

Infrastructure Issues Related to Subsea Pipelines

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Abstract

Subsea pipelines are essential infrastructure for the transport of oil, gas, and other products across vast distances beneath the ocean floor. These pipelines are critical components of the global energy supply chain, enabling the safe and efficient movement of resources from offshore production facilities to onshore processing facilities or distribution points. However, like all infrastructure, subsea pipelines are subject to a range of issues and challenges that can affect their operation and integrity. Some of these challenges are discussed.

Introduction

Subsea pipelines are typically designed for a service life of 20 to 50 years. The design basis of these pipelines dictates the type of materials and infrastructure required for their safe installation and operation. The infrastructure of subsea pipelines can range from a simple to a more complex system. Depending on the product, the pipeline can be simply made of carbon steel material or can be made with a steel pipe having a metallurgically bonded corrosion resistant alloy layer. In some cases, the pipeline requires concrete coated layer to increase its weight to be stable on the seabed and resist environmental loads during its service life. To mitigate flow assurance issues, the pipeline could have an insulation layer to maintain the product within a high enough temperature to avoid hydrate formation that could stop the flow of the product.

Subsea Pipelines Infrastructure Issues

Some of the issues related to the subsea pipeline's infrastructure are listed below.

1. Corrosion: Corrosion is one of the most significant challenges facing subsea pipelines. Pipelines that are exposed to seawater are particularly vulnerable to corrosion, which can cause leaks or ruptures. The corrosive effects of seawater can be intensified by factors such as high temperatures and pressures. To prevent corrosion, subsea pipelines are typically coated with a protective layer and sacrificial anodes.

2. Fatigue: Fatigue is another critical issue facing subsea pipelines. Over time, the repeated cycles of loading and unloading caused by the movement of waves and currents or temperature cycles can cause the pipeline to reduce its service life. To prevent fatigue issues, subsea pipelines are designed to resist the expected loads and have a build-in flexible system that allows them to withstand the stresses caused by these driving forces. Additionally, fatigue-resistant materials such as steel alloys can be used to increase the pipeline's resistance to fatigue.

3. Natural Disasters: Natural disasters such as hurricanes and earthquakes can cause

significant damage to subsea pipelines. Strong currents and high waves can dislodge or damage pipelines, while earthquakes can cause the seafloor to shift, potentially damaging the pipelines. To mitigate the risk of natural disasters, subsea pipelines are typically designed to either avoid with special features such as flexible joints, anchors, and protective structures.

4. Human Activities: Human activities such as fishing, shipping, and offshore drilling can also pose a threat to subsea pipelines. Fishing trawlers, for example, may accidentally snag and damage pipelines, while shipping vessels may drag anchors across the seafloor, potentially damaging pipelines in their path. To minimize the risk of human activity-related damage, subsea pipelines are often buried beneath the seafloor or marked with buoys to warn ships and boats of their presence.

5. Maintenance and Inspection: Maintaining and inspecting subsea pipelines is an essential part of ensuring their ongoing safety and integrity. Because subsea pipelines are difficult to access, maintenance and inspection must be carried out using Remotely Operated Vehicles (ROVs) or specialized equipment. Regular inspections can detect potential issues such as corrosion or fatigue, allowing for timely repairs or replacements to be carried out before a failure occurs.

Leveraging Technology to Safeguard Pipeline Infrastructure

In addition to robust engineering and strict adherence to the regulatory requirements, pipeline infrastructures are increasingly taking advantage of the recent advances in technology. For example, low-cost long-life subsea smart monitoring systems are being used to act as in-situ digital inspectors gathering millions of data point to provide intelligence on the health of the pipeline infrastructure and to also help optimize operation. Soon, the smart monitoring networks and digital twins will help provide real time data to not only safeguard the infrastructure but potentially increase its life through proactive targeted maintenance substantiated with data intelligence from these smart sensor's networks. In the future, advancement in material systems could be leveraged to implement seamless smartness into the pipeline infrastructure to deliver reliable energy. To eliminate the risk of corrosion, new materials such as light polymer composites are increasing replacing some steel pipes for certain applications

Conclusion

Subsea pipelines play a critical role in the global energy supply chain, but they are subject to a range of infrastructure issues and challenges. Corrosion, fatigue, natural disasters, human activities, and maintenance and inspection are just some of the issues that must be addressed to ensure the safe and reliable operation of subsea pipelines. By designing and constructing pipelines with these challenges in mind and implementing robust safety systems and inspection programs, the energy industry can minimize the risks associated with subsea pipelines and ensure the ongoing delivery of reliable energy resources. Smart monitoring system and smart networks implemented in digital twins will help provide real time data to not only safeguard the pipeline infrastructure but to also to optimize its operation. New and smart materials will further be leveraged to increase the robustness of the pipeline infrastructure.