Intervention on a Cavern Storage Well

Case Study

BACKGROUND:

Wild Well Control (WWC) Personnel responded to a well control event on a cavern storage well on the Texas Gulf Coast. This project posed some unique challenges associated with cavern well interventions that are much different from working with a conventional reservoir storage environment.

EVENT SUMMARY

The event began with a reported leak at the flanged connection between the A-section and B-section of the wellhead. The A-section was landed on the 20" intermediate casing and the 13 ⅜" casing was hung off with a modified hanger system that had limited data available. The 8 ¾" tubing (brine string) was landed in the B-section. Pressure was noted on the 13 ⅜" by 20" casing annulus indicating hydraulic communication between the two strings. A vent line and flare stack were installed on the A-section to flow this annulus for pressure management purposes, and to prevent a possible failure of the 20" casing.

The initial site assessment noted the following challenges:

- Cavern contained +/-6 BCF of processed natural gas. This was a huge concern for collateral damage if the containment of the wellbore was compromised.
- Any loss of containment of the well could lead to a catastrophic failure of the entire cavern and jeopardize neighboring cavern integrity.
- The well was located within a plant facility and thus collateral damage from a well failure would likely be severe.
- Cavern storage wells cannot be killed with hydrostatic pressure from a fluid column like conventional wellbores.
- The wellhead hanger contained a modified bushing which was reported, but no additional data could be located. This made pre-planning for any wellhead repairs very difficult.
- Wellhead body damage was present from the exiting flow.

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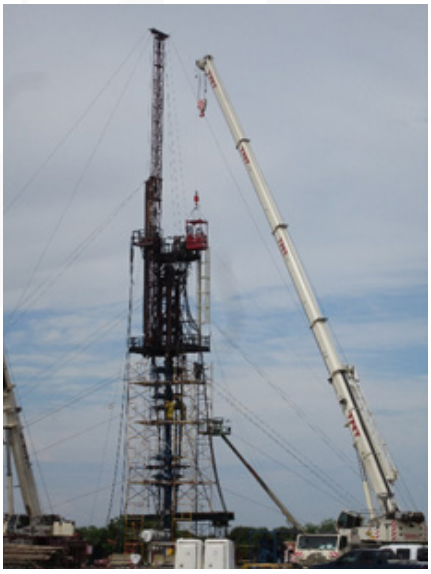
WWC personnel were successful in assisting with the well intervention efforts to remediate the integrity issues with the wellhead and provided the desired firefighting protection as a contingency measure for a loss of wellbore containment.

OPERATIONAL SUMMARY

Most well control operations involve multiple phases to achieve the ultimate goal of regaining control of the well. The following operational phases were completed for this project to reach the final resolution.

Initial Response and Assessment

Upon arrival to the wellsite, the 13 ⅜" by 20" casing annulus was flowing to a flare stack as discussed with the client prior to mobilization. The facility did not appear to have adequate fire suppression if a very large-scale release were to occur. The subject wellbore contained processed natural gas at +/-1,500 psi cavern pressure. Any loss of containment would be a major threat to the entire facility and surrounding area. The initial activities were completed to provide additional firefighting coverage to the area at strategic locations. This involved multiple high volume fire pumps and water storage installations, along with high-rate transfer from more permanent water sources within the plant.



Well Intervention and Recovery

After the fire suppression equipment was in place, the actual wellbore intervention began. The two primary flow paths suspected for the annulus pressure were from a failure point within the 13 ⅜" production casing, or through a failure in the wellhead seals. The modified bushing that was installed on the wellhead seal assembly would not allow for testing the seal integrity. The initial logging efforts indicated that the flow was not coming up the 13 ⅜" by 20" casing annulus, thus indicating that the wellhead seals were the most likely failure point. The primary plan was developed to isolate the cavern from the wellbore to facilitate a full wellhead replacement.

This plan required the removal of the 8 ¾" tubing string under pressure to allow for Bridge Plugs (BP) to be set in the 13 ⅜" production casing to isolate the cavern. A snubbing unit was utilized to execute this operation. The unit required would need to be able to handle the very

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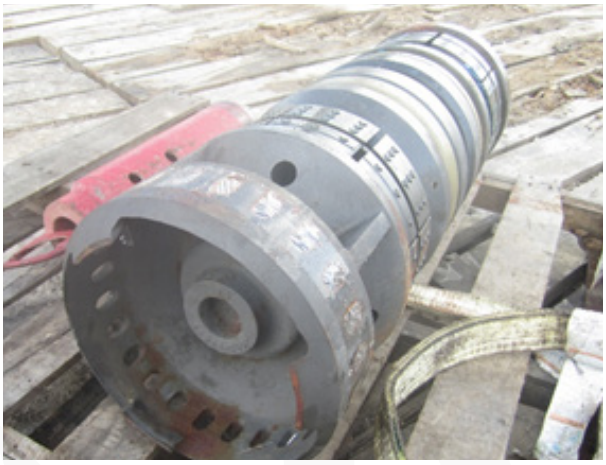
large 8 ¾" tubing string. A 600K unit was dispatched from Oklahoma and installed on the well. Diverting was continued throughout this entire process until the barriers could be established in the production casing.

The tubing string was successfully removed. There was a discrepancy in the reported pipe size on the wellbore schematic, and what pipe was recovered. During the recovery process, it was discovered that there were joints of 8 ⅝" pipe within the string. This required some additional steps for the snubbing operations, but the tubing was fully recovered from the well safely.
The 13 ⅝" pneumatic actuated master valve on the wellhead was closed and the snubbing unit and BOPs were rigged down for the next phase.



Two BPs were set in the 13 ⅜" production casing and tested. The well diversion through the vent line and flare stack was now complete and the cavern was fully isolated via the BPs. The tubing spool was removed, and it was confirmed visually that the seal assembly around the 13 ⅜" production casing was indeed the failure point and the location of the hydraulic communication between the annuli. The master valve was removed and sent for service while the wellbore was isolated with the BPs.

The existing wellhead and section of 20" casing was removed at a pre-determined depth. A new wellhead and appropriate length of 20" casing were assembled at the wellhead vendor's shop and delivered to the site. The new wellhead and casing were welded to the 20" string. The new seal assembly was installed, and the BOPs and snubbing unit were rigged back up to drill out the BPs. The plugs were milled out and the cavern was restored to operational status. The client did not intend to run the tubing string back into the wellbore at that particular time. All equipment was subsequently demobilized, and the project was successful in restoring integrity to the wellhead.