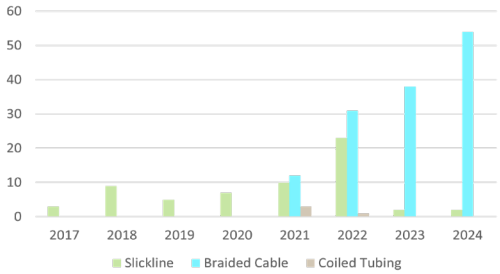
200+ Pressure-Balanced Sleeves Installed in World's Largest Offshore Natural Gas Field Avoid TRSV Replacement Workovers

Objectives

- Design pressure-balanced sleeves (PBS) to protect the internal mechanisms of the Optimax™ tubing retrievable safety valve (TRSV), including flapper torsion springs, from exposure to stimulation fluids (28% hydrochloric acid (HCl)) during carbonate reservoir stimulation and post-stimulation well cleanup operations. The PBS must:
  - Be suitable for high gas flow rates during post-stimulation well cleanup operations
  - Withstand high concentrations of hydrogen sulfide (H_2S) and carbon dioxide (CO_2) in the produced gas throughout well testing
  - Incorporate check valves to prevent pressure buildup in the annular space between the TRSV and the PBS
  - Be deployable in wells using standard wireline and coiled tubing techniques employed by the operator

Our Approach

- In collaboration with the customer, Weatherford engineers designed the PBS and the PBS running tools and conducted all required qualification testing. A cost-effective and robust PBS running tool was developed using the industry-standard GS tool, including a tell-tale device to indicate whether the PBS is set correctly.
- The system design allows for the PBS to be set and the running tool to be released by simple jarring down, while the PBS is retrieved by jarring up. The simple assembly and pinning mechanism eliminate the need to pin the running tool to the fishneck of the PBS. Additionally, the running tool can be quickly converted into the pulling tool. These features are crucial for offshore equipment maintenance and assembly, eliminating the need to ship the running/pulling tool to the shore base after each operation.
- Since the project began in 2017, field personnel used a 0.125-in. and 0.16-in. slickline to deploy the PBS. In 2021, the operator also began using a 7/16-in. braided cable. In 2022, three PBS were retrieved from wells with blackened surfaces between the external seals, indicating unusual contact with stimulation fluid.
- A thorough investigation by the Weatherford Qatar Operations and Engineering Teams revealed that the PBS were not set in the TRSVs due to increased static friction of the internal seals caused by higher well pressures. Contributing factors included deeper PBS setting depths and reduced jarring efficiency due to the use of the braided cable.



Number of jars to retrieve a PBS from the TRSV using 7/16-in. braided cable (2022 to 2024). The reliability of PBS enabled the operator to avoid costly TRSV replacement workovers, which could occur if the TRSV internal mechanisms were damaged during acid stimulation of carbonate reservoirs.

LOCATION
Qatar

WELL TYPE
High-rate gas production

FORMATION
Carbonate

DEPTH
600 to 1,200 ft (182 to 365 m)

PRODUCTS/SERVICES
- Optimax tubing retrieval safety valve
- Pressure-balanced sleeve
- PBS running tool for slickline
- PBS running tool for coiled tubing
- QX blanking plug for PBS

Weatherford®

200+ Pressure-Balanced Sleeves Installed in World's Largest Offshore Natural Gas Field Avoid TRSV Replacement Workovers

Our Approach

- Weatherford engineers implemented preventive and corrective actions, including adjustments to shear values to set the PBS and release the running tool based on well pressures, as well as improvements in the jarring technique to ensure the PBS could be set even in cases of premature release of the running tool. These actions prevented similar issues and led to 98.5% success rate in installations (197 out of 200).
- In 2023, a wireline provider encountered difficulties in one well due to the inability to retrieve the PBS from the TRSV in a single trip. As a result, the pulling tool was disconnected from the PBS and rerun, leading to two runs to retrieve the PBS instead of one, as per standard operating procedure.
- A thorough investigation by the Weatherford teams revealed that increasing the toolstring weight was recommended to enhance the impact force needed to retrieve the PBS from the TRSV. Additionally, setting the spring jar higher and increasing the overpull were recommended to facilitate PBS retrieval from the TRSV.
- Data from previous jobs was reviewed and used to establish KPIs to measure the operational efficiency of PBS retrieval operations. The median was preferred over the average, as it provides a better reflection of typical performance by minimizing the influence of extreme values. The increased success rate of PBS retrieval jobs, achieved through the updated procedure and the introduction of KPIs, allowed for immediate identification of any operational parameters needing improvement and significantly reduced PBS retrieval time. The corrective and preventive actions implemented helped prevent similar issues and led to a total successful retrieval rate of 99.5% (199 out of 200).
- Zero HSE incidents were encountered during the PBS installations and retrieval jobs.

Value to Customer

- Since 2017, 200+ PBS have been installed in gas production wells prior to the stimulation of carbonate reservoirs during the PST stage. To save time on rig up and reduce mobilization costs, the PBS were deployed using the available method at the rig site (slickline, braided cable, or coiled tubing) and did not require a specific deployment method.
- By using a simple, robust design, and premium materials, the 7-in. PBS have delivered reliable and cost-effective services. There were only three issues during 200+ PBS installations due to changes in deployment method and well conditions, but these were thoroughly investigated by Weatherford and prevented from recurring. There were zero failures attributed to the PBS design.

Weatherford®