# Introduction

Rig owner intends to replace existing Choke and Kill lines of 6.75inh outer diameter (4.5 inch inner diameter). Lines of 6.25 inch outer diameter (4.0 inch inner diameter) are readily available. A study is conducted to determine the effect on the mud flow rate due to change in inner diameter. This documents presents the findings along with the methodology used for the flow rate evaluation.

# Summary

Due to change in inner diameter from 4.5 inch to 4.0 inch, the impact on the flow rate is as follows:

* Assuming same power/energy allocated for pumping through choke line (before and after change out), the maximum decrease in flow rate is approximately 26%. Analysis is conducted for varying flow rates up to 10 bbl/min;
* Assuming same flow rate is maintained for 4 inch ID, the friction losses increases by a factor of 1.75;
* Assuming constant friction energy loss, the 26% decrease in flow rate is conservative. Decrease in flow rate (and associated velocity) will also decrease friction loss in other regions (rig piping, annulus flow below mudline and downhole) and thus reallocates power utilized to overcome various friction sources. This reallocation of more power for C/K friction loss will tend to improve the flow rate. However, a more detailed annulus loss evaluation is recommended based on rig pump capacity, expected well depth, flow rates and other parameters;
* The pump power requirements to maintain the same flow rate in the 4 Inch ID pipe can also evaluated if required.

# Design basis and Methodology

## Design Data

The existing C/K pipe dimensions (ID of 4.5 inch) are shown in Figure 1 while the potential pipe dimensions (4.0 inch) are shown in Figure 2.



Figure 1 – Existing Pipe



Figure 2 – Potential Pipe

The water depth, fluid properties and flow rate data considered for analysis is provided in Table 1.

|  |  |  |  |
| --- | --- | --- | --- |
| **Water Depth** | **Fluid Properties** | | **Flow Rate** |
|  | **Fluid Density** | **Fluid Viscosity** |  |
| 500 ft | 12.0 ppg | 30.0 cP | 0.2 bbl/min |
| 2000 ft | 13.0 ppg | 40.0 cP | 1.0 bbl/min |
| 4000 ft | 14.0 ppg | 50.0 cP | 2.0 bbl/min |
| 6000 ft | 15.0 ppg | 60.0 cP | 3.0 bbl/min |
| 8000 ft |  |  | 5.0 bbl/min |
| 10000 ft |  |  | 8.0 bbl/min |
|  |  |  | 10.0 bbl/min |

Table 1 – Design Data Points

## Flow Rate and Pressure Loss Calculation

The flow rate and pressure loss calculations are performed based on classical fluid mechanics internal flow through a pipe, [1]. The following outputs are evaluated

* The pressure (head) loss is determined in the C/K lines for various flow rate conditions;
* The increase in head loss due to change in inner diameter is also evaluated;
* The decrease in flow rate to ensure the head loss remains the same is also evaluated and presented;
* A detailed example calculation is provided in Appendix A.

## Energy Allocation

The pumping energy is typically used in the following manner:

* Rig Piping
* Choke/Kill (C/K) or both lines
* Annulus Friction Pressure loss below mudline
* Downhole losses (if any)

With change in inner diameter of C/K lines, the other sources of pressure loss are assumed to remain the same. However, note that the energy consumed by other sources marginally decreases but is not evaluated and the results provided by the calculation are conservative.

Only one pipe (Choke line) circulation scenarios is considered for analysis. However, two pipe (choke/Kill) circulation flow rate and pressure loss trends are expected to be the same.

## References

1. Fluid Mechanics: Fundamentals and Applications, 2nd Edition, Yunus A. Cengel, John M. Cimbala, McGraw-Hill, 2010

# Results

Flow rate and pressure calculations are performed and the findings are provided below:

* The decrease in flow rate (> 3 bbl/min) for all conditions considered is approximately 26%. The flow rate decrease for 4000 ft water depth is shown in Figure 3.
* The increase in pressure loss requirements for all conditions considered is 75%. The increase in pressure loss for 4000 ft is shown in Figure 4.
* Analysis results for range of parameters considered is given in Appendix B.



Figure 3 – Decrease in Flow Rate for 4000 ft Water Depth



Figure 4 – Increase in Power Requirements for 4000 ft Water Depth

– Friction Loss and Flow Rate Calculation



– Sensitivity Analysis

Results for varying water depth, fluid properties, flowrate are given in this section.

| **Water Depth** | **Fluid Density** | **Fluid Viscosity** | **Basecase Flow Rate** | **Friction Loss** | **% increase in power requirements for C/K loss** | **% Max decrease in flow rate with Constant power** |
| --- | --- | --- | --- | --- | --- | --- |
| 500 ft | 12.0 ppg | 30.0 cP | 0.2 bbl/min | 0.00 MPa | 60.2 | -37.6 |
| 500 ft | 12.0 ppg | 30.0 cP | 1.0 bbl/min | 0.00 MPa | 60.2 | -48.7 |
| 500 ft | 12.0 ppg | 30.0 cP | 2.0 bbl/min | 0.01 MPa | 248.8 | -37.6 |
| 500 ft | 12.0 ppg | 30.0 cP | 3.0 bbl/min | 0.02 MPa | 74.1 | -28.8 |
| 500 ft | 12.0 ppg | 30.0 cP | 5.0 bbl/min | 0.06 MPa | 74.7 | -27.0 |
| 500 ft | 12.0 ppg | 30.0 cP | 8.0 bbl/min | 0.12 MPa | 75.3 | -27.7 |
| 500 ft | 12.0 ppg | 30.0 cP | 10.0 bbl/min | 0.18 MPa | 75.7 | -27.5 |
| 500 ft | 13.0 ppg | 40.0 cP | 0.2 bbl/min | 0.00 MPa | 60.2 | -37.6 |
| 500 ft | 13.0 ppg | 40.0 cP | 1.0 bbl/min | 0.00 MPa | 60.2 | -48.7 |
| 500 ft | 13.0 ppg | 40.0 cP | 2.0 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 500 ft | 13.0 ppg | 40.0 cP | 3.0 bbl/min | 0.03 MPa | 73.8 | -22.7 |
| 500 ft | 13.0 ppg | 40.0 cP | 5.0 bbl/min | 0.06 MPa | 74.5 | -27.9 |
| 500 ft | 13.0 ppg | 40.0 cP | 8.0 bbl/min | 0.14 MPa | 75.1 | -27.8 |
| 500 ft | 13.0 ppg | 40.0 cP | 10.0 bbl/min | 0.21 MPa | 75.4 | -27.6 |
| 500 ft | 14.0 ppg | 50.0 cP | 0.2 bbl/min | 0.00 MPa | 60.2 | -37.6 |
| 500 ft | 14.0 ppg | 50.0 cP | 1.0 bbl/min | 0.00 MPa | 60.2 | -48.7 |
| 500 ft | 14.0 ppg | 50.0 cP | 2.0 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 500 ft | 14.0 ppg | 50.0 cP | 3.0 bbl/min | 0.01 MPa | 260.6 | -37.6 |
| 500 ft | 14.0 ppg | 50.0 cP | 5.0 bbl/min | 0.07 MPa | 74.3 | -27.7 |
| 500 ft | 14.0 ppg | 50.0 cP | 8.0 bbl/min | 0.16 MPa | 74.9 | -27.8 |
| 500 ft | 14.0 ppg | 50.0 cP | 10.0 bbl/min | 0.23 MPa | 75.2 | -27.6 |
| 500 ft | 15.0 ppg | 60.0 cP | 0.2 bbl/min | 0.00 MPa | 60.2 | -37.6 |
| 500 ft | 15.0 ppg | 60.0 cP | 1.0 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 500 ft | 15.0 ppg | 60.0 cP | 2.0 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 500 ft | 15.0 ppg | 60.0 cP | 3.0 bbl/min | 0.02 MPa | 60.2 | -37.6 |
| 500 ft | 15.0 ppg | 60.0 cP | 5.0 bbl/min | 0.08 MPa | 74.1 | -27.8 |
| 500 ft | 15.0 ppg | 60.0 cP | 8.0 bbl/min | 0.18 MPa | 74.7 | -27.8 |
| 500 ft | 15.0 ppg | 60.0 cP | 10.0 bbl/min | 0.26 MPa | 75.0 | -27.7 |
| 2000 ft | 12.0 ppg | 30.0 cP | 0.2 bbl/min | 0.00 MPa | 60.2 | -37.6 |
| 2000 ft | 12.0 ppg | 30.0 cP | 1.0 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 2000 ft | 12.0 ppg | 30.0 cP | 2.0 bbl/min | 0.02 MPa | 248.8 | -37.6 |
| 2000 ft | 12.0 ppg | 30.0 cP | 3.0 bbl/min | 0.09 MPa | 74.1 | -28.3 |
| 2000 ft | 12.0 ppg | 30.0 cP | 5.0 bbl/min | 0.22 MPa | 74.7 | -27.8 |
| 2000 ft | 12.0 ppg | 30.0 cP | 8.0 bbl/min | 0.50 MPa | 75.3 | -27.5 |
| 2000 ft | 12.0 ppg | 30.0 cP | 10.0 bbl/min | 0.73 MPa | 75.7 | -27.5 |
| 2000 ft | 13.0 ppg | 40.0 cP | 0.2 bbl/min | 0.00 MPa | 60.2 | -37.6 |
| 2000 ft | 13.0 ppg | 40.0 cP | 1.0 bbl/min | 0.02 MPa | 60.2 | -37.6 |
| 2000 ft | 13.0 ppg | 40.0 cP | 2.0 bbl/min | 0.03 MPa | 60.2 | -37.6 |
| 2000 ft | 13.0 ppg | 40.0 cP | 3.0 bbl/min | 0.11 MPa | 73.8 | -22.7 |
| 2000 ft | 13.0 ppg | 40.0 cP | 5.0 bbl/min | 0.25 MPa | 74.5 | -27.9 |
| 2000 ft | 13.0 ppg | 40.0 cP | 8.0 bbl/min | 0.57 MPa | 75.1 | -27.6 |
| 2000 ft | 13.0 ppg | 40.0 cP | 10.0 bbl/min | 0.84 MPa | 75.4 | -27.6 |
| 2000 ft | 14.0 ppg | 50.0 cP | 0.2 bbl/min | 0.00 MPa | 60.2 | -37.6 |
| 2000 ft | 14.0 ppg | 50.0 cP | 1.0 bbl/min | 0.02 MPa | 60.2 | -37.6 |
| 2000 ft | 14.0 ppg | 50.0 cP | 2.0 bbl/min | 0.04 MPa | 60.2 | -37.6 |
| 2000 ft | 14.0 ppg | 50.0 cP | 3.0 bbl/min | 0.06 MPa | 260.6 | -37.6 |
| 2000 ft | 14.0 ppg | 50.0 cP | 5.0 bbl/min | 0.28 MPa | 74.3 | -27.7 |
| 2000 ft | 14.0 ppg | 50.0 cP | 8.0 bbl/min | 0.64 MPa | 74.9 | -27.7 |
| 2000 ft | 14.0 ppg | 50.0 cP | 10.0 bbl/min | 0.94 MPa | 75.2 | -27.6 |
| 2000 ft | 15.0 ppg | 60.0 cP | 0.2 bbl/min | 0.00 MPa | 60.2 | -37.6 |
| 2000 ft | 15.0 ppg | 60.0 cP | 1.0 bbl/min | 0.02 MPa | 60.2 | -37.6 |
| 2000 ft | 15.0 ppg | 60.0 cP | 2.0 bbl/min | 0.05 MPa | 60.2 | -37.6 |
| 2000 ft | 15.0 ppg | 60.0 cP | 3.0 bbl/min | 0.07 MPa | 60.2 | -37.6 |
| 2000 ft | 15.0 ppg | 60.0 cP | 5.0 bbl/min | 0.32 MPa | 74.1 | -27.8 |
| 2000 ft | 15.0 ppg | 60.0 cP | 8.0 bbl/min | 0.70 MPa | 74.7 | -27.7 |
| 2000 ft | 15.0 ppg | 60.0 cP | 10.0 bbl/min | 1.04 MPa | 75.0 | -27.7 |
| 4000 ft | 12.0 ppg | 30.0 cP | 0.2 bbl/min | 0.00 MPa | 60.2 | -37.6 |
| 4000 ft | 12.0 ppg | 30.0 cP | 1.0 bbl/min | 0.02 MPa | 60.2 | -37.6 |
| 4000 ft | 12.0 ppg | 30.0 cP | 2.0 bbl/min | 0.05 MPa | 248.8 | -37.6 |
| 4000 ft | 12.0 ppg | 30.0 cP | 3.0 bbl/min | 0.18 MPa | 74.1 | -27.9 |
| 4000 ft | 12.0 ppg | 30.0 cP | 5.0 bbl/min | 0.44 MPa | 74.7 | -27.7 |
| 4000 ft | 12.0 ppg | 30.0 cP | 8.0 bbl/min | 0.99 MPa | 75.3 | -27.5 |
| 4000 ft | 12.0 ppg | 30.0 cP | 10.0 bbl/min | 1.47 MPa | 75.7 | -27.5 |
| 4000 ft | 13.0 ppg | 40.0 cP | 0.2 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 4000 ft | 13.0 ppg | 40.0 cP | 1.0 bbl/min | 0.03 MPa | 60.2 | -37.6 |
| 4000 ft | 13.0 ppg | 40.0 cP | 2.0 bbl/min | 0.06 MPa | 60.2 | -37.6 |
| 4000 ft | 13.0 ppg | 40.0 cP | 3.0 bbl/min | 0.21 MPa | 73.8 | -22.7 |
| 4000 ft | 13.0 ppg | 40.0 cP | 5.0 bbl/min | 0.51 MPa | 74.5 | -27.9 |
| 4000 ft | 13.0 ppg | 40.0 cP | 8.0 bbl/min | 1.14 MPa | 75.1 | -27.6 |
| 4000 ft | 13.0 ppg | 40.0 cP | 10.0 bbl/min | 1.68 MPa | 75.4 | -27.5 |
| 4000 ft | 14.0 ppg | 50.0 cP | 0.2 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 4000 ft | 14.0 ppg | 50.0 cP | 1.0 bbl/min | 0.04 MPa | 60.2 | -37.6 |
| 4000 ft | 14.0 ppg | 50.0 cP | 2.0 bbl/min | 0.08 MPa | 60.2 | -37.6 |
| 4000 ft | 14.0 ppg | 50.0 cP | 3.0 bbl/min | 0.12 MPa | 260.6 | -37.6 |
| 4000 ft | 14.0 ppg | 50.0 cP | 5.0 bbl/min | 0.57 MPa | 74.3 | -27.9 |
| 4000 ft | 14.0 ppg | 50.0 cP | 8.0 bbl/min | 1.27 MPa | 74.9 | -27.7 |
| 4000 ft | 14.0 ppg | 50.0 cP | 10.0 bbl/min | 1.88 MPa | 75.2 | -27.6 |
| 4000 ft | 15.0 ppg | 60.0 cP | 0.2 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 4000 ft | 15.0 ppg | 60.0 cP | 1.0 bbl/min | 0.05 MPa | 60.2 | -37.6 |
| 4000 ft | 15.0 ppg | 60.0 cP | 2.0 bbl/min | 0.09 MPa | 60.2 | -37.6 |
| 4000 ft | 15.0 ppg | 60.0 cP | 3.0 bbl/min | 0.14 MPa | 60.2 | -37.6 |
| 4000 ft | 15.0 ppg | 60.0 cP | 5.0 bbl/min | 0.63 MPa | 74.1 | -27.9 |
| 4000 ft | 15.0 ppg | 60.0 cP | 8.0 bbl/min | 1.41 MPa | 74.7 | -27.7 |
| 4000 ft | 15.0 ppg | 60.0 cP | 10.0 bbl/min | 2.07 MPa | 75.0 | -27.6 |
| 6000 ft | 12.0 ppg | 30.0 cP | 0.2 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 6000 ft | 12.0 ppg | 30.0 cP | 1.0 bbl/min | 0.03 MPa | 60.2 | -37.6 |
| 6000 ft | 12.0 ppg | 30.0 cP | 2.0 bbl/min | 0.07 MPa | 248.8 | -37.6 |
| 6000 ft | 12.0 ppg | 30.0 cP | 3.0 bbl/min | 0.28 MPa | 74.1 | -27.9 |
| 6000 ft | 12.0 ppg | 30.0 cP | 5.0 bbl/min | 0.66 MPa | 74.7 | -27.7 |
| 6000 ft | 12.0 ppg | 30.0 cP | 8.0 bbl/min | 1.49 MPa | 75.3 | -27.5 |
| 6000 ft | 12.0 ppg | 30.0 cP | 10.0 bbl/min | 2.20 MPa | 75.7 | -27.5 |
| 6000 ft | 13.0 ppg | 40.0 cP | 0.2 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 6000 ft | 13.0 ppg | 40.0 cP | 1.0 bbl/min | 0.05 MPa | 60.2 | -37.6 |
| 6000 ft | 13.0 ppg | 40.0 cP | 2.0 bbl/min | 0.09 MPa | 60.2 | -37.6 |
| 6000 ft | 13.0 ppg | 40.0 cP | 3.0 bbl/min | 0.32 MPa | 73.8 | -22.7 |
| 6000 ft | 13.0 ppg | 40.0 cP | 5.0 bbl/min | 0.76 MPa | 74.5 | -27.8 |
| 6000 ft | 13.0 ppg | 40.0 cP | 8.0 bbl/min | 1.71 MPa | 75.1 | -27.6 |
| 6000 ft | 13.0 ppg | 40.0 cP | 10.0 bbl/min | 2.51 MPa | 75.4 | -27.5 |
| 6000 ft | 14.0 ppg | 50.0 cP | 0.2 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 6000 ft | 14.0 ppg | 50.0 cP | 1.0 bbl/min | 0.06 MPa | 60.2 | -37.6 |
| 6000 ft | 14.0 ppg | 50.0 cP | 2.0 bbl/min | 0.12 MPa | 60.2 | -37.6 |
| 6000 ft | 14.0 ppg | 50.0 cP | 3.0 bbl/min | 0.17 MPa | 260.6 | -37.6 |
| 6000 ft | 14.0 ppg | 50.0 cP | 5.0 bbl/min | 0.85 MPa | 74.3 | -27.9 |
| 6000 ft | 14.0 ppg | 50.0 cP | 8.0 bbl/min | 1.91 MPa | 74.9 | -27.7 |
| 6000 ft | 14.0 ppg | 50.0 cP | 10.0 bbl/min | 2.81 MPa | 75.2 | -27.6 |
| 6000 ft | 15.0 ppg | 60.0 cP | 0.2 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 6000 ft | 15.0 ppg | 60.0 cP | 1.0 bbl/min | 0.07 MPa | 60.2 | -37.6 |
| 6000 ft | 15.0 ppg | 60.0 cP | 2.0 bbl/min | 0.14 MPa | 60.2 | -37.6 |
| 6000 ft | 15.0 ppg | 60.0 cP | 3.0 bbl/min | 0.21 MPa | 60.2 | -37.6 |
| 6000 ft | 15.0 ppg | 60.0 cP | 5.0 bbl/min | 0.95 MPa | 74.1 | -27.9 |
| 6000 ft | 15.0 ppg | 60.0 cP | 8.0 bbl/min | 2.11 MPa | 74.7 | -27.7 |
| 6000 ft | 15.0 ppg | 60.0 cP | 10.0 bbl/min | 3.11 MPa | 75.0 | -27.6 |
| 8000 ft | 12.0 ppg | 30.0 cP | 0.2 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 8000 ft | 12.0 ppg | 30.0 cP | 1.0 bbl/min | 0.05 MPa | 60.2 | -37.6 |
| 8000 ft | 12.0 ppg | 30.0 cP | 2.0 bbl/min | 0.09 MPa | 248.8 | -37.6 |
| 8000 ft | 12.0 ppg | 30.0 cP | 3.0 bbl/min | 0.37 MPa | 74.1 | -27.9 |
| 8000 ft | 12.0 ppg | 30.0 cP | 5.0 bbl/min | 0.88 MPa | 74.7 | -27.7 |
| 8000 ft | 12.0 ppg | 30.0 cP | 8.0 bbl/min | 1.99 MPa | 75.3 | -27.5 |
| 8000 ft | 12.0 ppg | 30.0 cP | 10.0 bbl/min | 2.94 MPa | 75.7 | -27.5 |
| 8000 ft | 13.0 ppg | 40.0 cP | 0.2 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 8000 ft | 13.0 ppg | 40.0 cP | 1.0 bbl/min | 0.06 MPa | 60.2 | -37.6 |
| 8000 ft | 13.0 ppg | 40.0 cP | 2.0 bbl/min | 0.12 MPa | 60.2 | -37.6 |
| 8000 ft | 13.0 ppg | 40.0 cP | 3.0 bbl/min | 0.43 MPa | 73.8 | -22.7 |
| 8000 ft | 13.0 ppg | 40.0 cP | 5.0 bbl/min | 1.01 MPa | 74.5 | -27.8 |
| 8000 ft | 13.0 ppg | 40.0 cP | 8.0 bbl/min | 2.27 MPa | 75.1 | -27.6 |
| 8000 ft | 13.0 ppg | 40.0 cP | 10.0 bbl/min | 3.35 MPa | 75.4 | -27.5 |
| 8000 ft | 14.0 ppg | 50.0 cP | 0.2 bbl/min | 0.02 MPa | 60.2 | -37.6 |
| 8000 ft | 14.0 ppg | 50.0 cP | 1.0 bbl/min | 0.08 MPa | 60.2 | -37.6 |
| 8000 ft | 14.0 ppg | 50.0 cP | 2.0 bbl/min | 0.15 MPa | 60.2 | -37.6 |
| 8000 ft | 14.0 ppg | 50.0 cP | 3.0 bbl/min | 0.23 MPa | 260.6 | -37.6 |
| 8000 ft | 14.0 ppg | 50.0 cP | 5.0 bbl/min | 1.14 MPa | 74.3 | -27.9 |
| 8000 ft | 14.0 ppg | 50.0 cP | 8.0 bbl/min | 2.55 MPa | 74.9 | -27.7 |
| 8000 ft | 14.0 ppg | 50.0 cP | 10.0 bbl/min | 3.75 MPa | 75.2 | -27.6 |
| 8000 ft | 15.0 ppg | 60.0 cP | 0.2 bbl/min | 0.02 MPa | 60.2 | -37.6 |
| 8000 ft | 15.0 ppg | 60.0 cP | 1.0 bbl/min | 0.09 MPa | 60.2 | -37.6 |
| 8000 ft | 15.0 ppg | 60.0 cP | 2.0 bbl/min | 0.19 MPa | 60.2 | -37.6 |
| 8000 ft | 15.0 ppg | 60.0 cP | 3.0 bbl/min | 0.28 MPa | 60.2 | -37.6 |
| 8000 ft | 15.0 ppg | 60.0 cP | 5.0 bbl/min | 1.26 MPa | 74.1 | -27.9 |
| 8000 ft | 15.0 ppg | 60.0 cP | 8.0 bbl/min | 2.82 MPa | 74.7 | -27.7 |
| 8000 ft | 15.0 ppg | 60.0 cP | 10.0 bbl/min | 4.14 MPa | 75.0 | -27.6 |
| 10000 ft | 12.0 ppg | 30.0 cP | 0.2 bbl/min | 0.01 MPa | 60.2 | -37.6 |
| 10000 ft | 12.0 ppg | 30.0 cP | 1.0 bbl/min | 0.06 MPa | 60.2 | -37.6 |
| 10000 ft | 12.0 ppg | 30.0 cP | 2.0 bbl/min | 0.12 MPa | 248.8 | -37.6 |
| 10000 ft | 12.0 ppg | 30.0 cP | 3.0 bbl/min | 0.46 MPa | 74.1 | -27.9 |
| 10000 ft | 12.0 ppg | 30.0 cP | 5.0 bbl/min | 1.10 MPa | 74.7 | -27.7 |
| 10000 ft | 12.0 ppg | 30.0 cP | 8.0 bbl/min | 2.48 MPa | 75.3 | -27.5 |
| 10000 ft | 12.0 ppg | 30.0 cP | 10.0 bbl/min | 3.67 MPa | 75.7 | -27.5 |
| 10000 ft | 13.0 ppg | 40.0 cP | 0.2 bbl/min | 0.02 MPa | 60.2 | -37.6 |
| 10000 ft | 13.0 ppg | 40.0 cP | 1.0 bbl/min | 0.08 MPa | 60.2 | -37.6 |
| 10000 ft | 13.0 ppg | 40.0 cP | 2.0 bbl/min | 0.15 MPa | 60.2 | -37.6 |
| 10000 ft | 13.0 ppg | 40.0 cP | 3.0 bbl/min | 0.53 MPa | 73.8 | -22.7 |
| 10000 ft | 13.0 ppg | 40.0 cP | 5.0 bbl/min | 1.26 MPa | 74.5 | -27.8 |
| 10000 ft | 13.0 ppg | 40.0 cP | 8.0 bbl/min | 2.84 MPa | 75.1 | -27.6 |
| 10000 ft | 13.0 ppg | 40.0 cP | 10.0 bbl/min | 4.19 MPa | 75.4 | -27.5 |
| 10000 ft | 14.0 ppg | 50.0 cP | 0.2 bbl/min | 0.02 MPa | 60.2 | -37.6 |
| 10000 ft | 14.0 ppg | 50.0 cP | 1.0 bbl/min | 0.10 MPa | 60.2 | -37.6 |
| 10000 ft | 14.0 ppg | 50.0 cP | 2.0 bbl/min | 0.19 MPa | 60.2 | -37.6 |
| 10000 ft | 14.0 ppg | 50.0 cP | 3.0 bbl/min | 0.29 MPa | 260.6 | -37.6 |
| 10000 ft | 14.0 ppg | 50.0 cP | 5.0 bbl/min | 1.42 MPa | 74.3 | -27.9 |
| 10000 ft | 14.0 ppg | 50.0 cP | 8.0 bbl/min | 3.19 MPa | 74.9 | -27.7 |
| 10000 ft | 14.0 ppg | 50.0 cP | 10.0 bbl/min | 4.69 MPa | 75.2 | -27.6 |
| 10000 ft | 15.0 ppg | 60.0 cP | 0.2 bbl/min | 0.02 MPa | 60.2 | -37.6 |
| 10000 ft | 15.0 ppg | 60.0 cP | 1.0 bbl/min | 0.12 MPa | 60.2 | -37.6 |
| 10000 ft | 15.0 ppg | 60.0 cP | 2.0 bbl/min | 0.23 MPa | 60.2 | -37.6 |
| 10000 ft | 15.0 ppg | 60.0 cP | 3.0 bbl/min | 0.35 MPa | 60.2 | -37.6 |
| 10000 ft | 15.0 ppg | 60.0 cP | 5.0 bbl/min | 1.58 MPa | 74.1 | -27.9 |
| 10000 ft | 15.0 ppg | 60.0 cP | 8.0 bbl/min | 3.52 MPa | 74.7 | -27.7 |
| 10000 ft | 15.0 ppg | 60.0 cP | 10.0 bbl/min | 5.18 MPa | 75.0 | -27.6 |