



Acoustic Emission (AE) Technology in Hydrocarbon Storage Tank Integrity Management

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Abstract— Hydrocarbon storage tanks are critical assets in the oil and gas industry, necessitating stringent integrity management to ensure safe and efficient operations. Traditional inspection methods often involve periodic and invasive procedures that can be both costly and time-consuming, with a risk of missing early-stage defects. Acoustic Emission (AE) technology offers a revolutionary approach by providing continuous, real-time monitoring of storage tanks, detecting sound waves emitted by the growth of defects such as cracks or corrosion. This method not only allows for the early identification of potential issues but also reduces the need for frequent, disruptive inspections, leading to significant cost savings. Furthermore, AE technology enhances operational safety by enabling prompt corrective actions and supports the long-term reliability of storage infrastructure. This paper discusses the implementation plan, data analysis methods, and alignment of AE technology with industry best practices and the strategic objectives of Vision 2030.

Keywords—Acoustic Emission (AE), Hydrocarbon Storage Tanks, Integrity Management, Real-Time Monitoring, Non-Destructive Testing.

I. INTRODUCTION

Hydrocarbon storage tanks play a vital role in the oil and gas industry, where maintaining their integrity is crucial to preventing failures, minimizing environmental risks, and ensuring operational efficiency. Traditional integrity management strategies often rely on periodic, invasive inspections, which can disrupt operations and result in significant costs. Acoustic Emission (AE) technology offers a transformative, non-destructive testing method that monitors the sound waves emitted by defect growth within materials. Unlike conventional approaches, AE technology allows for continuous, real-time monitoring, enabling proactive detection of potential issues before they escalate. By integrating AE technology into integrity management practices, the industry can significantly reduce downtime, lower maintenance costs, and enhance safety, marking a major advancement in the field.

II. BENEFITS OF AE TECHNOLOGY

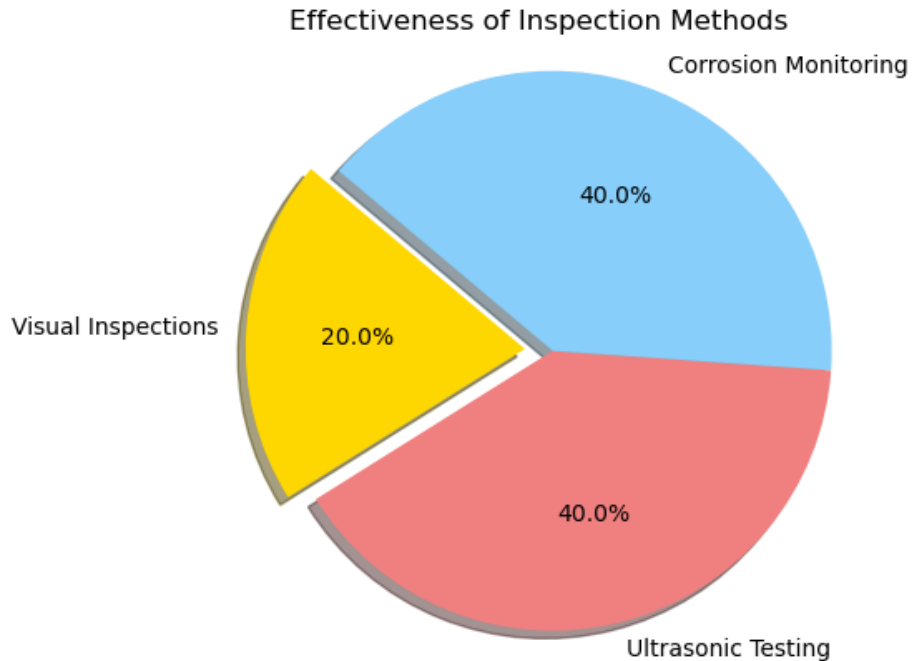
AE technology offers significant advantages over traditional inspection methods, transforming how hydrocarbon storage tanks are monitored and maintained:

- 1. Real-Time Monitoring:** AE technology enables continuous monitoring of sound waves generated by defect growth, allowing for immediate detection and response to potential

issues. This real-time capability ensures that operators are informed of critical changes as they happen, minimizing the risk of undetected damage.



- 2. Early Defect Detection:** By identifying early-stage defects such as cracks, corrosion, and weld failures, AE systems help prevent minor issues from evolving into catastrophic failures. This early detection capability is particularly valuable in high-stakes environments where safety and reliability are paramount.
- 3. Cost Savings:** The non-invasive nature of AE technology reduces the need for frequent shutdowns and extensive inspections. As a result, companies can achieve significant savings on maintenance costs and operational downtime, reallocating resources to other critical areas.
- 4. Enhanced Safety:** Early detection through AE technology allows for prompt corrective actions, significantly improving the safety of operations. By addressing defects before they escalate, companies can mitigate risks to both personnel and the environment.
- 5. Improved Operational Efficiency:** The real-time data provided by AE systems supports optimized maintenance strategies and resource allocation. With continuous insights into the condition of storage tanks, companies can plan maintenance more effectively, ensuring that resources are used where they are most needed.



Implementing AE technology in hydrocarbon storage tanks requires a structured approach to ensure effectiveness and seamless integration:

III. IMPLEMENTATION PLAN

- 1. Assessment and Planning:** Conduct a thorough evaluation of all storage tanks to identify those most susceptible to defects or those critical to operations. This assessment should consider factors such as tank age, historical inspection data, and operational significance. Detailed planning will establish the scope, budget, and timeline for AE implementation.
- 2. System Installation:** Install AE sensors and monitoring equipment on the identified tanks. This step involves strategic placement of sensors to maximize coverage and ensure accurate data collection. The installation should be coordinated with ongoing operations to minimize disruptions.
- 3. Integration with Existing Methods:** AE technology should be integrated with existing inspection techniques, such as ultrasonic testing or visual inspections. This hybrid approach ensures comprehensive coverage and validates AE data with established methods, enhancing overall reliability.
- 4. Training and Calibration:** Train personnel on the operation of AE technology, focusing on data interpretation and response protocols. Calibration of the AE system is crucial to ensure accurate readings and effective defect detection. Regular training updates should be scheduled to account for technological advancements and evolving industry standards.

- 5. Pilot Testing:** Before full deployment, conduct pilot tests on a select number of tanks to validate the effectiveness of AE technology in the specific operational environment. These tests will help identify any adjustments needed and provide valuable data to refine the deployment strategy.
- 6. Full Deployment:** Based on the success of the pilot tests, roll out AE technology across all relevant tanks. This phase should include continuous monitoring and periodic reviews to assess performance and address any issues. The deployment plan should also include a feedback loop to incorporate lessons learned and improve future implementations.

IV. DATA ANALYSIS AND REPORTING

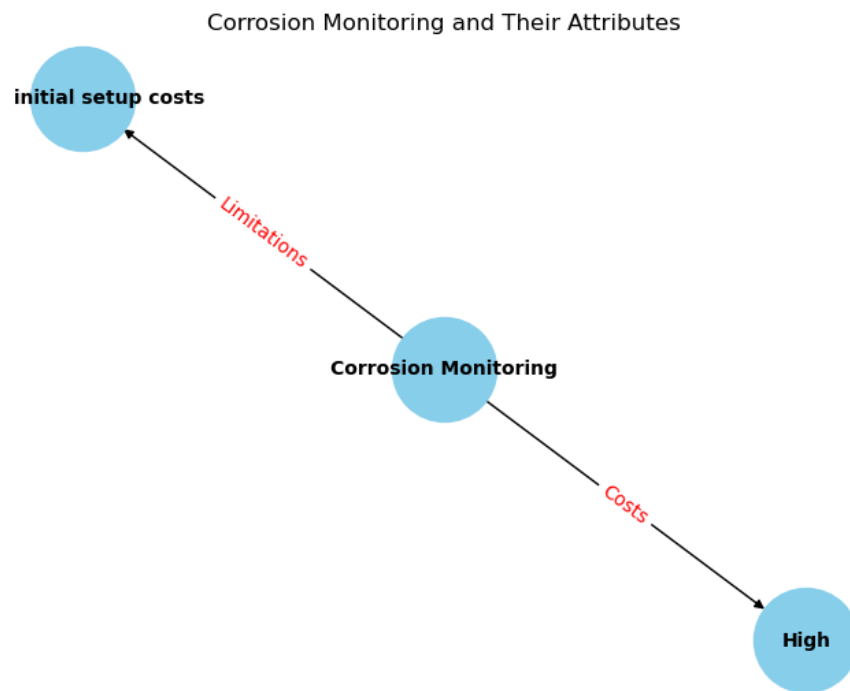
Effective data analysis and reporting are critical to leveraging AE technology for proactive integrity management. The process involves several key steps:

- 1. Signal Processing:** Raw AE signals are first filtered to remove noise and enhance signal clarity. Advanced signal processing techniques, such as wavelet transforms or Fast Fourier Transform (FFT), are employed to isolate defect-related events from background noise. This step ensures that only relevant data is used for further analysis.
- 2. Event Detection:** The processed signals are analyzed to detect events indicative of defects, such as crack initiation or corrosion. Sophisticated algorithms are used to identify patterns that correspond to specific types of material degradation. This automated detection reduces the risk of human error and ensures timely identification of potential issues.
- 3. Event Localization:** Once a defect-related event is detected, triangulation techniques are used to precisely locate the source of the acoustic emissions within the tank. This involves using multiple sensors to measure the time difference of arrival (TDOA) of the sound waves, enabling accurate pinpointing of defect locations. Accurate localization is essential for targeted maintenance actions.
- 4. Characterization of Defects:** After locating the defects, further analysis is conducted to characterize them in terms of type (e.g., crack, corrosion) and severity. This characterization involves comparing the detected signals with a database of known defect signatures. Understanding the nature and severity of the defect allows for more informed decision-making regarding maintenance priorities.
- 5. Trend Analysis:** Historical AE data is analyzed to track the progression of detected defects over time. Trend analysis helps in predicting future growth rates of defects, enabling maintenance teams to prioritize repairs and avoid unexpected failures. This step is crucial for long-term asset management and helps in optimizing maintenance schedules.

6. Reporting and Stakeholder Communication: The results of the data analysis are compiled into comprehensive reports that include visualizations, defect maps, and trend graphs. These reports are tailored to different stakeholders, such as maintenance teams, safety officers, and management, ensuring that the information is accessible and actionable. Regular reporting intervals are established to keep all parties informed and facilitate timely decision-making.

V. CONCLUSION

Integrating Acoustic Emission (AE) technology into the management of hydrocarbon storage tanks presents substantial advantages, fundamentally transforming the approach to tank integrity. This technology provides early and precise defect detection, significantly enhancing safety and operational reliability. The use of AE technology enables optimized maintenance strategies, leading to notable cost savings and ensuring compliance with stringent regulatory standards.



Here's a comparison table highlighting the overall impact of Acoustic Emission (AE) technology versus traditional methods on tank integrity management, maintenance costs, and operational efficiency:

Aspect	AE Technology	Traditional Methods
Tank Integrity Management	<ul style="list-style-type: none"> - Real-time monitoring and early defect detection. - Continuous assessment of tank condition. - Enhanced ability to detect subsurface defects. 	<ul style="list-style-type: none"> - Periodic inspections. - Limited to surface defects. - Potential for missed early-stage defects.
Maintenance Costs	<ul style="list-style-type: none"> - Reduced maintenance costs due to early detection and intervention. - Lower long-term costs from preventing major failures. 	<ul style="list-style-type: none"> - Higher maintenance costs due to reactive repairs. - Increased costs from undetected defects leading to major repairs.
Operational Efficiency	<ul style="list-style-type: none"> - Minimal disruption to operations with continuous monitoring. - Reduced downtime due to proactive maintenance. 	<ul style="list-style-type: none"> - Potential operational disruptions during inspections. - Increased downtime from unexpected failures.

By leveraging real-time data monitoring and advanced analysis, AE technology not only addresses existing challenges but also sets a new standard for proactive maintenance and risk management. The successful implementation and results from pilot projects underscore the technology’s potential to revolutionize tank management practices.

To fully capitalize on these benefits, stakeholders are encouraged to consider AE technology as a vital component of their integrity management strategies. Embracing this advanced approach will ensure the long-term safety, efficiency, and reliability of critical storage infrastructure.

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Biography

Sulaiman Ul Akram Ismail is a Business Development Manager at Advanced Creativity Co. with over a decade of experience in the Oil & Gas, Energy, and Infrastructure sectors. He specializes in digital transformation, strategic development, and leveraging advanced technologies to enhance supply chain management and sustainability. Akram has managed international partnerships and projects for major clients like Saudi Aramco, SABIC, and NEOM, driving operational excellence and significant business growth.