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Advancements In Digital And Computed Radiography For Pipe Weld Inspection: A Focus On Sensitivity Checks And Innovative IQI Placement Techniques

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Abstract

Digital Radiography (DR) and Computed Radiography (CR) have transformed non-destructive testing (NDT), offering superior imaging capabilities and efficiency in pipe weld inspection. A cornerstone of these technologies is the sensitivity check, which ensures accurate detection and visualization of weld defects. This paper highlights the significance of sensitivity checks in DR and CR, addressing the challenges posed by the placement of Image Quality Indicators (IQIs) and proposing innovative solutions to overcome them. The introduction of a novel fixer attachment for IQI placement streamlines the inspection process, minimizing the need for frequent recalibration and maintaining sensitivity thresholds. This advancement enhances compliance with industry standards while optimizing productivity in high-throughput environments. The proposed solutions set a new standard in radiographic testing, balancing precision, efficiency, and workflow optimization.

Keywords-Digital Radiography, IQI, Sensitivity, Nondestructive testing

1. Introduction

Non-destructive testing (NDT) ensures the safety and reliability of pipe welds in industries such as oil and gas, power, and construction. Digital Radiography (DR) and Computed Radiography (CR) have gained prominence due to their high-resolution imaging and real-time results. Sensitivity, or the ability to detect minute defects, is a critical parameter that requires rigorous validation through sensitivity checks.

This paper focuses on the sensitivity check process in DR and CR for pipe weld inspection, highlighting challenges in Image Quality Indicator (IQI) placement. An innovative IQI placement technique is introduced, featuring a unique fixer attachment that minimizes recalibration, enhances sensitivity, and streamlines high-production workflows, ensuring compliance with industry standards.

2. Sensitivity Checks in Digital and Computed Radiography

2.1 Importance of Sensitivity Checks Sensitivity checks are critical in DR and CR systems to ensure that the equipment can detect and visualize defects of a specified size. These checks involve the use of reference wires or Image Quality Indicators (IQIs) to establish a baseline for the system's performance. The visibility of these reference wires in the acquired images determines whether the system meets the required sensitivity criteria.

2.2 Sensitivity Check Process

The sensitivity check process for pipe weld inspection involves the following steps:

1. Selection of a Reference Wire: A reference wire with known dimensions and material properties is selected. This wire is typically placed on the outer surface of the pipe near the weld area.

2. Image Acquisition: The pipe weld is exposed to X-ray or gamma-ray radiation, and a digital detector captures the resulting image. Exposure parameters such as kilovoltage, milliamperage, and exposure time are optimized based on the inspection requirements.

3. Image Analysis: The acquired image is analyzed to evaluate the visibility of the reference wire. The wire must be clearly distinguishable from the background to confirm the system's sensitivity.

4. Sensitivity Determination: The visibility of the reference wire is compared against acceptance criteria specified in industry standards. If the wire meets the criteria, the system is deemed capable of detecting defects of the required size.

5. Adjustments and Documentation: If the reference wire does not meet the visibility criteria, adjustments are made to the system settings. The results of the sensitivity check, including the reference wire used and any adjustments made, are documented for traceability.

3. Challenges in IQI Placement

3.1 Traditional IQI Placement Methods

In DR and CR systems, IQIs are typically placed on the source side of the pipe weld to ensure accurate sensitivity calibration. However, this approach presents several challenges:

- Inaccessibility: In some cases, it is not feasible to place the IQI on the source side due to physical constraints.

- Frequent Calibration: NDT personnel must frequently visit the X-ray banker to place the IQI or perform sensitivity checks, which disrupts production workflows.

- Re-testing Requirements: If the sensitivity check fails after a four-hour calibration interval, all pipes tested within that period must be re-inspected, leading to significant delays and increased costs.

3.2 Impact on High-Production Environments

In high-production environments, the traditional IQI placement method is impractical due to the need for continuous inspection and the inability to halt production for frequent calibration. This creates a trade-off between maintaining sensitivity and meeting production targets.

4. Innovative Solution: Fixer Attachment for IQI Placement

4.1 Development of the Fixer Attachment

To address the challenges associated with IQI placement, a unique fixer attachment was developed. This attachment is integrated with the X-ray tube and positions the IQI approximately 1/2 inch above the pipe weld. This innovative approach offers several advantages:

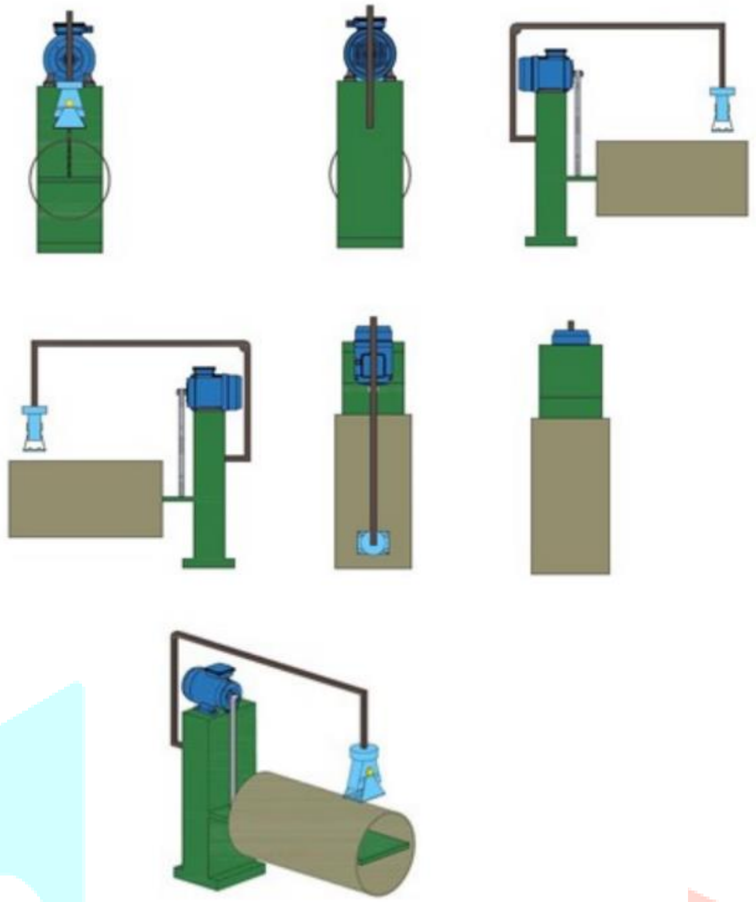

Figure 1: Remote sensitivity validation tool (design) - for industrial digital X-ray (UK design number **6414345**)

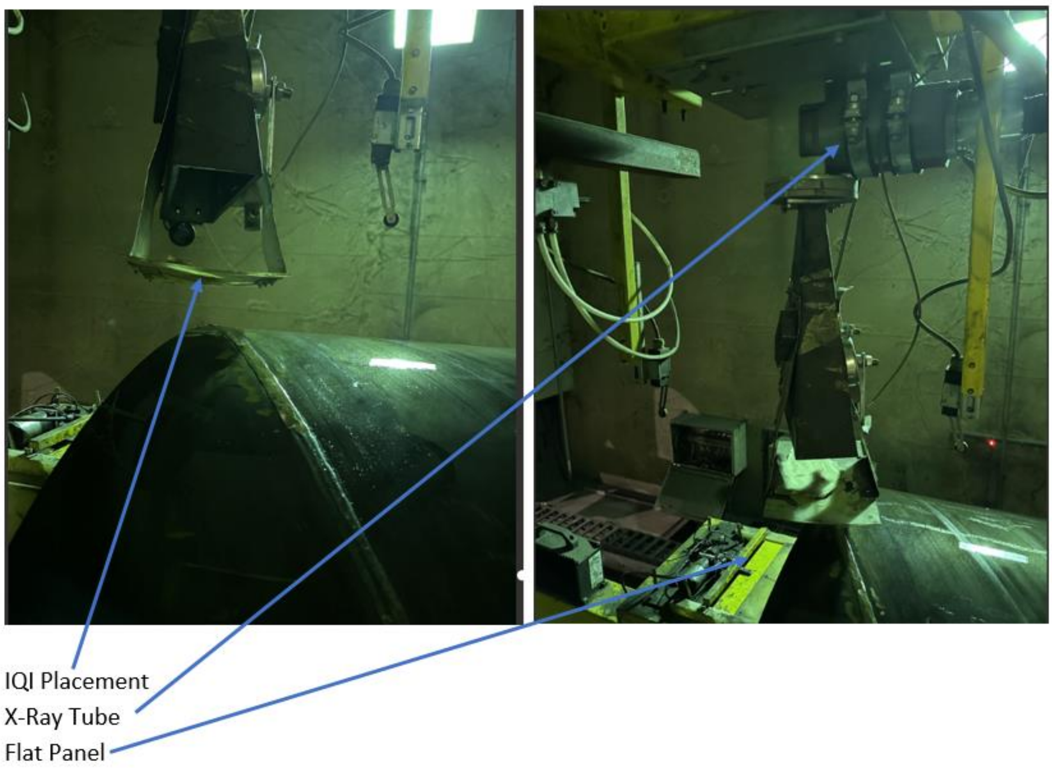

Figure 2: Real-time set up of IQI on a fixture that is in air

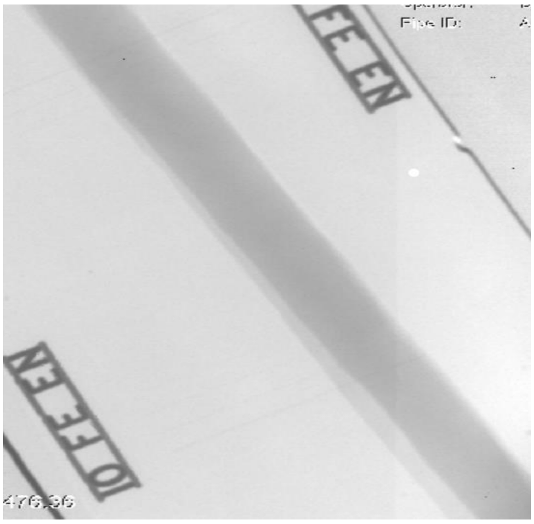

Figure 3: 1.5% sensitivity with wire-type IQI when the IQI is placed on an in-air fixture.

- Reduced Calibration Visits: The fixer attachment minimizes the need for NDT personnel to enter the X-ray banker frequently, thereby reducing disruptions to production.
- Consistent Sensitivity: By optimizing exposure parameters, the system achieves better-than-required sensitivity, ensuring reliable defect detection.
- Global Benchmark: This technology represents a significant advancement in radiographic testing, as it is the first of its kind to achieve the required sensitivity with the IQI placed above the pipe surface.

4.2 Benefits of the Fixer Attachment

The fixer attachment has revolutionized pipe weld inspection by:

- Enhancing efficiency in high-production environments.
- Reducing the risk of re-testing due to failed sensitivity checks.
- Maintaining compliance with industry standards while optimizing production workflows.

5.0 Duplex Wire Sensitivity

Duplex wire sensitivity refers to the use of two reference wires of different diameters to evaluate the system's ability to detect defects of varying sizes. This approach provides a more comprehensive assessment of the system's sensitivity and ensures that it can detect both small and large defects. The fixer attachment is compatible with duplex wire sensitivity checks, further enhancing its utility in pipe weld inspection.

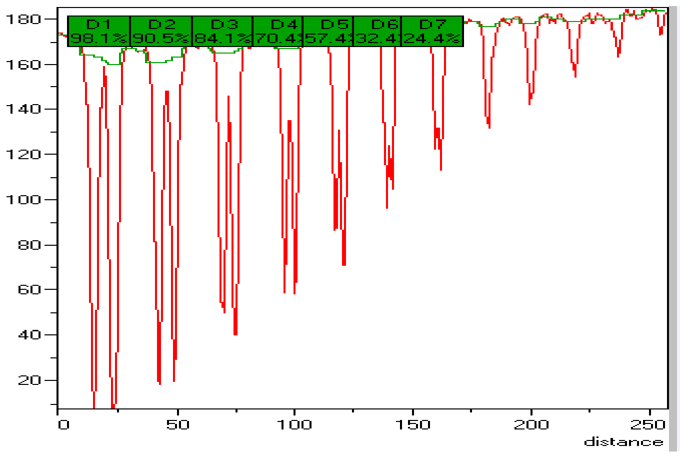

Figure 4: Duplex wire sensitivity when the Duplex IQI is placed on a fixture in air

6. Conclusion

Sensitivity checks are an essential aspect of DR and CR systems, ensuring the accurate detection of defects in pipe welds. However, traditional IQI placement methods often pose challenges, particularly in high-production environments. The introduction of a novel fixer attachment for IQI placement has successfully addressed these limitations by minimizing the need for frequent recalibrations, maintaining consistent sensitivity, and establishing a new standard in radiographic testing. This innovation highlights the critical role of continuous advancements in NDT technologies to meet the evolving demands of modern industries while optimizing efficiency and accuracy.

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