

ROGUE Composite Frac Plug Exceeds Customer Expectations in the Bakken



CASE STUDY

Background:

PetroFrac's **ROGUE** composite frac plug is the shortest composite frac plug on the market. The **ROGUE** incorporates a dissolvable flapper for isolation during multistage stimulation instead of a ball. The flapper has a close-on-demand feature that gives the operator the ability to close the flapper when ready. The short length of the plug and the dissolvable flapper greatly reduce the time needed to mill-up and clean the well compared to other plugs on the market.

Challenge:

A major operator in the Bakken had been trialing various frac plugs in an effort to reduce its completion cost in search of a reliable design to:

- Reduce mill out times
- Increase run-in-hole speed
- Increase reliability and hold during frac operations

Previous competitor's plugs had issues with slipping and an excessive amount of debris in the well after milling.

< 2-minute
drillout times

900 ft/min
run speeds

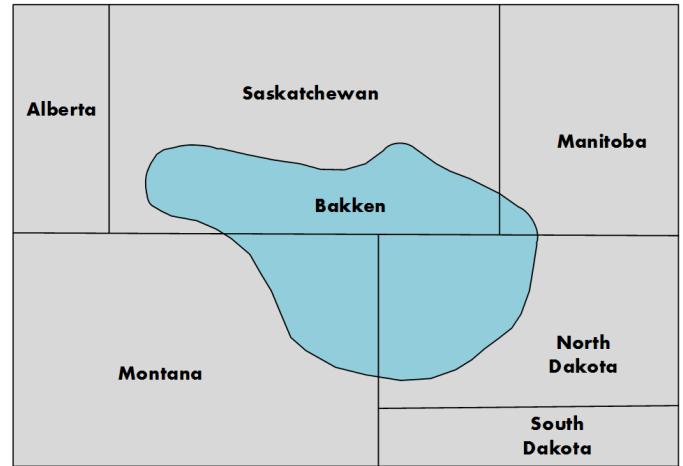
\$69,708
in savings



Solution:

PetroFrac's **ROGUE** Composite Frac Plugs were delivered to location and were successfully installed on an 8 well pad for the operator in the Bakken.

- The simplicity of design and the **ROGUE** Smart wireline adaptor kit allowed the operator to run in at up to 900 ft/min
- The Close on Demand feature allowed rate induced closure, positive indication of set, and 100% zonal isolation
- The compact design and dissolvable flapper reduced mill out times from an average of 7 minutes/plug to less than an average of 1.85 minutes resulting in a **savings of \$69,708** for the 8 well pad with minimal debris left behind.



Milling Times:

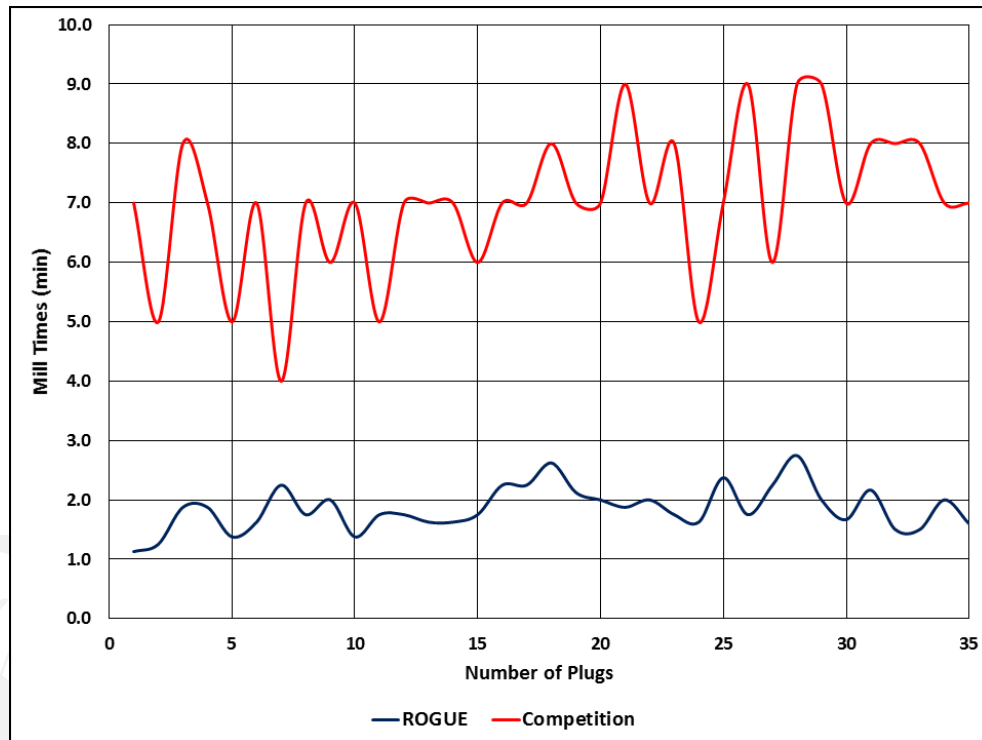
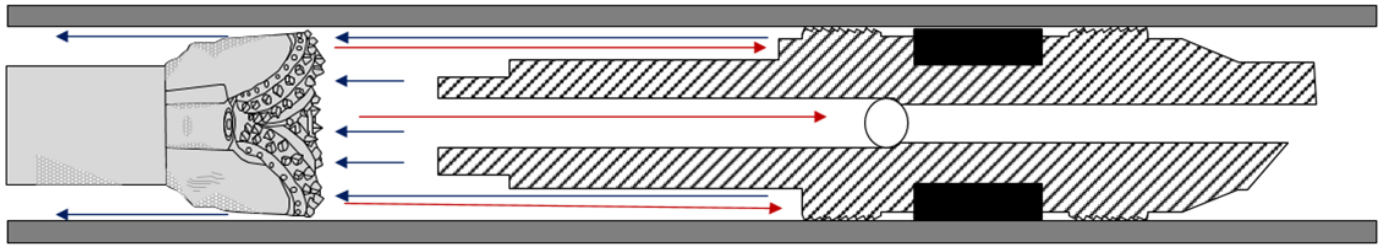


Chart comparing the milling times between the ROGUE and the Competition

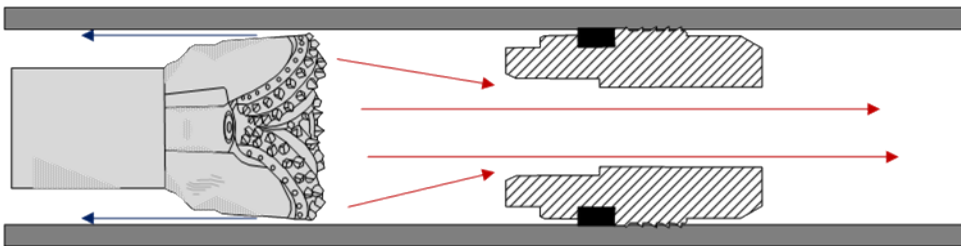
MILLING INNOVATION

Traditional Frac Plug During Milling



Fluid pumped from the surface during milling operations on a traditional frac plug creates a piston effect against the BHA keeping it from getting the full benefit of the weight applied from surface. Therefore more weight must be set on the BHA which creates additional friction between the coiled tubing and the casing. The reduced effective weight on bit and increased friction reduces the efficiency of the milling process and the depth the coiled tubing can push the BHA downhole.

ROGUE Frac Plug During Milling



Prior to milling operations, the **ROGUE** frac plug flapper has dissolved. The unobstructed flow path thru the plug reduces the piston effect which increases effective weight on bit. The increased effective weight on bit, along with the **ROGUE's** compact design, increases milling efficiency and increases the effective drilling of composites in long reach horizontals reducing the number of expensive dissolvable plugs needed at the toe of the well.

Debris size and friction factor:

The size and volume of plug debris has an impact on how efficiently it can be transported out of the wellbore. When larger pieces of debris are slow moving, or fall out of transport and accumulate, the coefficient of friction increases. Higher friction through the helical curvature causes an increase in the contact between the coiled tubing and casing wall. In most extended reach horizontal applications, the increased friction will increase the trip and circulating time between plugs, and in some cases cause friction lockup of the coiled tubing prior to reaching the desired mill depth.

The data collected from the coiled tubing operator showed that this well pad has one of the lowest overall friction factors due to the improved debris management and fluid control protocols.

A comparison between the debris of the **ROGUE** versus typical frac plugs show the following.

The **ROGUE**:

- has a weight of 4 lbs, versus 11lbs
- overall length of 7", versus a length of >14" for the competitors.

The average number of plugs run per well on this pad was 35, the compact design of the **ROGUE** resulted in:

- 240 lbs less material, (140 lbs vs. 385 lbs) per well
- 21' less overall milling (20' vs. 41')

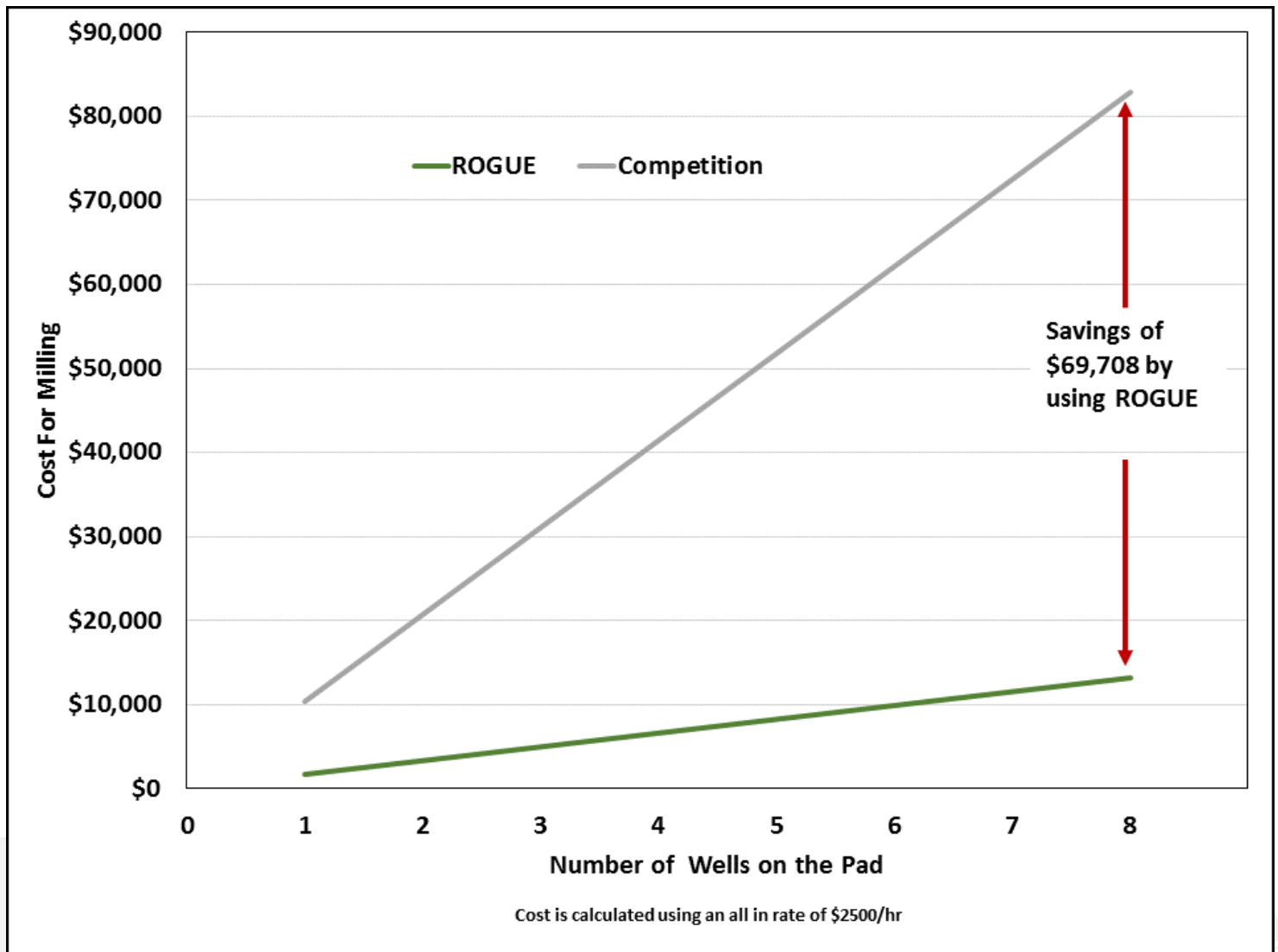
Combining these factors with the design features improves well cleanout, improved motor & bit life, while reducing the overall milling time by a minimum of 3 hours per well. A reduced final friction factor achieved on this pad proves the wells are much cleaner and TD was reached more efficiently.



Photo from the milled debris taken from the Well Pad in this Case Study

OPERATIONAL IMPACT

Chart shows the money saved by the operator by using the **ROGUE** from time saved during the milling operation



The savings in time and money from the fast run in speed and quick milling has made the ROGUE Composite Frac Plug the economical preferred solution.