Running Coiled Tubing in Sour Environments

Higher strength coiled tubing is needed to meet today's wellbore trajectories and client needs. Increased strength allows the wall thickness to be decreased, as the length increases, helping to limit physical weight. Alternatively, increased strength materials have a higher hardness, making them more susceptible to hydrogen embrittlement. The mechanism of embrittlement begins very similarly to the mechanisms behind general corrosion. Embrittlement causes reduced ductility and, in the presence of tensile stresses, can cause a micro-fracture, which acts as a crack initiation site, or in some severe cases, brittle cracking through the entire wall thickness of the tubing. The prospect of the sudden, unpredictable failure of a coiled tubing string warrants discussion of best practices to prevent embrittlement from occurring.

Three factors affecting embrittlement that can be difficult to control are: time, temperature, and pH at which the tubing is exposed to hydrogen. As the time of exposure increases, so does the likelihood of embrittlement occurring. Proper planning for coiled tubing operations is critical to reducing the exposure time in a sour well. Higher temperatures help avoid cracking. The increased temperature allows the microstructure of the steel to release hydrogen ions instead of trapping them. Higher concentrations of inhibitors and scavengers may be needed as the temperature decreases (Refer to chemical provider and testing). Similar to higher temperatures, higher pH levels prevent hydrogen from absorbing into the tubing.

With proper testing, planning, and execution, it has been proven that coiled tubing with up to 140,000-psi yield strength can be successfully used in harsh sour environments.

Best practices

- Test wellbore fluids ahead of time to confirm the presence of H_2S*
  - Prepare to use inhibitors and scavengers
- Select appropriate tubing string
  - Use the lowest strength of tubing that meets job requirements
  - ATP products have a preferred microstructure for sour environments
- Control the well chemically*
  - Utilize inhibitors and scavengers at appropriate concentrations
- Manage wellbore fluid pH
  - Add buffering chemicals to remain in the Basic pH spectrum (≥ 11 preferred)

**If running in a pure gas well, inhibitors and scavengers will not be as effective due to transportation of chemical.*

SPE 184806-MS "Development and Compatibility Testing of Coiled Tubing with 140-ksi Specified Minimum Yield Strength"