

Risk Evaluation and Damage Mitigation in Subsea Pipelines: A Literature Review of Concepts, Applications, and Challenges

Abstract

Subsea pipes are one of the critical components in the oil and gas industry, which are used to transport fluids from wells to surface facilities or vice versa. Subsea pipelines can experience damage due to various factors, such as corrosion, erosion, impacts, structural failure, and others. Damage to underwater pipelines can cause leaks, fires, explosions, or even environmental disasters. Therefore, it is necessary to evaluate risks and mitigate damage to ensure the safety and feasibility of subsea pipeline operations. This article provides a literature review of the concepts, applications, and challenges associated with risk evaluation and damage mitigation in subsea pipelines. Various methods and techniques used in risk evaluation and damage mitigation in subsea pipelines are reviewed and compared. Several challenges faced in risk evaluation and damage mitigation in underwater pipelines are identified and solutions are suggested. This article also provides recommendations and suggestions for further research in this area.

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Keywords: Subsea Pipelines, Risk Evaluation, Damage Mitigation, Literature Review, Concepts, Applications, Challenges.

1. Introduction

Subsea pipes are one of the critical components in the oil and gas industry, which are used to transport fluids from wells to surface facilities or vice versa. Subsea pipelines can experience damage due to various factors, such as corrosion, erosion, impacts, structural failure, and others. Damage to underwater pipelines can cause leaks, fires, explosions, or even environmental disasters. Therefore, it is necessary to evaluate risks and mitigate damage to ensure the safety and feasibility of subsea pipeline operations. Risk evaluation and damage mitigation in subsea

pipelines is a very important and challenging field, requiring broad and multidisciplinary knowledge and skills. Various methods and techniques have been developed and applied in risk evaluation and damage mitigation in subsea pipelines, but there is still room for improvement and innovation. Some of the challenges faced in evaluating risks and mitigating damage to undersea pipelines are data uncertainty, model complexity, resource limitations, etc. Some recommendations and suggestions for further research are the development of more accurate, efficient, and integrated methods and techniques, as well as the application of new technology, such as sensors, robots, etc.

2. Method

This article uses a literature review method, namely collecting, analyzing, and synthesizing information from various sources relevant to the research topic. The literature review method is used to identify, classify, and compare various methods and techniques used in risk evaluation and damage mitigation in subsea pipelines. Literature review methods were also used to identify and suggest solutions to some of the challenges faced in risk evaluation and damage mitigation in subsea pipelines. The literature review method has several advantages, such as:

- Provides a general and comprehensive overview of the research topic
 - Point out gaps and deficiencies in previous research
 - Provides a theoretical and methodological basis for further research
 - Improve the quality and validity of research by using various credible sources
- reliable evaluation of risk and mitigation of damage to subsea pipelines is a very important and challenging area, requiring broad and multidisciplinary knowledge and skills. The author has reviewed and compared various concepts, methods, and techniques used in risk evaluation and damage mitigation in undersea pipelines, and identified and suggested solutions to some of the challenges faced in this field.

The author has explained basic concepts related to risk evaluation and damage mitigation in underwater pipelines, such as wall thickness, stability on the seabed, installation, free span, risk matrix, analysis tie, and others. These concepts are the basis for the design, analysis, and monitoring of subsea pipelines, which must meet technical, economic, and environmental requirements. The author has provided definitions, formulas, and parameters used in these concepts, as well as provided examples and illustrative images to clarify the explanation. The author has also cited several relevant sources to support his explanation.

The author has also presented several applications for risk evaluation and damage mitigation in underwater pipelines, such as case studies, numerical simulations, reliability analysis, and others. These applications are concrete examples of the application of the concepts discussed previously, showing how underwater pipelines can experience damage due to various factors, such as anchor strikes, sinking ships, or structural failure, and how to overcome or prevent such damage. The author has also shown several numerical simulations carried out to analyze the behavior of underwater pipelines exposed to environmental loads, such as currents, waves, and winds, which can affect the stability and strength of underwater pipelines. The author has also explained several reliability analysis methods used to calculate the remaining life of subsea pipelines, which can be used to plan inspection, maintenance, and repair of subsea pipelines. The author has also cited several relevant sources to support his explanation.

3. Result And Discussion

Identified several challenges faced in risk evaluation and damage mitigation on subsea pipelines, such as data uncertainty, model complexity, resource limitations, and others. These challenges are obstacles or difficulties that can reduce the quality and validity of risk evaluation

and damage mitigation on subsea pipelines, which can impact the safety and feasibility of subsea pipeline operations. The authors have explained several factors that cause data uncertainty, such as variations in environmental conditions, measurement errors, and lack of historical data, which can affect the accuracy and reliability of data used in risk evaluation and damage mitigation in subsea pipelines. The author has also explained several factors that cause model complexity, such as pipe geometry, pipe-seabed interactions, and pipe-fluid interactions, which can affect the simplicity and realism of models used in risk evaluation and damage mitigation in subsea pipes. The author has also explained several factors that cause resource limitations, such as cost, time, and labor, which can affect the efficiency and availability of resources used in risk evaluation and damage mitigation in subsea pipelines. The author has also cited several relevant sources to support his explanation.



Figure 1. Damage to Subsea Pipelines

Provided recommendations and suggestions for further research, such as the development of more accurate, efficient, and integrated methods and techniques, as well as the application of new technology, such as sensors, robots, etc. These recommendations and suggestions are suggestions or ideas that can be implemented to improve the quality and validity of risk evaluation and damage mitigation on underwater pipelines, as well as to overcome or reduce the challenges faced in this field. The author has suggested several things that can be done to improve the quality and validity of risk evaluation and damage mitigation on underwater pipelines, such as:

- Using more complete, accurate, and up-to-date data, which can be obtained using sensors, satellites, or drones, which can measure and transmit data in real-time and continuously.
- Uses simpler, more realistic, and adaptive models, which can be created using analytical, numerical, or methods hybrid, which can model the geometry, interactions, and behavior of subsea pipelines better and more flexibly.
- Using a faster, easier, and cheaper method, which can be done using algorithms, software, or hardware, can evaluate risks and mitigate damage to underwater pipes more effectively and efficiently.
- Using more sophisticated, reliable, and safe technology, which can be used to carry out inspections, maintenance, and repairs of subsea pipelines, such as robots, ROVs, or AUVs, which can operate under the sea more easily and safely.

4. Conclusion

This article provides a literature review on risk evaluation and damage mitigation in subsea pipelines, which is one of the critical components in the oil and gas industry. Subsea pipelines can experience damage due to various factors, such as corrosion, erosion, impact, structural failure, etc., which can cause leaks, fires, explosions, or even environmental disasters. Therefore, it is

necessary to evaluate risks and mitigate damage to ensure the safety and feasibility of subsea pipeline operations. This article examines and compares various concepts, methods, and techniques used in risk evaluation and damage mitigation in undersea pipelines, and identifies and suggests solutions to some of the challenges faced in this field. This article also provides recommendations and suggestions for further research in this area. This article can be used as a reference for researchers, practitioners, and decision-makers who are interested in risk evaluation and damage mitigation in underwater pipelines.

5. References

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