

Single-Trip Multistage Proppant Fracturing System

Development and Deployment of Ragnarok Frac system in the Norwegian Continental Shelf

Background

A major North Sea operator was looking to improve production from low permeable sandstone reservoirs in mature assets.

The target was to ensure that near wellbore conductivity was sufficient for the required production rates. This dictated a need for a system that is robust in a proppant-filled environment, able to withstand and recover from potential screenouts, and accurately place the proppant without overflushing. Under-displaced, high proppant concentration fracs must be pumped in an efficient manner to unlock the potential value.

Project economics dictated that existing field infrastructure was to be used to execute the work. The time, cost, and space available on platform rigs were cost-prohibitive for mobilization of coil tubing. Therefore, the identified solution should be conveyed on drillpipe with the platform rig while in drilling mode. This method requires installing the upper completion after performing the frac stimulation.

Case study facts

Location: Norwegian Continental Shelf

Well type: Low-permeability oil producer

Products

- 5.5-in. 20-23 ppf Ragnarok Unlimited Frac System
- i-Con™ Downhole Monitoring Tool

General Well Information

- Host Casing size/weight: 9.625-in. 53.5 ppf
- Liner size/weight: 5.500-in. 20 ppf
- Open Hole Size: 8.500-in.
- Bottom Hole Temperature: 105 °C (221 °F)
- Measured well depth (MD): 6,950 m (22,800 ft)
- Well depth (TVD): 2,947 m (9,668 ft)



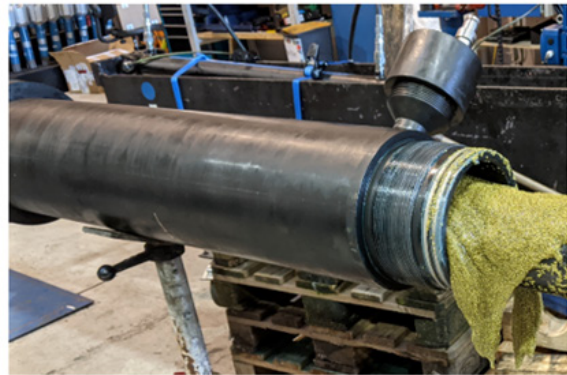
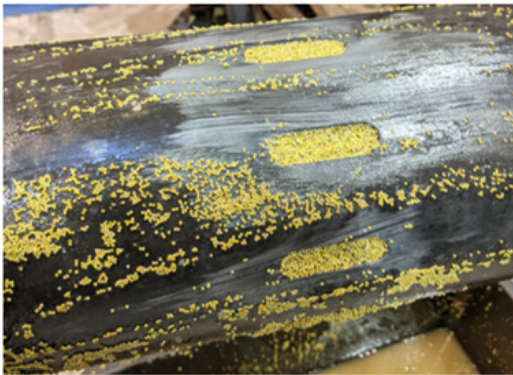
Case Study

Solution

The Ragnarok single-trip, multistage stage proppant fracturing system was developed to tackle these operational constraints and reliably perform in challenging offshore environments. The Ragnarok system consists of a frac sleeve system operated by a service tool assembly (STA) which can be run on drillpipe or coiled tubing. The unique feature of the Ragnarok system is that it allows multistage stimulation in a single trip without utilizing slips or packers, which could pose the risk of a stuck assembly or difficulty shifting the frac sleeves. Key considerations of the design included operability in proppant-packed environments, erosion resistance, and multiple contingencies built into the STA to allow operational flexibility.

The Ragnarok system was qualified to more than the expected downhole conditions during the fracturing treatments. To test erosion resistance and functionality in proppant-packed environments, the Ragnarok frac sleeve was exposed to 200 tons of one ppg proppant mixed in water at 30 bpm, followed by a flush with 10 ppg proppant slurry. The frac sleeve was then closed and pressure tested - as shown in the image below.

The Ragnarok service tool assembly was subjected to a total of 2000 tons of 5 ppg proppant mixed in linear gel at 30 bpm and inspected to confirm erosion resistance.



Results

The first trial well of the Ragnarok system was completed with four zones successfully stimulated.

Initial production from the well is encouraging. The second trial well scheduled for Q3 2022 will further test the capabilities of the Ragnarok system, with more stages and larger proppant volumes planned for the job.

