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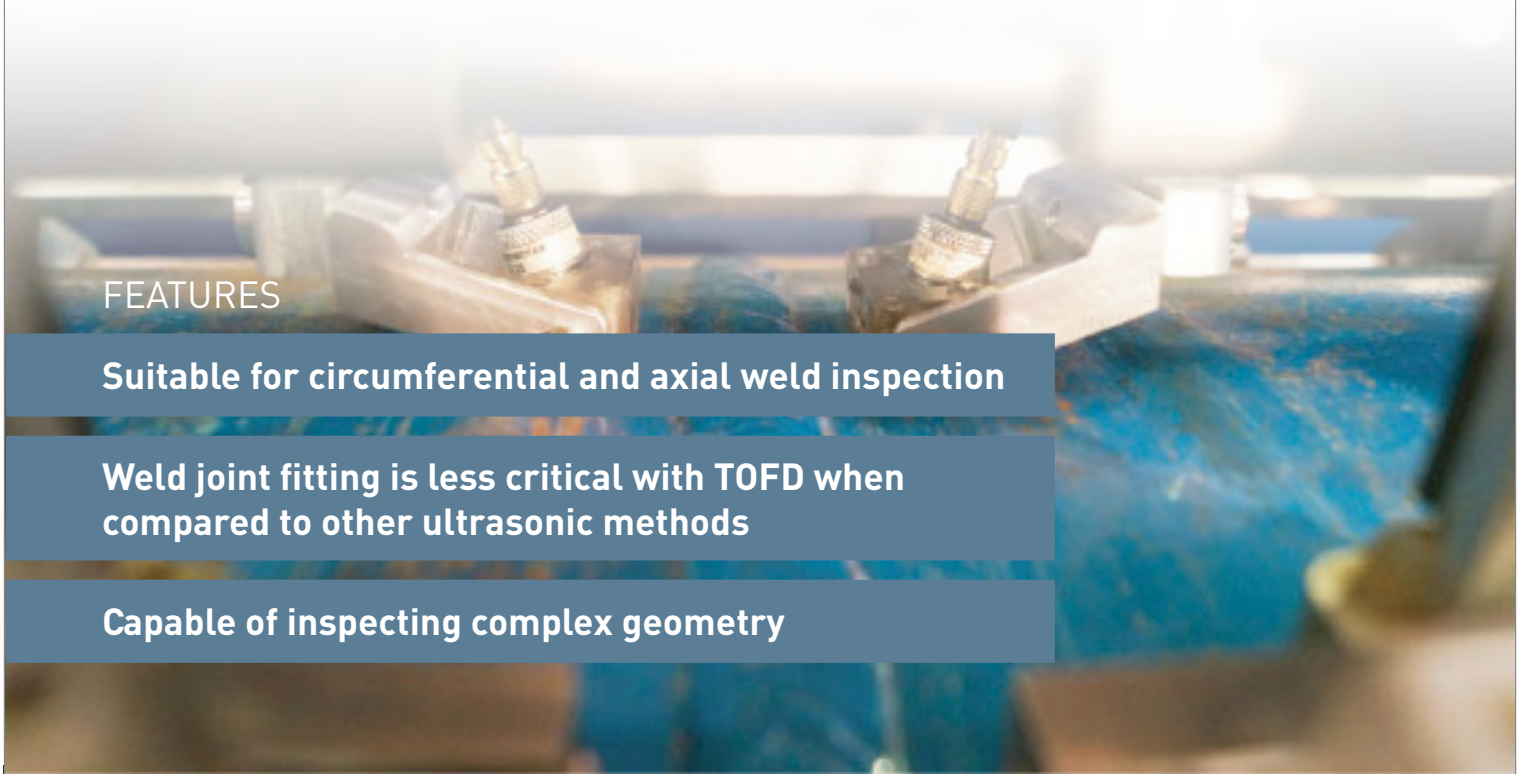
Time of Flight Diffraction

Weld flaw detection

Time of Flight Diffraction (TOFD) is an advanced ultrasonic inspection method that is used primarily for weld inspection. It is a key method in crack detection and sizing for in-service vessel and piping welds.

TOFD capitalizes on tip diffracted signals generated when a discontinuity within a weld receives ultrasonic mechanical energy. Tip diffracted signals are omni-directional wave fronts emitted from the very tips of discontinuities. This results in detection that is less sensitive to defect orientation and more accurate for through wall sizing when compared with amplitude reliant ultrasonic methods.

Given crack geometry can be erratic, TOFD is an excellent tool for detection and sizing.



FEATURES

Suitable for circumferential and axial weld inspection

Weld joint fitting is less critical with TOFD when compared to other ultrasonic methods

Capable of inspecting complex geometry

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Time of Flight Diffraction

Weld Flaw Detection

We use the Olympus OmniScan system for TOFD data collection. OmniScan is a battery-operated, portable, ruggedized system that is capable of high speed, high resolution data collection.

The system provides fully-encoded data collection ensuring 100% weld coverage, significantly increasing the probability of detection (POD) of weld flaws and in-service cracking, enabling engineers to determine the optimum repair strategy and improve risk life assessment (RLA) and risk based inspection (RBI) maintenance programs.

OmniScan presents TOFD data in A-Scan/ D-Scan format, enabling the operator to analyze data in real time and immediately detect and size areas of cracking, erosion, and corrosion.

Raw data is easily transferred and can be transmitted globally for Level 3 and third party analysis, auditing, or storage.

To ensure accurate and consistent probe/wedge placement for weld scanning, a chain link scanner may be used with an incorporated encoder and a water supply system (to ensure consistent ultrasonic coupling). The use of the chain link scanner negates the requirement for magnetic adherence of a scanning system, enabling the inspection of non-ferromagnetic materials. The scanner is also capable of scanning piping in the diameter range 1 to 42 inches while reducing scanner technician error.

For larger diameter piping and vessel inspection, a mag-scanner or A-frame (for non-ferromagnetic materials) can be used for data collection.

Applications

Pressure vessels and pressure systems are required to undergo periodic statutory inspection to ensure continued safe and reliable operation. Traditionally this has been achieved by means of Manual Ultrasonic Inspection or Radiography. TOFD provides a hardcopy of the weld data, much like Radiography, but without the associated safety issues of radiation. TOFD is also the most accurate tool for through wall height/ remaining ligature sizing and is less sensitive to defect orientation, such as lack of fusion/crack type flaws.

Advantages

- Through wall measurements based on arrival times, therefore more accurate than amplitude techniques.
- 100% coverage, permanent record, instant analysis, reproducible fingerprinting for condition monitoring.
- Reduced sensitivity to defect orientation, particularly applicable to cracks
- Capable of inspecting complex geometry including weld joints, such as bend to flange joints.
- High Temperature equipment can be used for temperatures up to 200°C
- Sensitivity / Theoretical Minimum Detectable flaw is ~0.5mm
- General Accuracy +/- 0.5mm
- Monitoring Accuracy +/- 0.3mm

Considerations

- Near-surface, dead zone, however, computer processing can overcome this restriction
- Generally, minimum nominal wall thickness ~6mm.
- Material to be inspected must be penetrable by ultrasonic sound waves, specifically any coating must allow ultrasonic coupling.
- Due to poor signal-to-noise ratios encountered during inspection of stainless steels, fine cracking, such as SCC can be difficult to detect. This is strongly dependent on grade of material, and trials/validations can be carried out to confirm suitability.
- The outer surface should be clean and free from loose impediments such as insulation or other debris. Debris could cause the ultrasonic signal to scatter, therefore not reaching the inner surface. In this scenario, the signal to noise ration may not be sufficient to allow credible data to be recorded. This is a prerequisite for all methods of ultrasonic inspection.
- Complementary inspection techniques including phased array or manual ultrasonic testing can be carried out for accurate flaw characterization.

Additional Features

- 100% encoded coverage of Weld & HAZ
- Digital storage of inspection data
- Fully auditable inspections
- Supplementary TOFD for 100% fusion face coverage, where phased array is carried out from one side only on pipe to fitting welds
- Various materials can be inspected, including stainless steels