*Mary Pramila Santhi[1], Susai Rajendran[2]**

[1]Department of Commerce and The Principal, [2]Corrosion Research Centre, Departmentof Chemistry, St.Antony's College of Arts and Sciences for Women, Thamaraipadi, Dindigul,Tamil Nadu, India. (Affiliated to Mother Teresa Women's University, Kodaikanal, India)

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Corrosion management in Petroleum Industry

ABSTRACT

The world is swiftly advancing towards the development of sustainable infrastructure, emphasizing the use of corrosion-resistant materials to effectively optimize corrosion control and reduce lifecycle costs. Addressing corrosion control and mitigation during the initial design and construction phases of assets proves to be more beneficial in the long term, particularly regarding enhanced safety, performance, asset longevity, environmental protection, and operational cost-effectiveness.Overall, the global cost attributed to corrosion is estimated to reach trillions. In general, corrosion is thought to affect approximately 4 percent of anation's GDP, and the continuously escalating environmental threat necessitates immediate and suitable actions.This article will concentrate on the different types of "Corrosion and its Prevention in the Oil and Gas Industry" that impact equipment, pipelines, and infrastructure within the oil and gas sector, along with strategies to alleviate these problems. Corrosion poses a significant challenge in the industry, resulting in safety risks, operational interruptions, and considerable financial losses. This article will address the following essential topics: Types of Corrosion in Oil and Gas, Impact of Corrosion on the Oil and Gas Industry, Corrosion Monitoring and Detection, Corrosion Prevention Methods, Best Practices in Corrosion Management, Case Studies and Industry Standards, and Future Trends in Corrosion Prevention.

Keywords: *corrosion, management, oil and gas industry, petroleum industry, pipe line corrosion*

INTRODUCTION

Management

Industrial management represents a distinct area of engineering dedicated to the advancement of management systems, while simultaneously integrating diverse engineering processes.This field includes industrial design, construction, and the utilization of scientific and engineering principles, all focused on improving the overall industrial infrastructure and processes.

The main focus of industrial management is to supervise industrial processes.Industrial managers are responsible for guaranteeing the optimal and efficient interaction of the four fundamental components referred to as the 4Ms: Man, Material, Machine, and Method, which are crucial for every organization.

Industrial management involves the evaluation of both machinery and employee performance. Experts are responsible for keeping equipment in peak operational condition and ensuring the quality of production results.The flow of materials throughout the facility is tracked to avoid any interruptions for either personnel or machinery. Regular inspections are performed to confirm that production rates align with set standards.

The economic consequences of corrosion in the oil sector total billions of dollars each year. This issue affects every aspect of exploration and production, including offshore platforms and casing materials. The conversation covers different methods for controlling and monitoring corrosion, along with an examination of the chemical elements that lead to its development.

A multitude of research articles has been published regarding corrosion management in the petroleum sector [1-25]. These studies are enumerated in the present research.

1. *An analytical risk-oriented methodology for determining the ideal inspection frequencies of a caustic soda recovery facility: a case analysis.*

Inspection and maintenance activities are crucial for guaranteeing the mechanical integrity and the safe, efficient functioning of systems and equipment.The organization of bare assets is of utmost importance, and it is essential to take into account the inspection and testing of equipment through suitable methods and procedures.The Risk Based Inspection (RBI) methodology, as specified

*Corresponding author: Susai Rajendran
E-mail: susairajendran@gmail.com
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by the American Petroleum Institute (API), currently acts as the primary practical standard for overseeing and scheduling in-service or on-site inspection activities within the chemical sector.This paper introduces the RBI technique, based on the API 581 standard, aimed at determining optimal inspection intervals for a caustic soda recovery facility.By evaluating inspection data concerning significant damage factors such as corrosion and wear, both the probability and implications of potential failures have been analyzed, along with the annual expenses related to the inspection program.

The innovation is found in the application of this analysis specifically to a caustic soda recovery facility, filling the voids in the current literature regarding this application and integrating various damage mechanisms to facilitate a more precise evaluation. As a result, the pertinent scenarios and possible failure outcomes are recognized, which leads to the suggestion of suitable inspection schedules and maintenance practices, based on the assumption that risk remains within acceptable limits between two scheduled intervals. This paper concludes that Risk-Based Inspection (RBI) is an effective maintenance approach for assessing hazardous equipment impacted by multiple damage mechanisms, offering a robust framework for inspection programs that improve operational availability and reduce unplanned shutdowns. [1].

2. A model for predicting corrosion, developed through data analysis, aimed at enhancing the digitization of subsea operations.

Corrosion significantly contributes to the failure of subsea processing operations, especially in subsea crude oil pipelines. The pressing requirement for a data-driven corrosion prediction model emerges from the digitization of subsea processing systems within the Industry 4.0 framework, which is vital for improving the intelligent risk management capabilities of these systems. This paper presents an innovative data-driven model that utilizes hybrid methodologies to evaluate corrosion degradation in subsea operations. The model incorporates three data-driven techniques: principal component analysis (PCA), artificial bee colony algorithm (ABC), and support vector regression (SVR). Its effectiveness in forecasting the corrosion rate of subsea crude oil pipelines has been assessed, facilitating proactive monitoring of corrosion levels. In this hybrid methodology, PCA is employed to diminish the dimensionality of factors affecting corrosion, with the resulting principal components acting as input variables for the model.

The ABC algorithm is utilized to enhance the hyperparameters of the SVR. The model is developed using a segment of historical data, and its efficacy is later assessed against the remaining dataset. A case study exemplifies the model's practicality and efficiency, contrasting it with four other models: SVR, PCA-SVR, PCA-GA-SVR, and PCA-PSO-SVR. The PCA-ABC-SVR model exhibited greater prediction accuracy and resilience, attaining metrics of MAE = 7.10%, RMSE = 9.19%, and R^2 = 0.976. This proposed model is expected to serve as a significant online resource for improving safety and aiding the digitization of processing systems[2].

3. Creating a fuzzy goal programming model to address health, safety, and environmental risks utilizing a hybrid fuzzy FMEA-VIKOR approach.

The operations of the oil industry, ranging from the exploration stage to the management of oil fields, pose considerable negative impacts on both public health and the environment. Therefore, organizations involved in this industry are required to recognize and mitigate their related risks. This document intends to emphasize the known risks arising from various elements such as expenses and volume. Furthermore, it aims to pinpoint the most essential corrective measures through the implementation of a goal-programming approach. To evaluate health, safety, and environmental (HSE) risks, the Fuzzy Delphi technique was utilized. The failure mode and effects analysis (FMEA) along with the fuzzy Vlse Kriterijumsk Optimizacija Kompromisno Resenje (VIKOR) methods were employed to overcome the shortcomings of FMEA in prioritizing HSE risks.

In contrast to other research, the FMEA–VIKOR method proposed here does not compute a risk priority number. Rather, it employs the Eigenvector method to assign weights to parameters such as time, cost, and quality, along with severity, occurrence, and detection, for the purpose of risk ranking. Following this, a fuzzy goal-programming model was created to identify optimal solutions for risk response. The findings of the study indicated that the most critical risks encompass fire and explosion threats associated with tanks and pipelines, as well as leaks from connections and pipelines, in addition to industrial waste. The main strategies for risk mitigation identified include the enhancement of alarm and fire suppression systems, the use of fiberglass tanks to reduce pipeline corrosion, and the implementation of advanced technologies for more efficient oil refining. The significant contribution of this paper is the integration of the FMEA–VIKOR methodology for risk ranking, which considers various factors such as time, cost, and quality, alongside severity, occurrence, and detection.

Furthermore, the establishment of a fuzzy goal-programming framework for pinpointing key risk responses adds additional value to this research.[3]

4. A probabilistic framework for evaluating the rate of corrosion affected by microbiological factors.

This research presents an innovative probabilistic method, in conjunction with traditional techniques, for estimating the rate of microbiologically influenced corrosion (MIC). The suggested approach considers the variability of factors that lead to corrosion, the complex interrelations of structures, and the necessity to adjust the corrosion rate in response to evolving conditions. This method aims to establish a highly parameterized Bayesian network specifically designed for evaluating the MIC rate. The model's validation is performed using field data associated with MIC. The results reveal that iron-oxidizing bacteria and methanogens are the key contributors to the corrosion rate. Furthermore, the study highlights the most intricate parameters influencing this rate. The model developed is crucial for safety evaluations and the management of corrosion risks in oil and gas production and processing facilities. [4].

5. Investigation into the technology for managing corrosion in petroleum pipelines and pressure vessels.

At present, there exists a considerable deficiency in localized corrosion rate data, understanding of corrosion mechanisms, and knowledge of inspection cases related to the corrosion of the upper module weight vessel and weight pipeline for both the fixed oil construction platform and the mobile oil storage and delivery platform. This shortcoming results in inaccurate evaluation outcomes and a fragile basis for integrity management. In response to this issue, the paper investigates the key factors that contribute to the corrosion process and performs a detailed analysis of the primary instruments involved. By meticulously examining elements such as pressure vessel design, material selection, engineering practices, coatings, and slow-release methods, in conjunction with various corrosion instruments, a thorough analysis of corrosion protection for pressure vessels is conducted. The objective is to determine the most effective system for weather protection and rust prevention, thereby ensuring that weight vessels function safely and efficiently within the realm of petrochemical production [5].

6. Generating Value from Existing Gas Fields by Evaluating Well Integrity Assurance through a Thorough Analysis of Different Logs and Inspected Tubular Surfaces.

The Sharjah National Oil Corporation (SNOC) oversees four above-ground gas condensate tanks, three of which are well-established, containing over 50 wells that have been extracting corrosive hydrocarbons for more than thirty years. The dependability of these legacy wells is often examined before any development activities, which complicates the evaluation of well integrity. The costs related to retrieving plugs for assessment and performing logging operations across all wells are considerable, and the range of advancing technologies for corrosion evaluation available in the market complicates the selection of the most dependable option. This paper presents a thorough analysis and comparison of electromagnetic thickness measurements obtained from 10% of the wells, covering the period from 2016 to the post-workover surface inspections of the downhole completion systems in 2020/21. Additionally, it explores how correlating different assessment methods for well integrity improves the reliability of the electromagnetic technology applied to these legacy wells.

Moreover, the document offers a comparison between automated and electromagnetic evaluations of thickness for the production casing in situ.Data from all accessible fuel sources over the last five years were gathered for six wells. After retrieving the downhole completion tubing via a hydraulic workover, an ultrasonic (UT) inspection was conducted at shallow depths. Both sets of results (logs and surface inspections) were examined on the same classification track to deliver a thorough comparison of actual surface observations against measurements acquired through in-situ logging.Furthermore, a multi-barrier corrosion and caliper log was performed in the production casing to assess their findings in conjunction with historical data. The concluding phase involved comparing all available data to create a comprehensive well integrity profile. It was observed that the remaining metal thickness of the production tubing, as identified by the electromagnetic tool (logs) and surface ultrasonic measurements, demonstrated good correlation within a margin of +/-10%.

In evaluating corrosion within the production casing, the electromagnetic tool exhibited an impressive correlation with the results derived from the caliper log. This suggests a significant degree of reliability for this technology in measuring corrosion in offset wells.The relationship between log data and surface inspection results across wells in the same reservoir did not indicate a notable presence of external corrosion. This research provides management with crucial insights for making well-informed business decisions concerning the future use of the well stock.This study marks the first thorough and critical assessment of electromagnetic thickness logging

technology, contrasting its findings on remaining wall thickness with various in-situ and surface technologies. The analysis includes comparisons between technologies from different providers, as well as mechanical versus electromagnetic measurements, emphasizing their respective benefits in maintaining well integrity.Furthermore, the paper presents insights into the condition of L-80 tubulars that have been operational for over 30 years [6].

7. Implementation of Non-Metallic Technologies for the Future ADNOC Production Facilities

Throughout the industry, the widespread occurrence of poverty and the decline of steel structures, coupled with the essential actions required to avert or alleviate these challenges, present considerable conservation and operational hurdles across multiple sectors. In light of these obstacles, ADNOC Group Technology, guided by our Non-Metallic Steering Committee and ADNOC Upstream, is partnering with selected specialized product companies to execute a series of innovative solutions as pilot trials within a thorough research and development initiative. This program is designed to transform our production and processing services, with a specific focus on integrity management. In particular, we are assessing the application of non-metallic pipelines, storage vessels, and downhole tubing and casing.

This paper will focus on the piloting of RTP Onshore, emphasizing a unique trial carried out in an ultra-sour gas field where the technology has successfully met the required performance standards. This encompasses the safe transportation of gas with hydrogen sulfide (H2S) concentrations of up to 10% by volume. The trial also illustrates that specially engineered non-metallic products can function effectively under the high temperature and high pressure (HPHT) conditions typical of our reservoirs. Consequently, as a result of this qualification program, ADNOC is anticipated to see an improvement in the durability of pipeline assets, along with a significant increase in reliability and availability, while also enjoying reduced maintenance costs over time. It has been demonstrated that RTP can provide life-cycle investment savings exceeding 60% in comparison to conventional carbon steel pipes.

The polymer feedstock employed in the creation of these products can be obtained locally, including resources supplied by Borouge in the UAE. This strategy promotes a thorough and sustainable cycle that includes manufacturing, usage, and recycling, thus improving In-Country Value (ICV) and creating additional economic opportunities within the developing non-metallic industrial sector of the country. A comprehensive description of this intricate value proposition is depicted in Figure 1 below. This illustrates how ADNOC and the UAE are demonstrating global leadership by cultivating and investing in sustainable, energy-efficient solutions across the entire value chain, while concurrently strengthening the national economy [7].

8. Assessment of an Accidental Emission of Liquefied Petroleum Gas at a Petrochemical Plant: A Case Study.

The Oil and Gas industry is presently experiencing considerable changes in knowledge, spurred by the increasing demand for energy. This industry continues to be a major source of risk, rendering risk assessment crucial for the protection of individuals, equipment, and the environment. Such assessments enhance management by alleviating these risks and establishing a proactive prevention and defense strategy to fulfill the goals of the Health, Safety, and Environment (HSE) management system. This research entails a quantitative evaluation of the risks linked to a Liquefied Petroleum Gas (LPG) storage and supply facility, suggesting a risk assessment methodology that allows for the analysis of various accidental scenarios that could result from an LPG release and their possible repercussions. It is vital to highlight that the triggering event is a complete and immediate rupture of the pipeline, leading to the uncontrolled discharge of a substantial quantity of liquid gas.

The analysis also takes into account small, medium, and large leaks. The main failure mechanisms identified for the pipelines consist of external leaks, blockages, and structural failures resulting from distortion or corrosion (in the absence of leaks or blockages). The primary causes of these failures are mechanical problems, frequently arising from overload, along with inadequate design and corrosion. Furthermore, external forces and human error may also play a role in these incidents. According to the event tree analysis, the recognized hazardous outcomes encompass an Unconfined Vapor Cloud Explosion (UVCE)/flash fire, pool fire, jet fire, and the release of a toxic cloud that leads to atmospheric pollution. The scenario concerning the release of the toxic cloud was excluded from our study. As a result, for minor leaks, the phenomena of pool fire, UVCE/flash fire, and jet fire are considered significant due to their relatively low occurrence rates, even though they have high frequencies of occurrence exceeding Ft = E-5 per year (in line with the ALARP principle).

The disappearance of the butane pool can be noted in the context of medium or large leaks, where the impacts are relatively minor.

Nevertheless, this situation is considered unacceptable in the event of a slick detonation. For average and large leaks, the occurrences of UVCE, flash fire, and jet fire are regarded as intolerable due to their severe consequences, despite their infrequent occurrence rates (1.28 E-5 and 3.2 E-5 per year for average leaks, and 1.092 E-5 and 1.82 E-5 per year for large leaks, respectively). The identified high-risk scenarios were examined using the ALOHA simulator, which enabled us to identify areas susceptible to various accidental effects, including thermal, toxic, and overpressure impacts. This analysis also aided in the formulation or revision of response strategies and emergency plans..[8].

9. Assessment of Fuzzy Criticality in Evaluating External Corrosion Risks of Systems in the Petroleum Industry—A Case Study.

Corrosion is the most common type of damage found in offshore installations and serves as a key factor influencing the longevity and reliability of these assets.Modern maintenance approaches are increasingly emphasizing risk and reliability.In the realm of intricate technical systems, such as offshore platforms, a variety of maintenance management techniques can be utilized, including reliability-centered maintenance (RCM).This method employs failure mode and effects analysis (FMEA) to evaluate the significance of potential failure modes by ranking the associated risks, especially those related to corrosion rates and the asset's remaining lifespan.Nevertheless, in some real-world situations, the conventional use of FMEA may become unfeasible due to the subjective nature involved in assessing risk factors.

As a result, this research seeks to present a more effective and practical approach for assessing the criticality of risks linked to external corrosion failures within the system. The suggested methodology incorporates fuzzy scale techniques, risk space diagrams, and weighted Euclidean distance, drawing on the expertise of specialists in external corrosion. Theoretically, this study highlights the significance of utilizing RCM for corrosion management in practical applications. From a practical perspective, the aim is to provide a tool that merges RCM with fuzzy logic and a multicriteria framework to prioritize systems for inspection. This groundbreaking FMEA model is intended to improve efficiency by reducing time and costs while minimizing fieldwork, thus enhancing quality, safety, and technical effectiveness in inspection and maintenance activities [9].

10. The 26th International Joint Conference on Industrial Engineering and Operations Management, IJCIEOM 2021.

The proceedings consist of 48 papers. This conference particularly focuses on Industrial Engineering and Operations Management. The subjects covered include: Contributions of Industry 4.0 to Sustainable Operations; fuzzy Criticality Assessment of External Corrosion Risks in the Petroleum Sector—A Case Study; Evaluation of the Coverage of Sustainability Dimensions by Maintenance Objectives and KPIs; Circular Economy and Supply Chain Management: Key Publications and Themes; Implementation Agenda for Autonomous Maintenance Utilizing the HTO Approach; Identification of Critical Risk Factors in an Effluent Drainage Network Project through AHP: A Case Study; Methodical Literature Review on Decision-Making Processes Related to Sustainability; Comparative Analysis of Business Simulation Games for Teaching Production Engineering; Descriptive Bibliometric Study on Vaccine Supply Chain Management during COVID-19; Evaluation of Circular Economy Impacts on Companies within a Brazilian Industrial Ecosystem; Analysis of Disaster Effects on Travel Movements through System Dynamics; Examination of Deprivation Costs in Humanitarian Logistics:

A Comprehensive Review; Evaluation of Universities' Strategic Commitment to the Sustainable Development Goals; Modification of the Framework for the Service Sector while Preserving Economic, Social, and Environmental Sustainability; Examination of Biosafety Protocols in Supermarkets: Insights from Customers; Development Framework for Skills Utilizing a Decision-Making Matrix: A Case Analysis; Significance of Advanced Manufacturing or Industry 4.0 Research to Technological Advancement; Assessment of CO2 Emissions in the Soil–Cement Brick Sector: An Educational Example in Southwest Paraná; Examination of Attitudes Towards Target Costing through a Teaching Case Study; Management of the Packaging Recycling Network in Brazil. [10].

11. Improving the mean time before failure (MTBF) in rod-pumped wells by analyzing corrosion barriers.

Subsurface pumps and production tubulars are essential for extracting crude oil from underground reservoirs to surface facilities in established oil and gas fields.The integrity of downhole pumps and tubulars is greatly affected by electrochemical degradation, which will be analyzed concerning the operational environment.The extent of damage to sucker rods that reach the pump in rod pump wells will be discussed.A self-enhancing corrosion management strategy is proposed through a discussion of inspection, monitoring, and mitigation techniques.The corrosion decision tree is vital for assessing corrosion failures and offers a unique method for risk evaluation.Both qualitative and

quantitative assessments of the Mean Time Between Failures (MTBF) for rod-pumped wells have been performed.An action plan was formulated to tackle corrosion and/or friction-related failures.Consequently, the annual trend of workovers has shown a decline due to the implementation of the action plan.On average, oil and gas companies dedicate a specific percentage of their operational budget to address corrosion issues.Factors such as physical failure, presentation development, costs, and maintenance present considerable risks to erosion control.

Review and monitoring techniques alone are inadequate for accurately forecasting future performance. By integrating inspection, monitoring, mitigation, and predictive methodologies, a thorough corrosion management program can be developed. Following this, necessary remedial actions can be systematically executed to mitigate the effects of corrosion barriers. The Mean Time Before Failure (MTBF) can be considerably improved by following the practices specified in the action plan. For operators involved in extracting subsurface oil from difficult environments, the suggested method is to employ go-gauging and inhibitor washing for tube-shaped structures. The corrosion decision tree assesses the risks linked to corrosion, while corrosion management comprises a series of barriers aimed at preventing material failure. Performing MTBF analysis can offer operators critical insights into the reasons behind failures in subsurface pumps and downhole tubing..[11].

12. Society of Petroleum Engineers - SPE International Conference and Exhibition on Oilfield Corrosion 2021, OFCS 2021

The proceedings consist of 17 papers. The topics addressed include: the use of electrochemical noise for assessing green corrosion inhibitors; leveraging industry data to improve strategies for managing corrosion beneath insulation; the improvement of mean time before failure (MTBF) in rod-pumped wells through the examination of corrosion barriers; crevice corrosion in oxygen scavenger injection systems; discussions on the oxygen threshold level for corrosion processes in seawater injection systems; risk-based management strategies for corrosion under insulation; the dissolution of sulfate and sulfide field scales using a newly developed scale dissolver; and metrics in microbial biology to assess the effects of biocides on souring control and to enhance curdling modeling. [12].

13. Tackling the challenges related to pigging pipelines that are considered unpiggable.

Carbon steel tubes are extensively used for the transportation of hydrocarbons globally, owing to their relatively simple manufacturing process, safety in application, availability of raw materials, and cost-effectiveness. Nevertheless, in spite of these benefits, carbon steel is prone to considerable corrosion and various other complications. Pipeline corrosion presents a significant challenge in the oil and gas industry, resulting in numerous minor and major incidents of containment failure, which can lead to fatalities, environmental harm, asset loss, and production disruptions. The rising incidence of failures in operational pipelines has led the Department of Petroleum Resources (DPR) to strengthen its regulatory oversight of pipeline integrity assessments and operations in Nigeria, ensuring that Oil Producing Companies comply rigorously with regulatory standards.

According to the DPR Act (Section 2.5.2.1), all pipelines with a diameter greater than 6 inches must be inspected every five years utilizing intelligent pigs (inline inspection tools) to effectively evaluate their condition. However, numerous pipelines in Nigeria are either unpiggable or difficult to inspect with intelligent pigs due to the unavailability of pigging services (especially in brownfield areas), along with complications arising from short bend radii, dual lengths, and flow parameters. This paper provides case studies that investigate the use of advanced inline inspection methods to enable the simultaneous inspection of complex dual-diameter pipelines. [13]

14. A semi-empirical model that addresses the erosion-corrosion of carbon steel pipelines exposed to wet gas-solid flow conditions

The examination of erosion-corrosion (E-C) phenomena affecting carbon steel pipelines exposed to wet gas-solid flow is receiving considerable focus in the domain of oil and gas engineering. This research introduces a semi-empirical model designed to predict and evaluate the risks linked to the combined CO2 E-C rate under these particular circumstances. The model incorporates the changes in fluid characteristics that are affected by the system environment during gas-solid flow. By employing the Eulerian-Lagrangian method, the Navier-Stokes equations are utilized to investigate the flow field within the computational domain, while the force balance equation is applied to monitor the migration paths of solid particles within the simulation environment, ensuring a comprehensive analysis of fluid-solid interactions. An empirical model for CO2 corrosion, along with its revised version, has been created and validated, in addition to an erosion wear model, both specifically developed for carbon steel. Moreover, the synergistic impacts of these models are also considered.

The CFD-DPM technology, which utilizes the previously mentioned test data, is used to derive parameters relevant to both models. This facilitates the calculation of the overall CO2 E-C rate, the distinct erosion rate, and the separate CO2 corrosion rate at various points along the pipeline wall. Furthermore, the dominant rate is identified and analyzed, which allows for the evaluation of the severity of the combined CO2 E-C effects based on the total CO2 E-C rate. The proposed model is designed to efficiently and accurately compute the dominant rate and severity at different locations, thus identifying vulnerable areas and conditions that could potentially lead to pipeline failures. This model aims to provide theoretical insights for the prevention and management of risks related to carbon steel pipeline failures during oil and gas production and transportation, ultimately ensuring the safe and reliable achievement of established manufacturing objectives and the realization of economic benefits..[14].

15. An initial assessment of the corrosion issues faced by pipelines transporting hydrocarbons.

Pipelines are widely acknowledged as a secure and environmentally friendly, as well as economically feasible, method for the transportation of multiphase fluids of various kinds. Nevertheless, in the absence of adequate monitoring, they can present considerable risks to both health and the environment. Although progress is being made in operational and maintenance practices, new challenges continue to arise, particularly regarding the quality of the fluids being transported, with hydrocarbons being a primary concern. For example, crude oil often contains hydrogen sulfide (H2S); new pipelines are currently being developed to transport and inject supercritical fluids; and emerging corrosion issues may occur due to the—partially understood—damage mechanisms linked to biofuels, as well as from external aggressive environments such as deep seawater. Drawing on over 40 years of expertise in the field of corrosion, especially in pipeline-related projects, the author of this paper seeks to summarize the key damage mechanisms, current understanding, and potential future threats, from the viewpoint of a former Oil & Gas industry professional who is now working as a consultant in the field..[15].

16. Thorough evaluation of hybrid approaches for the suppression of gas hydrates.

In the ***subsea oil and gas sector***, shifting from a strategy that solely aims to avoid gas hydrates to one that incorporates risk-based hydrate management may result in considerable cost savings and improve the viability of new projects.A comprehensive evaluation of the probability of hydrate formation, conducted through the gathering of statistically significant data from independent hydrate formation occurrences, is crucial for accurately assessing the risk of hydrate blockages.This evaluation is especially vital when employing low-dosage kinetic hydrate inhibitors (KHIs), which affect the kinetics of hydrate formation rather than the thermodynamic stability envelopes, unlike thermodynamic hydrate inhibitors (THIs).In this regard, we introduce the use of a second-generation, Peltier-cooled, high-pressure, stirred, automated lag time apparatus (HPS-ALTA) that is specifically designed to accurately measure hydrate formation under conditions that simulate a methane-rich natural gas environment.Over 2,500 hydrate formation events were documented using a low-salt-content brine, which enabled the creation of smooth, high-resolution hydrate probability distributions in the presence of three chemical inhibitor additives and their combinations (including a corrosion inhibitor, a KHI, and a conventional THI).Furthermore, this approach not only allows for swift and accurate testing of potential interactions among inhibitors but also clearly demonstrates the ability to effectively modify the boundaries of formation likelihood through a combination of thermodynamic and kinetic inhibition effects.These hybrid inhibition strategies can result in prolonged induction times at operationally relevant formation temperatures (surpassing 2 days at 2.5 °C in this study) and may be more beneficial and/or cost-effective compared to methods focused solely on complete hydrate prevention..[16].

17. The conveyance of oil and water in segments to reduce pipeline corrosion.

A novel strategy for reducing pipeline corrosion during the transport of oil-water mixtures has been introduced, marking a departure from conventional techniques. This strategy employs a flow management concept that begins with the separation of the mixed fluids into oil and water. Following this, a batch transportation system for both oil and water is utilized to modify the water wetting condition at the pipeline's bottom. This modification significantly lowers the corrosion risk at the base of the pipe with only minimal changes to the transportation process. The theoretical and experimental validation of this approach has shown its effectiveness in reducing corrosion when compared to traditional oil gathering systems utilized in CO2-enhanced oil recovery (EOR) operations. It was noted that the effectiveness of corrosion mitigation is positively related to the dimensionless span of the oil phase, which is affected by the input lengths of the oil and water

batches as well as the resulting flow pattern at the oil/water interface. This method is especially beneficial in situations where large volumes of free water cannot be integrated into the oil phase. The proposed strategy for corrosion reduction presents significant potential for use in the transportation of corrosive oil-water mixtures within the petroleum sector, including CO2-EOR and offshore oil extraction..[17].

18. Evaluation and oversight of corrosion within a shale gas collection and transportation system: A case analysis from the Changning-Weiyuan National Shale Gas Demonstration Zone

In the Changning-Weiyuan National Shale Gas Demonstration Area, situated in the southern Sichuan Basin, volumetric fracturing technology is primarily utilized for the extraction of shale gas. The amount of fracturing fluid and proppant, specifically quartz sand ceramsite, consumed per horizontal well generally falls between 40,000 to 50,000 cubic meters and 2,500 to 3,000 tons, respectively. After the fracturing process is completed, the flowback fluid from shale gas extraction can cause varying levels of corrosion in the surface drainage and gathering systems, which may lead to equipment and pipeline failures that threaten the safe operation of the production system. To improve the safety of the shale gas gathering and transportation infrastructure, an analysis was performed on the corrosion characteristics and control strategies for the gathering and transportation system in the southern Sichuan Basin.

This analysis encompassed the evaluation of the corrosion environment and production performance, the assessment of material failures, the optimization of materials, and the application of bactericides and corrosion inhibitors, in addition to the control and optimization of production parameters. This initiative was backed by the natural gas corrosion control technology platform of PetroChina Southwest Oil &Gasfield Company. The results revealed that the main types of corrosion impacting the shale gas gathering and transportation system in the southern Sichuan Basin are erosion corrosion and electrochemical corrosion.

Erosion corrosion primarily occurs during the technological processes at the shale gas station, presenting as ongoing mechanical wear induced by sand particles at bends, tee joints, valves, and other components.

Electrochemical corrosion mainly occurs in the gas gathering pipeline outside the shale gas station, defined by the combined corrosion effects of CO2 and sulfate-reducing bacteria in a liquid loading environment.Effective management of erosion corrosion can be accomplished by improving desanding efficiency and refining process design.Likewise, electrochemical corrosion can be effectively controlled through the application of bactericides and erosion inhibitors, in addition to implementing supportive production management strategies.It is crucial to take into account corrosion evaluation and the redesign of the shale gas gathering and transport system during the initial design phase.[18].

19. An extensive examination of permeation damage in polymer liners utilized in oil and gas pipelines

Non-metallic pipe (NMP) resources function as both internal coatings and standalone piping solutions in the oil and gas industry, representing an innovative strategy for managing erosion.These NMP materials are naturally susceptible to gradual degradation due to factors including creep, fatigue, permeation, manufacturing flaws, and installation mistakes.

When subjected to acid gases (CO2, H2S) and hydrocarbons under high pressures and temperatures, the primary type of damage occurs due to infusion.

The comprehension of potential damage from permeation is still insufficiently defined, posing difficulties in managing asset integrity.

At present, the assessment of permeation damage is performed through a variety of evaluations of mechanical, thermal, chemical, and structural properties, employing techniques such as Tensile Testing, Differential Scanning Calorimetry (DSC), Fourier-transform Infrared Spectroscopy (FTIR), and Scanning Electron Microscopy (SEM)/Transmission Electron Microscopy (TEM) to examine alterations in tensile strength, elongation, weight changes, crystallinity, chemical properties, and molecular structure.Typically, coupons are utilized to study the degradation of polymers; however, they operate as separate devices and do not yield real-time data.Their weight and mechanical characteristics are evaluated for assessment.

Since polymers are dielectric materials, their dielectric properties can be analyzed using Impedance Analyzers and Dielectric Spectroscopy.This review presents a succinct summary of the challenges associated with the failure of polymer liners in pipelines, which is linked to the presence of acid gases, hydrocarbons, and various contaminants. The discussion includes permeation, examples of liner failures, the current status of monitoring practices, and the introduction of new exclusive dielectric properties. A thorough

perspective is offered, emphasizing the difficulties related to monitoring the polymer liner material within the pipeline, especially concerning the requirements for lifetime prediction..[19].

20. Developments in the Progress of Safety Technologies for Oil Storage Tanks.

Petroleum is a vital element of the national economy and serves as an essential strategic resource for the country's survival and growth. At present, tank storage is the primary method utilized for the storage of raw materials and products in the petroleum and petrochemical industries. As a result, the operation, maintenance, and anti-corrosion strategies for storage tanks are crucial for ensuring industrial safety throughout the entire sector. This paper evaluates the latest advancements in tank anti-corrosion technology within the petrochemical industry, investigates the challenges associated with both internal and external corrosion of tanks, outlines various anti-corrosion approaches, highlights the significance of tank anti-corrosion protection, and anticipates future trends in this area. Petroleum acts as the driving force behind modern industry and plays a significant role in national security. The adoption of effective anti-corrosion measures for storage tanks is especially critical for the strategic management of oil reserves in China..[20].

21. Forecasting the internal corrosion rate of gas pipelines: A novel approach utilizing transformer architecture

The precise evaluation of internal corrosion rates in steel natural gas pipelines is an essential aspect of managing the integrity of oil and gas pipelines. Nevertheless, the current models employed for forecasting internal corrosion rates frequently encounter several challenges, including low accuracy, inadequate generalization, and insufficient interpretability. To effectively tackle these issues, we introduce CNN-BO-Transformer and utilize DeepSHAP to enhance the model's interpretability. The CNN-BO-Transformer is designed to predict the corrosion rate in natural gas pipelines, while DeepSHAP is applied to examine the causal relationships between input variables and the model's predictions. The proposed model is validated using a real pipeline excavation dataset sourced from a gas field in Northwest China, achieving an average error of 0.21mm/y. This indicates reductions of 69.74% and 66.67% compared to the errors associated with support vector regression (SVR) and the Transformer model, respectively. The suggested method significantly enhances the accuracy and reliability of corrosion rate predictions in natural gas gathering and transportation pipelines, thereby offering an effective strategy for predictive maintenance and repair of steel gathering in transmission pipelines within gas fields [21].

22. A Bayesian methodology that incorporates real-time monitoring data to estimate the dynamic Remaining Useful Life (RUL) of equipment impacted by sulfidation and corrosion from naphthenic acids.

Corrosion caused by sulfidation and naphthenic acids is a prevalent mechanism in the processing of crude oils that contain high levels of sulphur. This study highlights the necessity for dependable corrosion management strategies within the chemical industry, particularly in the context of energy transition and the simultaneous impact of emerging scenarios such as economic and geopolitical factors. The aim is to create a dynamic model that estimates the remaining lifespan of equipment by utilizing predictive modeling techniques alongside monitoring data of process variables that affect the deterioration mechanism. The model developed will aid in preventing adverse outcomes resulting from equipment degradation and will enhance the optimization of inspection and maintenance programs. By providing an innovative tool for corrosion management, this research seeks to contribute to ongoing initiatives aimed at improving the efficiency and sustainability of energy production processes. Given the emergence of certain scenarios, refineries may be inclined to increase the processing of raw materials with high sulphur content; these materials are more readily available and cost-effective, yet they accelerate the deterioration of equipment materials, thereby heightening the associated risks. The method proposed in this article facilitates more effective safety management through the monitoring of the conditions of critical components [22].

23.The co-gasification of blast furnace dust with petroleum coke for sustainable waste management.

This research utilized a lab-scale fluidized bed steam gasification system to conduct co-gasification experiments involving blast furnace dust (BFD) and petcoke (PC), which are by-products from the steel and refining sectors, respectively.A series of experiments were carried out under optimized conditions to analyze the influence of the mineralogical composition of the feed samples on the parameters of gasification performance. The introduction of the iron and zinc-rich BFD sample into the PC resulted in a significant improvement in the gasifier's capacity to generate hydrogen-rich synthesis gas, which was linked to an increase in the number of surface active sites that enhance gasification reactivity.

The catalytic influence of the iron and zinc-containing components in the resultant ash led to an increase of nearly 3% in cold gas efficiency and approximately 12% in carbon conversion efficiency, which in turn contributed to a notable rise in both the heating values and the yields of the product gas.

To understand the catalytic effect, the feed and product samples were analyzed using analytical techniques including XRF, XRD, TGA, FTIR, and SEM with EDX analysis. The co-gasification product ash sample revealed the presence of various minerals dominated by zinc and iron, such as franklinite ($ZnFe_2O_4$), zincite (ZnO), hematite (Fe_2O_3), and magnetite (Fe_3O_4), to meet the increasing global mineral demands as a secondary mineral resource. This study presented an innovative approach to repurpose industrial waste while simultaneously eliminating toxic substrates. In summary, the potential for energy recovery from industrial by-products was emphasized, offering valuable insights for the development of sustainable waste management technologies with scalable opportunities within a circular industrial economy [23].

24. The engineering design and implementation of a large-scale project for the treatment of oil-based drilling cuttings.

Thermal phase separation technology represents an innovative and comprehensive treatment method that involves heating oil-based cuttings to a specific temperature to vaporize both oil and water components.This analysis is based on a significant project focused on the comprehensive utilization of oil-based drilling cuttings, examining the engineering design and the effectiveness of thermal phase separation technology in practice.

Results indicate that this technology can lower the oil content of the purified residue to between 0.1% and 0.2%, achieving an average base oil recovery rate of 94.12%, with an annual recovery of approximately 4800 tons of base oil. Furthermore, the purified residue is free from corrosive, leaching toxicity, and other hazardous characteristics, making it suitable for use in the production of bricks or building materials.Overall, thermal phase separation technology is a highly effective treatment and utilization method that offers significant engineering and environmental advantages, demonstrating considerable potential for widespread application[24].

25. A thorough review of polymeric anti-corrosion coatings integrated with fluorescent materials

Corrosion has a profound effect on metallic structures, leading to significant safety risks and financial losses. The catastrophic incidents resulting from unnoticed corrosion, including the 2013 oil pipeline explosion in Qingdao, China, and the 2014 explosion in Kaohsiung, Taiwan, underscore the critical need for effective detection methods. Worldwide, the financial burden of corrosion surpasses $4 trillion each year—accounting for 6% of the global GDP—divided between maintenance expenditures and losses due to damage.

Identifying early-stage corrosion is essential yet difficult with traditional techniques. Recently, fluorescent material-based polymeric coatings have emerged as a groundbreaking solution for the early detection of corrosion. These advanced coatings utilize fluorescence-based indicators that respond to corrosion byproducts, such as metal ions or acidic compounds, by changing their fluorescence characteristics. This innovation offers a real-time, non-invasive approach to monitor the integrity of metals, facilitating timely interventions and lowering maintenance expenses.This review explores the mechanisms involved in fluorescence-based corrosion detection, focusing specifically on the types of fluorescent indicators utilized, their incorporation into polymeric matrices, and the analytical techniques employed for fluorescence monitoring.These coatings provide considerable advantages, such as ongoing monitoring and early detection of corrosion, which helps to avert damage in advanced stages. Nonetheless, challenges persist in optimizing these systems for various environments and enhancing their sensitivity and durability.

Never the less, progress in this domain holds the potential for substantial benefits for industries that depend on metal infrastructure. The future is oriented towards the integration of these coatings with real-time monitoring systems, utilizing predictive analytics and fostering collaboration between industry and academia. Such advancements are set to transform corrosion management, rendering it more proactive, cost-efficient, and standardized [25].

CONCLUDING REMARKS

- Corrosion represents the foremost threat to integrity in oil and gas pressure containment and processing facilities.
- Effectively managing corrosion serves as the foundation for integrity management, and establishing a corrosion management strategy is crucial for fulfilling the requirements of a corrosion management policy.
- Additionally, corrosion is the primary risk factor driving Risk Based Inspection (RBI) activities; it is the essential mechanism through which the

inspection strategy, vital for maintaining integrity, is implemented.

- Several methods have been examined to evaluate and manage the integrity of assets, including topside facilities, processing plants, utilities, marine terminals, tank farms, pipelines, and more.
- We have to assess qualitative, semi-qualitative, and quantitative risk assessment methodologies.
- Risk assessment is a key criterion for optimizing RBI.
- We have to explore how different risk assessment approaches affect the resulting risk and the implications for integrity management.
- Furthermore, we have toanalyze the influence of risk assessment on the Asset Integrity Management (AIM) strategy and reference software developed by WGK (Wood Group Kenny), highlighting how its application can lead to the safe and cost-effective operation and management of oil and gas facilities.
- RBI has progressed into a sophisticated approach for optimizing inspection processes and frequencies to achieve cost-effective AIM.
- The design of RBI integrates multi-disciplinary expertise and considers conditional factors, variations in operating conditions, asset operation and maintenance, asset criticality, data interpretation, and condition forecasting.

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REFERENCES

[1] S.Arena, R.Perna, M.T.Pilloni (2022) A quantitative risk-based approach for assessing optimal inspection intervals of a caustic soda recovery plant: a case study, Proceedings of the Summer School Francesco Turco.

[2] X.Li, L.Zhang, F.Khan, Z.Han (2021) A data-driven corrosion prediction model to support digitization of subsea operationsProcess Safety and Environmental Protection, 153, 413–421.https://doi.org/10.1016/j.psep.2021.07.031

[3] M.Nabizadeh, M.Khalilzadeh, S.Ebrahimnejad, M.J.Ershadi (2021) Developing a fuzzy goal programming model for health, safety and environment risks based on hybrid fuzzy FMEA-VIKOR method. Journalof Engineering, Design and Technology, 19(2), 317–338. http://dx.doi.org/10.1108/JEDT-09-2019-0245

[4] A -W. Dawuda, M.Taleb-berrouane, F. Khan (2021) A probabilistic model to estimate microbiologically influenced corrosion rate Process Safety and Environmental Protection, 148, 908–926,2021. https://doi.org/10.1016/j.psep.2021.02.006

[5] Z.Wan, J. Yang (2021) Research on corrosion management technology of petroleum pipeline and pressure vessel IOP Conference Series: Earth and Environmental Science, 692(4), 042057. http://dx.doi.org/10.1088/1755-1315/692/4/042057

[6] C., Jain, S., Obaid, S., Nakeeb, F.A. (2021) Generating Value from Mature Gas Fields by Quantifying Well Integrity Assurance with a Critical Analysis of Multiple Logs & Retrieved Tubular Surface Inspection Golaco, Society of Petroleum Engineers - Abu Dhabi International Petroleum Exhibition and Conference, ADIP 2021. http://dx.doi.org/10.2118/208204-MS

[7] R.N. Burke, A.M.A.R.AlTamimi, W.S. Al Shouly, D.E.Baetsen (2021) Non-Metallic Technology Deployment for the Next Generation of ADNOC Production Facilities.Society of Petroleum Engineers-Abu Dhabi International Petroleum Exhibition and Conference, ADIP 2021. https://doi.org/10.2118/207830-MS

[8] A. Imane, C. Samia, H. Djamel (2021) Assessment of an Accidental Liquified Petroleum Gas Release at a Petrochemical Site: a Case Study Proceedings of the International Conference on Industrial Engineering and Operations Management, 113. http://dx.doi.org/10.46254/AP01.20210071

[9] R. Caiado,M. Rios, G.C. Martins, P.IvsonNetto, F.RamosElmas (2021) Fuzzy Criticality Assessment of Systems External Corrosion Risks in the Petroleum Industry—A Case Study F.,Springer Proceedings in Mathematics and Statistics, 367, 153–166. http://dx.doi.org/10.1007/978-3-030-78570-3_12

[10] A.M.T.Thome, R.G.Barbastefeno, L.F.Scavarda, J.C.G.D .Reis, M.P.C.Amorim (2021) 26th International Joint Conference on Industrial Engineering and Operations Management, IJCIEOM 2021, Springer Proceedings in Mathematics and Statistics, 367.

[11] K.L.Chanchlani, N.Khanduja, D.Gunwant (2021) Improving mean time before failure MTBF in rod pumped wells by analyzing corrosion barriersSociety of Petroleum Engineers - SPE International Oilfield Corrosion Conference and Exhibition 2021, OFCS 2021. http://dx.doi.org/10.2118/205043-MS

[12] (2021) Society of Petroleum Engineers - SPE International Oilfield Corrosion Conference and Exhibition 2021, OFCS 2021 [No Authors Found]

[13] C.Oragwu, D.Molyneux, L.Lawal, S.Ameh (2021) Overcoming challenges of pigging the unpiggable pipelines Oragwu, Society of Petroleum Engineers - SPE Nigeria Annual International Conference and Exhibition 2021, NAIC 2021. http://dx.doi.org/10.2118/207147-MS

[14] L.Zhao, Y.Yan, X.Yan (2020) A semi-empirical model for CO2 erosion-corrosion of carbon steel pipelines in wet gas-solid flow, Journal of Petroleum Science and Engineering, 196, 107992. https://doi.org/10.1016/j.petrol.2020.107992

[15] G.Gabetta (2024) A tentative summary of corrosion issues in pipelines transporting hydrocarbons Lecture Notes in Civil Engineering, 102, 77–87. http://dx.doi.org/10.1007/978-3-030-58073-5_6

[16] P.J.Metaxas, V.W.S.Lim, S.F.McKay, Z.M.Aman, E.F.May (2020) High-fidelity evaluation of hybrid gas hydrate inhibition strategies Metaxas, Energy and Fuels, 34(12), 15983–15989. http://dx.doi.org/10.1021/acs.energyfuels.0c02803
[17] K.Wang, Z.M. Wang, G-L Song (2020) Batch transportation of oil and water for reducing pipeline corrosion Journal of Petroleum Science and Engineering, 195, 107583.http://dx.doi.org/10.1016/j.petrol.2020.107583
[18] M.Xie, Y. Tang, B.Song, W.Zhao, G.Wu (2022) Corrosion evaluation and control of a shale gas gathering and transportation system: A case study of the Changning-Weiyuan National Shale Gas Demonstration Area | Natural Gas Industry, 40(11), 127–134. http://dx.doi.org/10.1088/1742-6596/2539/1/012039
[19] H.U.Khalid, M.C.Ismail, N.Nosbi (2020) Permeation damage of polymer liner in oil and gas pipelines: A review Polymers, 12(10), 1–31, 2307. https://doi.org/10.3390/polym12102307
[20] M-Y.Dou, X-H. Liao, S.-J .Yang, S.Zou, F.-C.Huang (2020) Development trend of protection technology for oil storage tank IOP Conference Series: Earth and Environmental Science, 526(1),012117. http://dx.doi.org/10.1088/1755-1315/526/1/012117
[21] L.Tan, Y. Yang, K. Zhang, K.Liao, G.He, J.Tian, X. Lu (2025) Prediction of internal corrosion rate for gas pipeline: A new method based on transformer architecture,Computers and Chemical Engineering, 198, 109084. https://doi.org/10.1016/j.compchemeng.2025.109084
[22] G.Ancione, P. Bragatto, M.F. Milazzo (2025) A Bayesian approach integrating real-time monitoring data for the estimation of a dynamic RUL of equipment affected by sulfidation and naphthenic acids corrosion,Journal of Loss Prevention in the Process Industries, 95, 105582. https://doi.org/10.1016/j.jlp.2025.105582
[23] R.Saini, D.S.Rao, S.D.Barma (2025) Co-gasification of blast furnace dust with petcoke for sustainable waste management,Waste Management, 193, 506–516.https://doi.org/10.1016/j.wasman.2024.12.027
[24] Y.Zhou, C. Deng, X. Chen, X, Y.He, G.Fang, Z.Jin, Y. Liu (2025) Engineering design and application of large-scale oil-based drilling cuttings treatment project, Waste Management and Research, 43(2), 282–292. http://dx.doi.org/10.1177/0734242X241231393
[25] S.Arshad, S.Habib, R.A.Shakoor (2025) Fluorescent material-integrated polymeric anti-corrosion coating: A comprehensive review,Journal of Industrial and Engineering Chemistry, https://doi.org/10.1016/j.jiec.2025.02.056

IZVOD

UPRAVLJANJE KOROZIJOM U NAFTNOJ INDUSTRIJI

Svet brzo napreduje ka razvoju održive infrastrukture, naglašavajući upotrebu materijala otpornih na koroziju kako bi se efikasno optimizovala kontrola korozije i smanjili troškovi životnog ciklusa. Rešavanje problema kontrole i ublažavanja korozije tokom početnih faza projektovanja i izgradnje imovine pokazalo se korisnijim na duži rok, posebno u pogledu poboljšane bezbednosti, performansi, dugovečnosti imovine, zaštite životne sredine i operativne isplativosti. Ukupno, procenjuje se da globalni troškovi koji se pripisuju koroziji dostižu trilione. Generalno, smatra se da korozija utiče na približno 4 procenta BDP-a nacije, a kontinuirano rastuća pretnja po životnu sredinu zahteva hitne i odgovarajuće akcije. Ovaj članak će se fokusirati na različite vrste „korozije i njene prevencije u naftnoj i gasnoj industriji“ koje utiču na opremu, cevovode i infrastrukturu u naftnom i gasnom sektoru, zajedno sa strategijama za ublažavanje ovih problema. Korozija predstavlja značajan izazov u industriji, što rezultira bezbednosnim rizicima, prekidima u radu i značajnim finansijskim gubicima. Ovaj članak će se baviti sledećim osnovnim temama: Vrste korozije u naftnoj i gasnoj industriji, Uticaj korozije na naftnu i gasnu industriju, Praćenje i otkrivanje korozije, Metode sprečavanja korozije, Najbolje prakse u upravljanju korozijom, Studije slučaja i industrijski standardi i Budući trendovi u sprečavanju korozije.
Ključne reči: *korozija, upravljanje, naftna i gasna industrija, naftna industrija, korozija cevovoda*

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Susai Rajendran https://orcid.org/0000-0002-0040-2435