APPLICATION OF 2D AND 3D DIGITAL IMAGE CORRELATION IN TESTING PRESSURE EQUIPMENT AND RELATED MATERIALS

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Abstract

Digital Image Correlation (DIC) method, including both 2D and 3D DIC, plays an important role in testing and evaluating pressure equipment integrity, as well as materials used in pressure equipment. The 2D DIC method, employing a single-camera setup, is particularly suited for assessing surface deformation and strain distribution in simpler geometries and thin-walled pressure components under various loading conditions. This technique efficiently identifies localized strains, surface defects, and initial crack formation, crucial for maintaining the structural integrity of pressure vessels, piping, and storage tanks. Due to its ease of implementation, 2D DIC is often applied in laboratory tensile tests, pressure cycle tests, and validation of finite element models for flat or nearly flat pressure equipment surfaces.

On the other hand, 3D DIC, utilizing a stereo, dual-camera arrangement, significantly expands the measurement capabilities, allowing accurate assessment of complex, three-dimensional deformation fields present in curved or intricate geometries typical of pressure equipment. The method effectively captures out-of-plane displacements and complex strain distributions arising under internal pressure conditions, thermal loading, and fatigue tests, that are common operational scenarios for pressure equipment. The advanced spatial measurement capabilities of 3D DIC enable precise identification of critical regions prone to failure, including weld joints, nozzles, and geometrical discontinuities. Consequently, 3D DIC provides critical insights into material behavior and structural response, enhancing safety, performance, and reliability in pressure equipment.

Integrating DIC methodologies with advanced data processing techniques, further improves the predictive capabilities and accuracy of strain measurements. These advancements facilitate early damage detection and real-time structural health monitoring, significantly reducing the risk of unexpected equipment failures. Ultimately, the focused application of 2D and 3D DIC in pressure equipment testing supports more efficient design optimization, maintenance scheduling, and regulatory compliance, reinforcing its importance within the domain of structural integrity assessment.

Keywords: *Digital Image Correlation, Pressure Equipment, Strain Measurement, Structural Integrity, Material Testing*