



Symposium on Natural and Applied Sciences

Hosted Online from London, United Kingdom

Date: 5th June, 2026

Website: <https://econferencia.com>

ASSESSMENT OF WELDING JOINT QUALITY IN STORAGE TANKS OF HAZARDOUS INDUSTRIAL FACILITIES USING MODERN NON- DESTRUCTIVE TESTING METHODS

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Abstract

Storage tanks used in hazardous industrial facilities are exposed to various operational loads, and the reliability of their welded joints directly affects the overall safety of the structure. This article examines the quality assessment of welded joints in storage tanks and analyzes the causes of defects that may occur during welding and operation. Particular attention is paid to the methods used for detecting welding defects, including visual inspection, ultrasonic testing, radiographic examination, and magnetic particle testing. The article concludes that regular inspection of welded joints, combined with proper maintenance and technical diagnostics, is necessary to ensure safe operation of storage tanks at hazardous industrial facilities.

Keywords: storage tank, welded joint, welding defects, non-destructive testing, ultrasonic testing, technical inspection, industrial safety, structural reliability.

Introduction

Storage tanks are widely used in oil and gas, chemical, and other industrial sectors for storing liquid and gaseous substances. Since many of these substances are hazardous, the technical condition of storage tanks must be continuously monitored throughout their service life. One of the most important elements affecting the reliability of such structures is the quality of welded joints.



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During manufacturing, installation, repair, and reconstruction of storage tanks, welding operations are widely used. The strength and durability of welded joints depend on many factors, including welding technology, quality of welding materials, qualification of specialists, preparation of metal surfaces, and compliance with technological requirements.

In practice, welding defects are among the main reasons that can lead to premature failure of industrial structures. Even small defects that are not detected during inspection may gradually develop under the influence of operational loads, corrosion processes, temperature changes, and internal pressure. As a result, cracks, leakage, and loss of structural stability may occur.

For this reason, evaluation of welded joint quality is considered an important part of technical diagnostics of hazardous industrial facilities. Modern inspection methods make it possible to determine the condition of welded connections without damaging the structure and to identify defects at an early stage.

The purpose of this study is to analyze the main defects occurring in storage tank welded joints and evaluate the effectiveness of modern methods used for their detection and assessment.

Materials and Methods

The research was carried out based on the analysis of scientific publications, industrial standards, technical documentation, and practical approaches used for inspecting welded structures in hazardous industrial facilities. The study considered welded joints of steel storage tanks operating under conditions typical for industrial environments. Particular attention was paid to defects that affect the strength and reliability of welded connections.

During the research, visual inspection methods were analyzed as the initial stage of quality assessment. This method allows specialists to identify visible defects



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such as irregular weld shape, surface cracks, undercuts, and deviations from required dimensions. Although visual inspection is simple and widely used, it cannot detect internal defects located inside the weld metal. To assess hidden defects, non-destructive testing methods were studied. Ultrasonic testing was considered as one of the most effective methods for examining welded joints. This method makes it possible to detect internal discontinuities, including cracks, lack of fusion, and incomplete penetration, without damaging the structure.

Radiographic testing was also analyzed as a method for determining internal defects by obtaining an image of the welded area. This method provides detailed information about the internal structure of welds and is commonly applied to critical industrial components. Magnetic particle testing was considered for detecting surface and near-surface defects in steel structures. This method is especially useful for identifying small cracks that may not be visible during visual inspection.

The obtained information was compared and analyzed to determine the advantages and limitations of different inspection methods and their application possibilities for storage tanks.

Results

The analysis showed that the quality of welded joints has a direct influence on the operational reliability of storage tanks. During the research, it was found that the most common welding defects include cracks, pores, lack of fusion, incomplete penetration, slag inclusions, and geometric irregularities of welds. Cracks were identified as one of the most dangerous defects because they can develop under repeated loading and lead to sudden failure of the structure. They may appear due to improper welding conditions, residual stresses, rapid cooling, or unsuitable welding materials.



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Incomplete penetration and lack of fusion were also considered critical defects because they reduce the effective strength of the welded connection. Such defects decrease the load-bearing capacity of the joint and may become a starting point for further damage. The results showed that visual inspection alone is not sufficient for a complete evaluation of welded joint quality. Although it allows detection of surface defects, internal defects can remain unnoticed. Therefore, the use of ultrasonic and radiographic testing methods significantly improves the accuracy of technical assessment.

The study also demonstrated that regular inspection of welded joints during operation helps to identify defects before they reach a critical level. Early detection allows maintenance activities to be planned in advance and reduces the probability of emergency situations. The combined use of several diagnostic methods provides more reliable results. For example, visual inspection can be used together with ultrasonic testing to obtain information about both external and internal conditions of welded joints.

Discussion

The obtained results confirm that welding quality control should be considered an essential part of ensuring the safe operation of storage tanks. Since welded joints are exposed to mechanical loads and environmental influences during operation, their condition may change over time. In many industrial facilities, technical inspections are carried out according to scheduled periods. However, only periodic visual examination may not provide complete information about the actual condition of welded structures. Therefore, the use of non-destructive testing methods allows a more accurate assessment of structural reliability.

The choice of inspection method depends on the type of equipment, material properties, operating conditions, and possible defect characteristics. For storage



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tanks operating in hazardous environments, a combination of different testing methods provides more reliable results compared to the use of a single method. The obtained results also indicate that improving welding quality during manufacturing and repair processes has a direct impact on reducing operational risks. Proper selection of welding technology, qualified personnel, and regular technical control are necessary conditions for increasing the service life of storage tanks.

For industrial facilities in Uzbekistan, where many tanks have been operated for long periods, improving methods for evaluating welded joints remains an important technical issue. The application of modern diagnostic approaches can help determine the actual condition of equipment and prevent failures related to welding defects.

Conclusion

The research results show that the condition of welded joints plays an important role in ensuring the safe operation of storage tanks at hazardous industrial facilities. Defects formed during welding or developed during operation can reduce the strength of structures and increase the risk of accidents. Modern non-destructive testing methods, including ultrasonic testing, radiographic examination, magnetic particle testing, and visual inspection, provide an opportunity to assess welded joints without damaging the equipment. Their regular application allows detecting defects at an early stage and planning necessary repair measures.

Thus, improving welding quality control systems and applying modern diagnostic methods are important steps toward increasing the reliability and safety of storage tanks. A systematic approach to inspection and maintenance helps extend



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equipment service life and reduce risks associated with hazardous industrial operations.

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