoir exposure and production potential. The average total depth improvement across these wells was 930.4’, or an additional 4.3%, which, although modest, when combines with the 9.3% reduction in time to reach these depths as noted previously, highlights again, MPD’s ability to significantly enhance both operational efficiency and geological outcomes in the Wolfcamp B formation.

The analysis of total depth performance in both the Wolfcamp A and B formations again reaffirms the value of MPD in enhancing drilling operations. In the Wolfcamp A formation, MPD improved the average total depth by 294’, or 1.4%, while also reducing the time to reach TD by 22%. Similarly, in the Wolfcamp B formation, MPD extended the average total depth by 930.4’, or 4.3%, while again reducing the time to reach TD, this time by 9.3%. These results highlight MPD’s benefits in helping to achieve deeper wells, while simultaneously drilling them faster. The ability to dynamically manage bottomhole pressure mitigates common challenges such as wellbore instability enabling more efficient and also more consistent adherence to well plans. Together these improvements demonstrate MPDs critical role in optimizing well delivery and achieving operational and geological objectives.

3. Rate of Penetration Comparison

Wolfcamp A

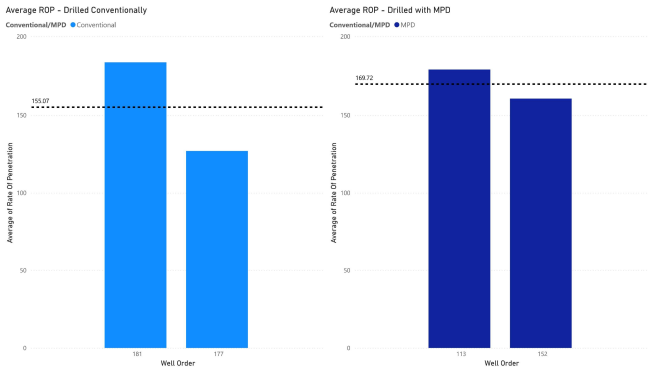

Figure 5: Average ROP Comparison - Wolfcamp A

The comparison of the average Rate of Penetration in the Wolfcamp A highlights another key performance indicator and advantage for MPD over conventional drilling. Conventional wells achieved an average ROP of 155.07 ft/hr, with individual ROPs of 127 ft/hr and 184 ft/hr. In comparison, wells drilled with MPD showed both improved and more consistent ROPs, averaging 169.72 ft/hr, with individual ROPs of 179 ft/hr and 160 ft/hr. This represents an improvement of 9.5% in the average ROP when utilizing MPD. The consistent ROP performance in MPD wells indicates enhanced drilling efficiency, likely due to the optimizations allowed by being able to control the bottomhole pressure precisely, which reduces the frequency of wellbore instability events, differential sticking, and other NPT interruptions that are more commonly experienced in conventional drilling. These results again show MPDs capability to maintain higher and more consistent ROPs, further supporting its value in improving operational efficiency in the Wolfcamp A formation.

Wolfcamp B

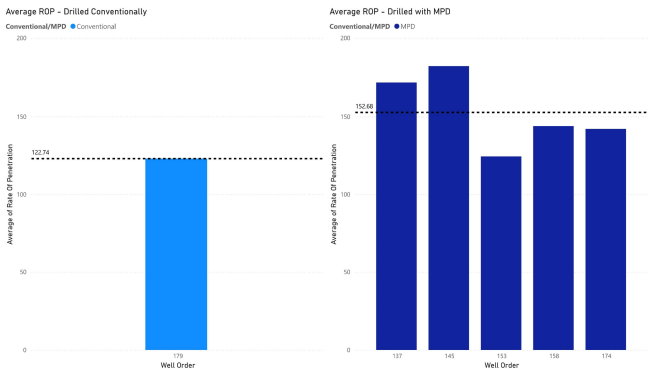

Figure 6: Average ROP Comparison - Wolfcamp B

The Wolfcamp B formation showed significant improvements in ROP when utilizing MPD compared to

drilling conventionally. MPD wells achieved an average ROP of 159.27 ft/hr, surpassing the 122.74 ft/hr that the conventional well performed at. This is a massive 29.8% improvement in average ROP. This substantial increase shows MPDs capability to adapt to the dynamic challenges of the Wolfcamp B formation, such as varying pressure regimes through quick bottomhole pressure adjustments that just can't be achieved as instantaneously through conventional drilling. The ability to maintain a consistent ROP with fewer interruptions highlights MPDs value in mitigating NPT and optimizing drilling performance in this challenging formation.

Across both the Wolfcamp A and B formations, the implementation of MPD technology resulted in improvements in ROP. For the Wolfcamp A, the ROP increased by 9.4%, while the Wolfcamp B experienced a much more significant 29.8% boost. These results underscore MPDs capacity to deliver enhanced drilling efficiency, particularly in formations characterized by geological complexity. By minimizing drilling interruptions and optimizing bottomhole pressure, MPD facilitated smoother and faster drilling operations, solidifying that it is a critical technology for improving overall drilling performance.

4. 100' Moving Average of ROP Comparison

Wolfcamp A

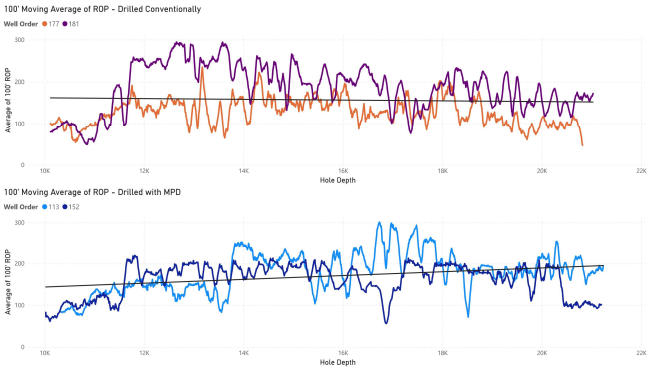

Figure 7: 100' Moving Average of ROP - Wolfcamp A

In the Wolfcamp A formation, the 100' moving average of ROP further underlines the benefits of MPD. Conventional wells showed noticeable fluctuations in ROP, reflecting challenges such as wellbore instability and varying formation pressures. Conversely, MPD wells displayed smoother ROP profiles, indicating steady drilling and fewer interruptions. This consistency suggests that MPDs ability to dynamically manage bottomhole pressure not only enhances drilling efficiency but also contributes to improved wellbore stability. As a result, the overall drilling performance in the Wolfcamp A was significantly optimized when utilizing MPD.

Wolfcamp B

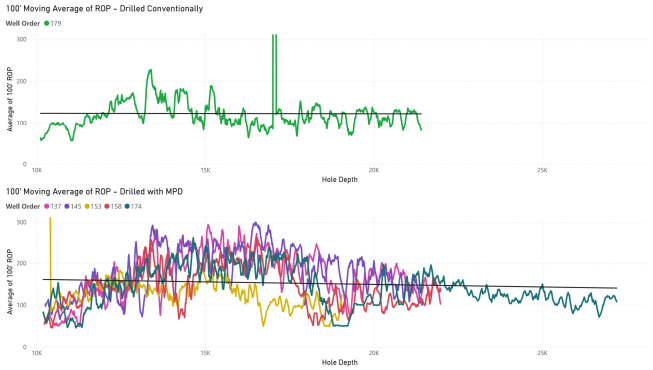

Figure 8: 100' Moving Average of ROP - Wolfcamp B

The analysis for the 100' moving average of ROP in the Wolfcamp B formation highlights even greater advantages of MPD technology. Conventional wells demonstrated again a less consistent ROP. MPD wells, however maintained a higher and more stable ROP profile, showing off the adaptability to dynamic formation conditions. The enhanced control provided by MPD facilitated the drilling of longer lateral sections with fewer interruptions, further emphasizing its benefits over conventional drilling in the Wolfcamp B.

The 100' moving average of ROP analysis for both the Wolfcamp A and B formations reinforces MPDs ability to deliver consistent and efficient drilling performance. While conventional wells exhibited fluctuations and interruptions, MPD wells maintain smoother and more stable ROP profiles across much longer lateral lengths. This consistency translated to improved operational efficiency and reduced NPT. The ability of MPD to dynamically manage bottomhole pressure played a major role in achieving these results, highlighting its effectiveness in optimizing drilling operations across different formations.

Conclusions

The analysis comparing the use of conventional drilling techniques to MPD drilling techniques in the Delaware Basin demonstrates MPDs clear advantages in terms of ROP, time to total depth, and operational efficiency. In both Wolfcamp A and B formations, MPD consistently outperformed conventional methods, delivering higher and more stable ROPs, doing so in shorter drilling times, and drilling wells much deeper while doing so! The dynamic control of bottomhole pressure provided by MPD mitigates common challenges with wellbore instability, these challenges often lead to needing to ream large sections of the wells drilled conventionally which could have otherwise been avoided by utilizing MPD. These findings confirm MPD as a technology that should be employed for drilling in complex geological environments, offering a pathway to more reliable and cost-effective well delivery.

Acknowledgments

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Nomenclature

TD = Total Depth
ROP = Rate of Penetration
MPD = Managed Pressure Drilling
NPT = Non-Productive time
BHP = Bottomhole Pressure
ft/hr = Feet per hour
TD = Bottomhole Assembly
100' Moving Average of ROP = Rolling average of ROP over a 100-foot interval

References

AADE. 2023. "Managed Pressure Drilling: The Future of Safe and Efficient Drilling." American Association of Drilling Engineers. Accessed January 22, 2025. Available at: http://www.aade.org/publications/managed-pressure-drilling-overview.

GeoScienceWorld. 2022. "Thermal Maximum and Overpressure of the Wolfcamp Formation in the Delaware Basin." GeoScienceWorld, 2022. https://pubs.geoscienceworld.org/aapg/aapgbull/article/108/11/2073/649154/Thermal-maximum-and-overpressure-of-the-Wolfcamp.

PetroWiki. n.d. "Managed Pressure Drilling." PetroWiki. Accessed January 22, 2025. https://petrowiki.spe.org/Managed_pressure_drilling.

U.S. Energy Information Administration (EIA). 2022. "Today in Energy: Permian Basin Continues to Drive U.S. Crude Oil and Natural Gas Production Growth." U.S. Energy Information Administration, June 2022. https://www.eia.gov/todayinenergy/detail.php?id=54079.