CASE STUDY

HALLIBURTON

Australia

CHALLENGE

- A fluid-sensitive reservoir completion strategy required perforating 600 m of a near-horizontal interval in underbalanced conditions in one trip
- The deepwater FLNG facility was abrasive and debris sensitive
- The perforating string, which would be left in the well, needed to survive downhole for 20-plus years without deterioration

SOLUTION

- Halliburton collaborated with client to develop the new Corrosive Hostile Environment (CHETM) perforating gun system featuring a specially developed material built to withstand corrosive environments that would normally deteriorate standard equipment
- A special Dominator® shaped charge was also developed specific to the formation and downhole conditions

RESULT

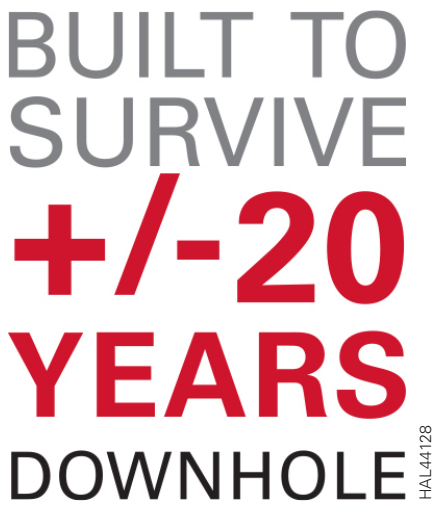
- Successful deployment and detonation on the deepwater corrosive environment project
- Provides long-term assurance needed to protect downhole and surface investments
- Allows access to reservoirs that once were not technologically viable to produce
- Offers exceptional corrosion protection

Halliburton collaborates with client to develop world's first corrosive hostile environment gun system

CHE™ technology built to last 20-plus years in extreme deepwater environments

Overview

The deepwater project was challenged by formation sensitivity to different completion fluids. This discovery led to the decision to run the completion and perforation string at the same time with the purpose of leaving the perforation string in the well. The FLNG (Floating Liquefied Natural Gas) facility will be moored for up to 25 years, which created its own set of challenges because the facility is abrasive and debris sensitive. Leaving standard guns in the hole across the production interval increases the likelihood that the equipment will deteriorate in the corrosive environment downhole and damage the deepwater FLNG facility.



Challenge

One well-completion challenge faced on the deepwater project was its sandface completion strategy, which formation evaluation studies had determined should be cased and perforated. The 600-m near-horizontal interval was in underbalanced conditions and needed to be perforated in one run. The perforating systems needed to be placed in the near-horizontal section of the well prior to running the completion, which would be run in and placed above the perforation interval prior to perforating. Post-perforating, the perforating string would need to automatically drop off to allow for retrievability in manageable sections for later recovery to surface if desired.

The fact that the deepwater FLNG facility would be in place for up to 25 years created its own challenge. The FLNG facility is abrasive and debris sensitive—like all production facilities. Thus, leaving the guns in the hole across the production interval would greatly increase the likelihood of deterioration of standard-material equipment in the corrosive environment. The consequences of deteriorating equipment on the FLNG facility hardware over the well production life was not an acceptable risk. Because of the lengthy time the guns were to be deployed and left across the reservoir section in a highly corrosive production zone, the risks were also high that the FLNG facility would encounter some adverse effects, which would need to be addressed.

Solution

The client dispatched these issues by working closely with Halliburton to develop the world's first Corrosive Hostile Environment (CHE™) material tubing-conveyed perforating (TCP) gun system. To alleviate the apparent risks of the new CHE perforating gun system, the client and Halliburton undertook an extensive development and testing program. This program focused on proving the unique CHE gun material and developed customized tooling, instituting a "ground-up" risk-based methodology to ensure robustness of the design, manufacturing, and operational quality plans. The ground-up method involved a tiered review of the specific deepwater application and identified potential failure modes, associated causal events/factors, and contributing conditions. These were then individually addressed in the design and plans.

All exposed system components were manufactured with special CHE machinable materials to resist deterioration in the presence of H_2S, CO_2, produced hydrocarbons, and other wellbore and completion fluids. Since the CHE material changed the metallurgical properties, a comprehensive requalification testing program was developed and executed to ensure the proper operation of all components. The holistic perforating system was tested for explosive reliability, performance, and survivability.

To ensure the enhanced operation, the perforating charge specifically developed for the project wells was performance qualified at the Advanced Perforating Flow Laboratory in an API 19B Section II test. This resulted in a Dominator® charge optimized for the specific formation and downhole conditions. In addition, the entire explosive package was thermally tested and qualified for extended downhole duration of 1000 hours at temperature.

> The special CHE materials can more than triple the service life of components. This allows access to reservoirs that once were not technologically and economically viable to produce.

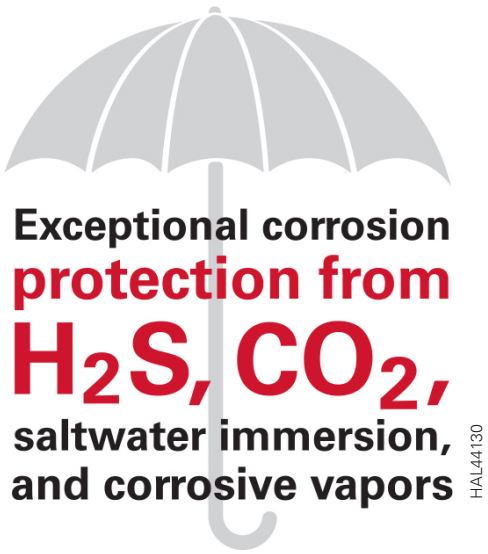
Result

The successful deployment and detonation of the CHE gun system with the initial well performance goals in terms of unload/cleanup, as well as minimal initial debris generation being met during the deepwater completions, demonstrated conclusive proof of concept for the completion design.

In the bigger picture, the CHE system is a step-change for perforating in hostile environments. This complete solution addresses the new challenges experienced as the industry moves to exploit hostile reservoirs. The CHE system targets corrosive environments, which would deteriorate standard system components over time leading to increased downhole debris. This could potentially damage millions to tens of millions of dollars of surface production equipment when flowed to surface.

Built to survive downhole without significant deterioration for +/-20 years, the CHE system provides the long-term assurance needed to protect downhole and surface investments.

CASE STUDY



More information about this case study can be found in the OTC-26615-MS paper, Development of the World's First Corrosive Hostile Environment CHE Gun System.

All exposed system components are modified with special CHE machinable materials to resist deterioration and offers exceptional corrosion protection from H_2S, CO_2, saltwater immersion, corrosive vapors, and other hostile environments due to its transmission properties. The special CHE materials can more than triple the service life of components. This allows access to reservoirs that once were not technologically and economically viable to produce.

For more information, contact your local Halliburton representative or visit us on the web at www.halliburton.com

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