The Importance of Conducting Tests to Ensure the Proper Functioning of Chemical Injection and Lift Gas Valves

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This work aims to highlight the importance of Chemical Injection Test Units and Check Valve Test Benches for offshore operations, which involve high costs. The objective is to ensure the efficient and safe operation of lift gas valves and chemical injection valves through leak-tightness, performance, and durability tests. This testing circuit follows a specific sequence to guarantee its effectiveness and safety, resulting in the delivery of a technical report presenting the obtained results.
Keywords: Pre-Salt. Valves. Test.

Most oil wells at the beginning of production have enough energy for the fluids from the deposits to reach the surface naturally. This occurs due to the high pressure in the well, which, after drilling, allows the oil to rise spontaneously. Over time, as the well continues to produce fluids from the reservoir, the bottom pressure tends to decrease, becoming insufficient for the natural elevation of the oil. It becomes necessary to implement artificial elevation methods in the production column [1].

LIFT gas is one of the widely used methods for lifting oil, especially in wells that lack sufficient pressure for natural flow or require increased production. This technology involves injecting pressurized gas into the lower part of the production pipeline to maintain or increase the well's potential. The injected gas mixes with the produced fluid, significantly reducing its density and consequently reducing the pressure necessary to lift the oil at the bottom of the well [2].

In cases of oil extraction in deep waters, such as the Brazilian pre-salt, paraffin waxes can form, which are the primary components of the solids encrusted by crude oil in production pipes. This occurrence reduces the diameter of the production pipe, causing significant losses in oil extraction. In more extreme cases, it can block the flow and interrupt production.

Paraffin can precipitate when there is a change in the oil's composition, a reduction in pressure, or mainly due to the temperature difference between the well and the platform in deep waters. The oil is at a temperature of approximately 60 °C, while the external environment is at around 5 °C, resulting in rapid cooling [3].

The difficulty of access aggravates the problem of paraffin crystallization in deep-water production pipes. When this occurs, it results in significant production losses, and the maintenance costs are high due to the required downtime for carrying out the necessary repairs. Given this scenario, this work aims to bring knowledge about the importance of chemical injection test units and check valve test benches for offshore operations. These operations are carried out in difficult-to-access locations, at high costs and under high pressures, making it crucial to ensure that the LIFT gas valves and Chemical Injection valves operate effectively and safely. This is achieved through leak-tightness, performance, and durability tests conducted on these units, thereby guaranteeing their proper functioning.

Materials and Methods

The method used in this work to highlight the importance of test units in ensuring the reliability of valve usage involved a comparative study based on several scientific works. This study addressed

Received on 12 May 2025; revised 21 July 2025.
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J Bioeng. Tech. Health 2025;8(4):339-342

the difficulty in extracting oil from offshore wells that have been in operation for a long time in deep waters, such as the Brazilian pre-salt, where the pressure is no longer sufficient for the natural rise of oil. It is necessary to use extraction methods, such as artificial lift, as in the case of gas lift valves.Paraffin wax encrustations inside the production pipes were also analyzed, which formed due to the temperature difference between the well and the platform.. This is exacerbated by the difficulty of access in deep waters, necessitating the use of chemical injection valves to remove them.

Based on this information, the importance of the chemical injection valve test units and the check valve test bench was highlighted in terms of conducting tightness, durability, and performance tests to ensure their proper functioning, given the conditions encountered during activities in the Brazilian pre-salt.

The method used in the test units aims to highlight the importance of these installations and ensure the reliability of valve use. This process follows a test circuit that begins with a planning phase, followed by the receipt of the test demand to be carried out. Then, the requested operational scope is aligned with the units' capabilities, resulting in the preparation of the test matrix. Finally, detailed work instructions are prepared to carry out operational tests (Figure 1).

Results and Discussion

The Check Valves Test Bench is a unit designed to perform tightness tests on retention devices present in gas lift valves (GLV) and chemical injection valves (CIQ). To assess tightness, an inert gas is used, such as Nitrogen (N_2), Helium (He), or another compressive gas at room temperature, with a pressure of 100 psi ±10 psi. This pressure is maintained for at least 10 minutes at room temperature. Tightness is assessed by measuring the leak rate, observing the pressure drop recorded on the pressure gauge or pressure transmitter.

The Chemical Injection Valve Test Unit is an industrial plant that utilizes demineralized water at room temperature to conduct a test circuit evaluating the performance of VIQ under various conditions.

To carry out operational tests on these units, a specific sequence is followed to ensure their effectiveness and safety, such as:

1. Initially, the tightness test of the retention devices is conducted on the check valve test bench to verify the functioning of the retention mechanism at the beginning of the test circuit [4].
2. Following this, a brief tightness test is performed. This involves checking the performance of the chemical injection valves during the opening and closing phases at the start of the test circuit. After subjecting the component to a liquid flow, counter pressure is applied to the valve discharge to ensure no leakage occurs. Variables such as flow rate, pressure, and time are controlled during these tests to assess the results [4].
3. Subsequently, the performance test is carried out to evaluate the valve's capacity under simulated operating conditions. The performance curve is used to assess whether the valve has satisfactory performance before the durability test begins [4].

Figure 1. Description of the test planning phase.

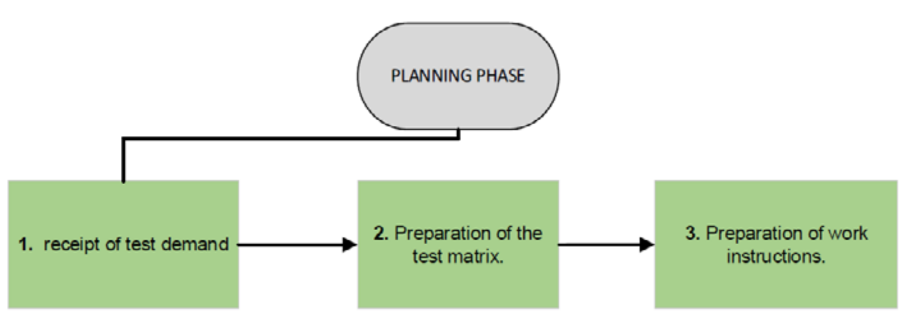
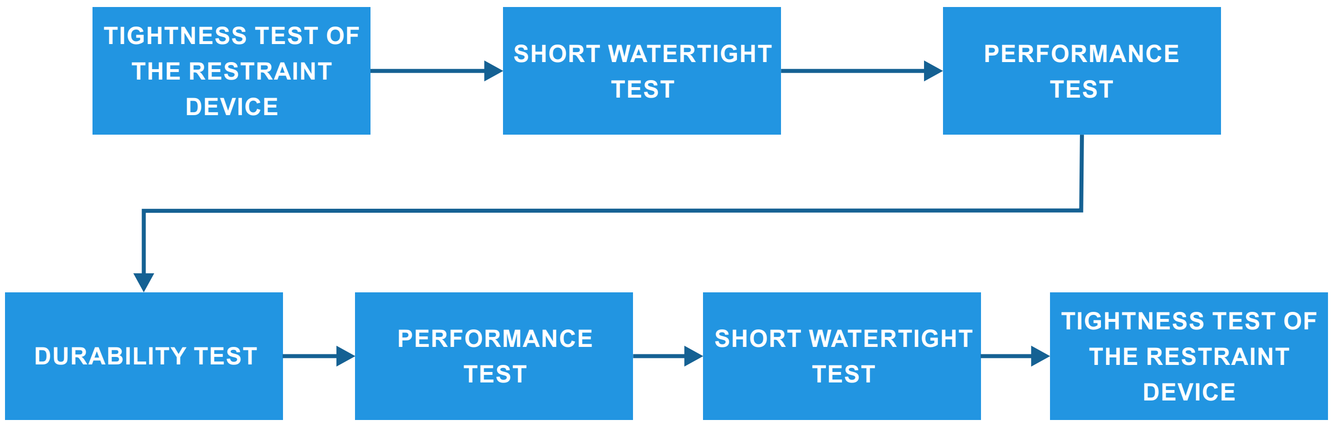


Figure 2. Operational test circuit.



4. Soon after, a durability test is carried out to verify the valve's durability after continuous use. This ensures that the valve can withstand prolonged operating conditions without failure, taking into account the variables of flow, pressure, and time to evaluate the results [4].
5. Then, the performance test is carried out again to evaluate the valve's capacity in simulated operating conditions, using the performance curve to assess whether the valve maintains its performance after the durability test, with flow and time as controlled variables [4].
6. Next, the tightness test is performed again to assess the valve's behavior during opening and closing at the conclusion of the test circuit. After subjecting the component to liquid flow, counter pressure is applied to the valve discharge to ensure there are no leaks following the durability and performance tests. Controlled variables, including flow rate, pressure, and time, are used during the tests to evaluate the results [4].
7. Finally, the tightness test of the retention device is repeated on the check valves test bench, to ensure that the retention mechanism is working correctly after the sequence of tests carried out there [4].

The test circuit is conducted according to the sequence in Figure 2.

At the end of the test circuit carried out in the units, a technical report is prepared to present the results obtained. Furthermore, the entire acquired database is delivered to the test requester.

Conclusion

This study highlights the importance of testing chemical injection valves (CIVs) and gas lift valves (GLVs) used in offshore oil extraction operations. As time passes and oil wells lose their natural pressure, reliance on artificial lifting methods, such as gas lift, becomes increasingly indispensable. These methods, along with the injection of chemicals to manage issues such as paraffin crystallization, ensure continuous and efficient production.

The study highlights the tests necessary to ensure the adequate performance, tightness, and durability of these valves under high-pressure conditions, typical of deep-water environments, such as the Brazilian pre-salt fields. Test units, including the Check Valves Test Stand and Chemical Injection Valve Test Unit, play a key role in verifying the reliability and safety of valves through a structured test circuit.

This study reinforces that without these tests, the operational integrity of the valves cannot be guaranteed, which could lead to significant production losses and high maintenance costs. Ensuring valves operate effectively and safely is crucial to maintaining productivity and minimizing downtime in the demanding conditions of offshore oil extraction.

By implementing these testing methodologies, operators can significantly mitigate risks and improve the longevity and performance of their equipment, thus ensuring more stable and profitable operations.

References

1. Thomas JE. Fundamentos de Engenharia de Petróleo. 2ª ed. Rio de Janeiro: Interciência; 2004. Disponível em: http://www.escolaelectra.com.br/alumni/biblioteca/Fundamentos_da_Engenharia_do_Petroleo.pdf.
2. Santos GS. Abordagem para o problema de gás lift com quantidade de petróleo pré-planejada utilizando meta-heurísticas [Monografia de Graduação]. Natal (RN): Universidade Federal do Rio Grande do Norte – UFRN; 2022.
3. Santana EA. Avaliação da temperatura de cristalização da parafina em sistemas: parafina, solvente e tensoativo [Dissertação de Mestrado]. Natal (RN): Universidade Federal do Rio Grande do Norte – UFRN, Programa de Pós-graduação em Engenharia Química; 2005.
4. Petrobras. Especificação Técnica ET-3000.00-1244-220-P9D-001. Revisão B. Válvulas de Gás Lift. Available at: https://canalfornecedor.petrobras.com.br/documents/10591749/12053533/valvula_de_gas_lift.pdf?download=true.
5. Sabóia GO. Equipamentos submarinos para produção de petróleo e gás. Disponível em: https://www.seaerj.org.br/pdf/equipetro.pdf.
6. Petrobras. Pré-sal. Disponível em: http://www.petrobras.com.br/pt/nossas-atividades/areas-de-atuacao/exploracao-e-producao-de-petroleo-e-gas/pre-sal/.
7. Silva DYC, Franciss R. A completação de poços de petróleo – uma revisão do planejamento das operações e equipamentos. Petrópolis (RJ): Centro de Engenharia e Computação, Universidade Católica de Petrópolis; 2019.