JoFRISE 2 (3) (2024)
Journal of Frontier Research in Science and Engineering
https://journal.riau-edutech.com/index.php/jofrise
Publisher :
Andester Riau Edutech
Pusat Inovasi Pendidikan dan Teknologi
ISSN : 3032-0348

Non-Destructive Use in Gas Inspection

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Submiited: 12/08/2024
Revised: 13/08/2024
Accepted: 13/08/2024
Published: 23/09/2024
Vol. 2
No. 3

ABSTRACT

Non-destructive testing (NDT) is a set of analytical techniques used to assess the properties of a material, component, or structure without destroying or damaging the object under test. The purpose of NDT is to find defects or non-conformities such as cracks, porosity, welding imperfections, and material inhomogeneity. The oil and gas industry is a very important sector for the global economy, providing a major source of energy for a wide range of activities. Assets in this industry, such as wells, pipes, tanks, and other equipment, require rigorous maintenance and inspection to guarantee operational safety and reliabilityNDT works using a variety of techniques that utilize the physical properties of materials, such as sound waves, X-rays, magnetic fields, or penetrating fluids. These techniques are used to detect internal or external defects in objects, such as cracks, corrosion, porosity, or material misconformities. For example, in ultrasonic testing, the way UT works uses high-frequency sound waves directed into the material and then reflected back by material defects or boundaries. The transducer receives the reflected waves and converts them into electrical signals that can be analyzed to determine the location and size of the defect. This article presents an overview of the applications of NDT in oil and gas inspection, highlighting the advantages of this technology in detecting corrosion, cracks, and wear on pipelines and equipment. With a focus on the reliability and accuracy of inspection results, the use of NDT is expected to continue to grow as a reliable solution in effectively maintaining the integrity of oil and gas infrastructure.

Keywords: *Uses, Non-DestructiveTesting (NDT), Oil and Gas Industry*

1 Introduction

The oil and gas industry is one of the most critical sectors of the global economy, providing a major source of energy for human activities. Oil and gas exploration, production, processing, and distribution activities depend on complex and expensive infrastructure, ranging from wells, pipelines, tanks, reactors, and other equipment. To ensure the safety, efficiency, and reliability of operations, a comprehensive inspection and inspection of all these assets is required. Non-Destructive Testing technology is becoming more common in oil and gas inspections and is becoming the first choice for engineers and industry professionals. Non-Destructive Testing allows for a thorough inspection of an asset without compromising its structural integrity. This allows for early identification of defects and potential problems, which in turn helps prevent costly and dangerous failures.

Non-Destructive Testing saves time and cost because it allows engineers to find possible problems without disrupting normal operations. In addition, NDTs offer the flexibility required in harsh environments, such as oil and gas facilities where temperatures, pressures, and aggressive chemical environments are rigorous. The use of Non-Destructive Testing in oil and gas inspections also involves monitoring the condition of periodic inspections. Using NDT technology, operators can monitor changes in equipment conditions over time, spot signs of material fatigue or corrosion, and prevent unwanted failures before they occur.

How to Cite :
Isabella, R.. *et al.*(2024). Non-Destructive Use in Gas Inspection. *Journal of Frontier Research in Science and Engineering(JoFRISE)*, 2(3), 14-19.

In addition, as technology advances, Non-Destructive Testing is increasingly integrated into automated sensor-based monitoring systems, allowing engineers to obtain real-time data on equipment health. This not only improves the efficiency of asset management but also enables the implementation of preventive maintenance strategies, thereby reducing the risk of failure and unplanned downtime. NDT continues to be an invaluable tool for professionals in this field because of its ability to detect defects without damaging materials, its flexibility in harsh environments, and its ability to monitor conditions periodically.

2 Research Methodology

This study uses a literature study method with a qualitative approach. The purpose of this study is to describe the overall results regarding the use of non-destructive testing. The material for this research was obtained from company procedures, files, industry journals, and related files related to the results of the use of non-destructive testing (NDT).

2.1 Non-Destructive Testing (NDT)

Non-destructive testing (NDT) refers to a group of analytical techniques used to evaluate the properties, integrity, and quality of materials, components, or structures without causing damage to those structures. By employing the NDT method, engineers and inspectors can identify deficiencies, defects, or discontinuities in the object being tested without altering its physical or mechanical properties.

2.2 Oil and Gas Industry

The oil and gas industry is an economic sector that includes a wide range of activities ranging from exploration, extraction, to marketing of petroleum and natural gas products. The process begins with exploration to find new reserves through geological surveys and drilling. Once reserves are found, crude oil and gas are extracted from the earth.

The extracted crude oil is then refined and processed into various finished products such as gasoline, diesel, and LPG. Natural gas is also processed for household and industrial use. Transportation of oil and gas from extraction sites to refineries and then to markets involves pipelines, tankers, and other transportation methods.

3 Results and Discussion

3.1 Definition of Non-Destructive Testing

Non-destructive testing (NDT) is a set of analytical techniques used to assess the properties of a material, component, or structure without destroying or damaging the object under test. The purpose of NDT is to find defects or non-conformities such as cracks, porosity, welding imperfections, and material inhomogeneity. This allows for routine inspections and maintenance without stopping operations or replacing the components being tested, which makes them essential in a variety of industries.

NDT includes a variety of techniques such as ultrasonic testing, where high-frequency sound waves are used to detect defects in materials; radiographic testing, which uses X-rays or gamma rays to produce images from within the material; magnetic particle testing, which relies on magnetic fields to detect cracks on the surface of ferromagnetic materials; and liquid penetrant testing, where a special liquid is used to identify small cracks in the surface. Each method has certain applications and advantages, depending on the type of material and the type of defect sought.

3.2 Types of NDT Method

There are many NDT methods, each with its own advantages and limitations. Some of the key techniques include:

Ultrasonic Testing (UT)

UT uses high-frequency sound waves to detect flaws, measure thickness, and evaluate material properties. This method is versatile, precise, and can be used on a wide variety of materials, but it requires a skilled operator and may not work well on highly corroded or irregular surfaces.

Figure 1. Ultrasonic Testing

Magnetic Particle Inspection (MPI)

MPI uses magnetic fields to identify surface and near-surface defects in ferromagnetic materials. This MPI is Fast, cost-effective, and easy to implement. However, it is limited to ferromagnetic materials and only detects surface or near-surface defects.

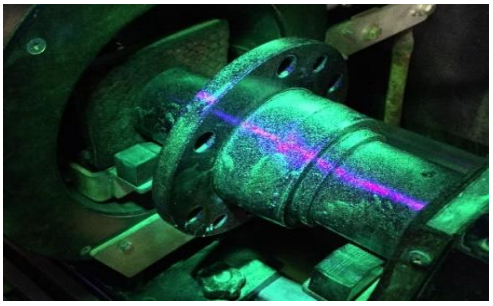

Figure 2. Magnetic Particle Inspection (MPI)

Eddy Current Testing (DLL)

ECT uses electromagnetic fields to detect defects and measure material properties in conductive materials. ECT is sensitive, non-contact, and can detect minor defects. However, it is limited to electrically conductive materials and may be affected by complex geometries or surface conditions.

Figure 3. Eddy Current Testing (DLL)

Visual Inspection (VI)

VI is the simplest NDT method, involving direct observation of a material or structure to identify defects or irregularities. VI is limited by human factors, such as visual acuity and fatigue, and may not detect subsurface defects.

Figure 4. Visual Inspection (VI)

Thermal Infrared (IRT) Testing

IRT uses infrared cameras to detect temperature variations on the surface of a material, which can indicate weaknesses, leaks, or other problems. However, it is limited to surface indications and can be affected by environmental factors, such as temperature and humidity.

Figure 5. Thermal Infrared (IRT) Testing

3.3 Advantages and Disadvantages of the use of NDT in the Oil and Gas World

The use of Non-Destructive Testing (NDT) techniques in the oil and gas industry provides various advantages as well as several disadvantages that need to be considered. The following is a summary of the main advantages and disadvantages:

Advantages of Using NDT in the Oil and Gas Industry:

1. **Non-Destructive Defect Detection**: NDT detects defects in oil and gas equipment without damaging the material being inspected. This is important because oil and gas infrastructure often consists of expensive and vital equipment that cannot be challenged.
2. **Periodic Condition Monitoring**: With NDT, oil and gas companies can conduct periodic condition monitoring on their equipment. This allows for early identification of potential problems and the taking of preventive measures before serious failures occur.
3. **Improved Safety**: Through early detection of defects and damages, the use of NDT helps improve operational safety in the field. By knowing the actual condition of the equipment, companies can take the necessary precautions to avoid further accidents or damage.
4. **Time and Cost Savings**: NDTs can save time and cost by enabling quick and efficient inspections without shutting down normal operations.

Disadvantages of the Use of NDT in the Oil and Gas Industry:

1. **High Initial Cost**: While NDT can save long-term costs by preventing equipment failure, the initial cost of acquiring and training personnel in the use of NDT techniques can be high.
2. **Technology Limitations**: Some NDT technologies are not suitable for all types of equipment or environmental conditions in the oil and gas field
3. **Reliance on Specific Expertise**: NDT requires specialized expertise in data interpretation and equipment usage. Reliance on these specific expertise can be challenging in maintaining and developing a competent inspection team.
4. **Time and Resources Required for Inspection**: Inspections using NDT require significant time and resources. This can disrupt operational schedules and require careful planning.

With its ability to detect defects without damaging materials, NDT remains an irreplaceable tool for oil and gas companies in ensuring the safety, reliability, and operational efficiency of their infrastructure.

There are various examples of applications of Non-Destructive Testing (NDT) techniques in the oil and gas (oil and gas) industry, including:

1. **Pipeline Inspection**: NDT is used for pipeline inspections used in oil and gas transportation. Techniques such as ultrasonics and radiography can be used to detect defects, corrosion, or other damage to pipe walls.
2. **Storage Tank Inspection**: Oil and gas storage tanks often corrode due to the harsh environment and chemicals stored in them. NDTs are used for routine inspections of storage tanks to detect damage, corrosion, or leaks without the need to empty the tank.
3. **Inspection of Equipment and Machinery**: NDT is used for inspections on equipment and machinery used in oil and gas production processes, such as pumps, compressors, or turbines. Regular inspections using NDT techniques help detect signs of wear, corrosion, or other damage that could affect the performance of the equipment.
4. **Corrosion Monitoring**: Corrosion is a common problem in the oil and gas industry that can threaten the safety and integrity of infrastructure. NDT is used for corrosion monitoring of pipes, tanks, and other structures by techniques such as ultrasonic, electromagnetic, or radiography.
5. **Welding Testing**: Welding or joining metals is an important part of the construction of oil and gas infrastructure such as pipelines and offshore platforms. NDT is used to ensure the quality of these joints by detecting defects such as cracks, porosity, or shrinkage that may occur during the welding process.

4 Conclusion

The conclusion of the material above is that the use of Non-Destructive Testing (NDT) techniques in the oil and gas (oil and gas) industry has a very important contribution in improving the efficiency, reliability, and operational safety of infrastructure. The various advantages of using NDT, such as its ability to detect defects without damaging materials, periodic condition monitoring, time and cost savings, improved security, and better asset management, make it an irreplaceable tool in maintaining the quality and performance of oil and gas equipment. Overall, the use of NDT techniques assists the oil and gas industry in maintaining the quality, reliability, and safety of their infrastructure, thus playing a crucial role in supporting the productivity and sustainability of the oil and gas sector.

Reference

American Petroleum Institute. (2007). *API 570: Piping Inspection Code*. Washington, D.C.: American Petroleum Institute.

American Petroleum Institute. (2016). *API 510: Pressure Vessel Inspection Code*. Washington, D.C.: American Petroleum Institute.

American Society of Mechanical Engineers. (2013). *ASME Boiler and Pressure Vessel Code (BPVC)*. New York: The American Society of Mechanical Engineers.

American Society of Mechanical Engineers. (2017). *ASME Boiler and Pressure Vessel Code (BPVC)*. New York: The American Society of Mechanical Engineers.

B. D. Silverman, "Ultrasonic Testing," in Encyclopedia of Materials: Science and Technology, 2nd ed., pp. 9371-9377, 2001.

Beentjes, M. P., & Iannucci, A. (2020). Non-destructive testing for the assessment of structural integrity of offshore wind turbine monopiles. *Renewable Energy, 151*, 1174-1189.

Charles, J. A., & Blessing, R. T. (2001). *Ultrasonic Nondestructive Testing: A Practical Guide*. Elsevier.

Dou, W., Zhou, N., & Jin, Y. (2021). "Smart Nondestructive Testing and Evaluation for Safety-Critical Components." CRC Press.

Eskin, I. A. (2014). *Handbook of Nondestructive Testing*. CRC Press.

Faizal, M., & Umam, S. (2018). Analysis of the strength and quality of weld joints with variations in oil and air cooling on ASTM A36 material by NDT (Non Destructive Test) test. *Bina Teknika*, *14*(2), 131. https://doi.org/10.54378/bt.v14i2.338

Giampaoli, J., Elsener, M., & Hagedorn, C. (2019). Non-destructive testing of composite materials for aerospace applications. *Aerospace Science and Technology, 89*, 105071.

International Organization for Standardization. (2005). *ISO 9712: Nondestructive testing - Qualification and certification of personnel*. Geneva: International Organization for Standardization.

International Organization for Standardization. (2016). *ISO 9712: Nondestructive testing - Qualification and certification of personnel*. Geneva: International Organization for Standardization.

J. A. Gale, "Thermal Imaging in Nondestructive Testing," in Comprehensive Composite Materials, vol. 3, pp. 455-475, 2000.

Jones, R., & Radosavljevic, B. (2016). *Non-destructive testing for condition monitoring and assessment of materials*. Woodhead Publishing.

Kraemer, W., Maisonette, C., & Thompson, R. B. (2018). *Nondestructive testing for in-service inspection of power plant and industrial boiler components*. Springer.

Kumar, A., Gupta, S., & Shukla, A. (2020). "Internet of Things (IoT) in 5G Mobile Technologies." Springer.

Lu, Y., & Tian, G. (2016). Non-destructive testing and evaluation of composite materials and structures. *Materials Science and Engineering: R: Reports, 82*, 1-49

Muin. (1998). *At- Omizing Burner*. *10*(2), 156–168.

Y. LeCun, Y. Bengio, and G. Hinton, "Deep Learning," Nature, vol. 521, no. 7553, pp. 436-444, 2015.