Case study: Onshore, East Java, Indonesia

TeleCoil service installed expandable casing patches to 7 shut-in wells, brought all back online

A customer with an onshore field in Indonesia needed to install a casing patch to reduce the gas/oil ratio and allow produced gas below the capacity of the surface gas handling facility. To accomplish these objectives, the customer would have to overcome several challenges. The wells were sour, with 1.6% hydrogen sulfide (H_2S) and a downhole temperature of 270°F (132°C). Limited space existed around the wellhead to rig up the tower due to pipeline and instrumentation installation. The presence of H_2S and the high-pressure sequences during the setting of the casing patch contributed to high coiled-tubing fatigue. An excessive pressure phases would aid in elongating and stretching the coiled tubing (CT) pipe exposed to the wellbore, exerting extra force on the setting tool and creating grounds for tool damage. Lastly, during the casing patch installation, pressure had to be applied and released at the surface to expand the metal tube downhole in sections. That made it impossible to utilize a conventional check valve at the motorhead assembly. With these challenges in mind, the customer turned to Baker Hughes for a solution.

Baker Hughes recommended the **TeleCoil™ intelligent coiled tubing service**, enhanced with the tension, compression and torque module, as the optimum conveyance method. TeleCoil technology reduces job time and accelerates well recovery in all major interventions by supplying downhole power to—and receiving real-time data from—a bottomhole assembly (BHA). In this manner, customers can intervene at exact depths, monitor performance, and confirm results in real time. This technology deemed critical to monitor pipe deformation via tension-compression-torsion sensor and address the challenge of variable forces acting on setting tool. An additional requirement from the operator called for the ability to log with the coiled tubing, a standard feature of the TeleCoil service.

The candidate well had been cased-hole completed with three perforation intervals. Due to the excessive gas flow from the reservoir, these producers

The TeleCoil service eliminates redundant personnel and equipment costs by combining the functionality of conventional coiled tubing and wireline. And since telemetry BHAs can be connected in as little as 30 minutes, the service also reduces downtime between runs.

Challenges

- High setting pressure causing CT stretch and elongation that acts an excessive force on setting tool
- Sour wells with 1.6% H_2S and temperature 270°F (132°C)
- Excessive pipe fatigue due to CT cycling under high internal pressure while expanding the patch in H_2S environment
- Limited space around the wellhead to rig up the tower due to pipeline and instrumentation installation
- Inability to install conventional check valve at the motorhead assembly because a casing patch is required to apply and release CT pressure at the surface

Results

- Installed 27 casing patches in 7 wells
- Reduced gas/oil ratio and allowed produced gas below the capacity of the surface gas handling facility
- Brought shut-in wells back online after three years
- Delivered significant additional production capacity
- Experienced no HSE issues

required to be choked back and eventually was fully isolated in 2017. The customer identified the high gas/oil ratio came from the top perforation interval due to gas coning. Zonal isolation of the upper perforation, a total length of approximately 117 ft (35.6 m), utilizing expandable metal patches was identified as a suitable remediation technology.

The Baker Hughes scope of work was to convey several expandable steel patches, locate them precisely in the wellbore at predefined depths, ensure patches overlapped with each in order to leave no gap, and expand via pressuring up the setting tool up to 7,500 psi (51.7 MPa) on the surface—9,000 psi (62 MPa) downhole—in multiple pressure stages.

The TeleCoil service enabled field personnel to run the wireline caliper tools on CT across the required setting depth. Following that diagnostic run, the patches were precisely located at the depths identified by the operator. During the setting sequence, the downhole differential pressure at the setting tool was continuously monitored. Advanced tension compression and torque sensors measured the coiled tubing stretch and elongation through the applied pressure cycle. As inflation pressure increased, the CT elongated and the string applied downward (compression) force to the packer. Before the packer could be inflated, however, the coiled tubing was tensioned to prevent it from causing excessive compression to the packer during inflation. As the packer decreased the pressure, the CT stretched and the string applied upward (overpull) force to the packer. Before deflation, the coiled tubing was slacked off to prevent the CT from causing excessive overpull to the packer during deflation.

Any excess packer movement under pressure had been highlighted as a significant risk to patch expansion success and the TeleCoil service's tension, compression, and torsion tool was considered a major value to the operation enabling the CT unit operators to adjust surface loads and compensate for stretch and elongation of the pipe throughout the process.

Each well was set with three to four casing patches. Each casing patch required 28 to 33 pressure sequences to be expanded in incremental steps. During pressure stages surface pressure increased 5,000 to 7,500 psi (34.4 to 51.7 MPa) and deflated to 1,000 to 1,200 psi (6.8 to 10.3 MPa).

Reverse circulating the motorhead assembly with mechanically activated check valves had been engineered into the BHA to address the bleeding off the packer pressure after each inflation cycle. The check valve held open during the patch setting process and was intended to be activated in case any leak developed at the setting tool.

With planned fatigue management, two strings were used for this operation. Both mechanical (bending) fatigue and accelerated fatigue due to H_2S exposure were monitored on-the-fly using **CIRCA™ RT real-time CT simulation and analysis software** which incorporates the same algorithms as the **CYCLE™ CT fatigue life management software**. The CIRCA RT software provided service delivery benefits by continuously monitoring well and CT pressures and weights and then update safe operating limits. When fatigue in the casing patch depth interval reached a range of 30 to 40%, the string was cut for to avoid high fatigue on the setting depth area.

Baker Hughes successfully completed the setting patch of all 7 wells with total 27 patches (819 pressure cycles) meeting the health, safety and environmental (HSE) and service delivery targets in a flawless execution. As the customer expected, the campaign delivered significant additional well production capacity, reduced the gas/oil ratio, and allowed produced gas below the capacity of surface gas handling facility.

CYCLE pipe management software provides an on-site assessment of the entire coiled tubing string. The software is designed to accurately manage and assess the life span of coiled tubing strings based on fatigue, ballooning,

Baker Hughes