Aphron System vs Nitrogen - EaZy Drill Performance on Bakken Shale Pad

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An oil and gas operator in the Bakken Shale enlisted Workover Solutions to provide thru-tubing BHA components and tool specialists for their coil tubing-conveyed frac plug drillout operations. In this application, the well was extremely poor in terms of wellhead pressure and return rate. During the operation, the flow path into the formation posed the least amount of resistance for the fluid, rather than the annular wellbore. The first attempt to reach bottom, nitrogen was used while the second attempt, an Aphron fluid system was utilized.

Nitrogen can result in issues with the motor stator due to the N2 impregnating the rubber and causing it to swell, therefore, losing efficiency and/or total functionality. In addition, the EaZy drill is also affected since nitrogen is compressible and dampens the pressure pulse (or hammer effect). Aphron maintains a fluid state during the entire operation and does not hinder the tools, its main application is to create a pressure barrier in the formation and divert flow up the wellbore.

The result of the nitrogen operation yielded 18 of 29 plugs drilled out over 3 separate BHAs and no additional progress could be made. As opposed to the Aphron system operation, that drilled out the remaining 11 plugs and made it to TD on one BHA and minimal issues. The nitrogen operation saw high fluctuation in wellhead pressure (average of 270 psi) and return rate (average of 3.80 BPM) at an average pump rate of 4.98 BPM, with points of wellhead pressure and return rate lost all together. Progress deeper into the well was extremely slow due to the decrease in effectiveness of the EaZy Drill, with average wash times between plugs of 2 hours and 15 minutes (not including pulling out for BHA trips). The Aphron system generated much higher and more stable wellhead pressures (average of 685 psi) and better return rates (average of 4.80 BPM) with a lower average pump rate of 4.5 BPM. The Eazy Drill had no issue in aiding the coil string in its objective to make it to TD, average wash times were at 1 hour and 15 minutes.

Operation Parameters

- 7” 32# casing with 4-1/2” 13.5# liner
- 2-3/8” coil tubing unit
- 2-7/8” BHA with high flow EaZy Drill and 3-3/4” mill
- Composite frac plugs

Application Challenges

- Poor wellhead pressure
- Low return rate due to fluid invasion
- Nitrogen impregnation and compressibility

Nitrogen vs Aphron Results

	Nitrogen	Aphron
Open to Close (hrs)	133	28
BHA Count	3	1
PBTD (ft)	21,122	21,122
MD Reached (ft)	21,136	21,136
Plug Count	29	10
Plugs Drilled	18	10
Total Mill Time (min)	52	35
Avg Mill Time (min)	2.9	3.5
Total Wash Time (min)	6,056	676
Avg Wash Time (min)	356	75
Avg Circ PSI	5,061	5,280
Avg WH PSI	270	685
Avg Pump Rate (BPM)	4.98	4.50
Avg Return Rate (BPM)	3.80	4.80