NDT - COMPOSITE VESSELS

GENERAL

Vessels and tanks in composite materials are used in plants and production sites for various process purposes. While most process equipment is monitored and covered by maintenance- and integrity programs, the composite vessels are often challenging as there are few non-intrusive inspection methods available for objective and quantitative data of vessel integrity. As a result the vessels must be taken out of operation to perform a valid inspection.

This application note concerns in-service inspection and NDT of composite vessels:
- APV (air pressure vessels)
- Chemical Storage Tanks
- GRE, GRP and CFRP piping and components

PROBLEM

When planning for preventive or corrective maintenance the status of system integrity is very important. The status is established through in-service inspection and integrity activities in the process plant during production and operation.

In case there is no back-up or by-passing solutions, an unexpected failure or condition can result in a plant shutdown and lost production time.

Interferometrical technology for inspecting composite products is well established within several industries. EG: avionics and automotive industries. The traditional systems are sensitive to vibrations, noise and do require stable surroundings. Thermal excitation of object is often applied as inspection principle. The mentioned factors related to interferometrical systems have resulted in technical solutions less adapted to the requirements present in process plants on- and offshore.

Fig 1.
The Optonor system for non- destructive testing, SNT 410, is developed for inspection of composite materials under demanding conditions. Combined with the new Acoustic Derivative Detection (ADD) technology it provides robust and reliable solutions.

SOLUTION

By introducing new technology for quality control and monitoring of composite products like vessels and piping, the achievements will be:

- Enables condition monitoring and better maintenance planning.
- Avoids unplanned stops and production down-time
- Monitoring solutions for in-service inspection programs permits increased life-time.

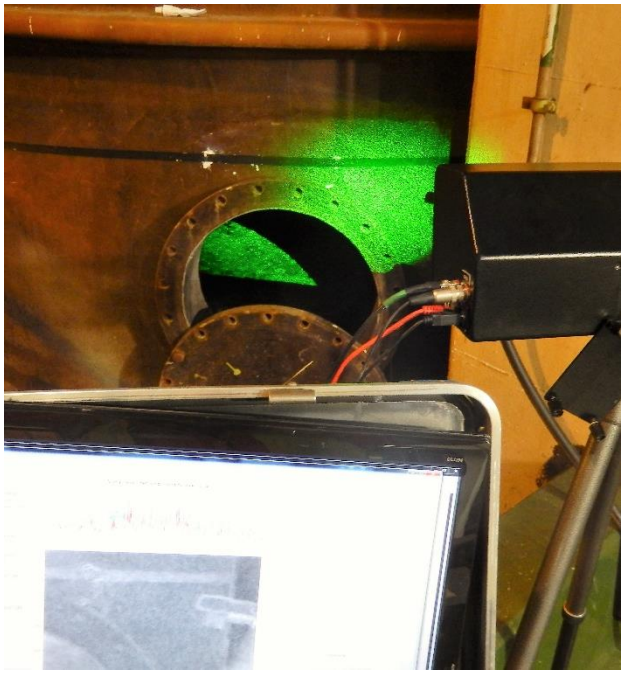


Fig 2. Critical areas are investigated for sub - surface defects and results are displayed in instantly (in the real-time mode).

TECHNICAL PRINCIPLES

Optonor developed the SNT 410 for fast and efficient testing of composite components and structures. The object surface is illuminated by an expanded laser beam and the object is imaged by a zoom lens onto a CMOS sensor array. The SNT 410 measures the spatial derivative of the dynamic surface deflections, as the deflection of each point on the surface is measured relative to a neighboring point. The distance between the SNT 410 optical head and the target surface can be up to 5 meters, or even further depending on surroundings, wind and thermal conditions.

The SNT 410 uses a signal generator for object excitation. The excitation results in structural vibrations or surface waves that propagate across the object field, revealing surface or subsurface defects. Vibration amplitude contour maps can be displayed in real-time or as numerical recordings.

For simple and informative interpretation and evaluation, Optonor has developed Defect Detection Scan in the SNT 410 system. This algorithm performs a frequency scan to detect discontinuities in vibration pattern and modes. The frequency range is modified according to the inspection material. By use of advanced filtering routines, the system detects and displays defects and discontinuities as bright spots or areas. Interpretation of complex vibration patterns is no longer necessary, and results are presented in real time.

APPLICATION EXAMPLE

System: Glass fiber reinforced plastic - Chemical vessel

Dimensions: OD: 4 m / 500 m3 / 16 mm WT

Inspection point: Vessel shell and nozzles in critical areas

Plant: Metal smelting plant in Norway

Material: Norpol 72-70 / Hetron-197

INSPECTION PREPARATION

Prior to inspection the selected inspection points must be defined. Selected points can be based on general arrangement drawings and an in-sevice, risk based inspection approach, or plant-specific experience and knowledge to degenerating mechanisms.

By advanced filtering solutions the system is not affected by process vibrations, winds and waves. The use of piezo-electrical transducers for excitation of objects enables scanning through a range of frequencies providing increased sensitivity to deviations and anomalies. To establish probability of detection and system sensitivity it is recommended to have a sample/calibration object available.

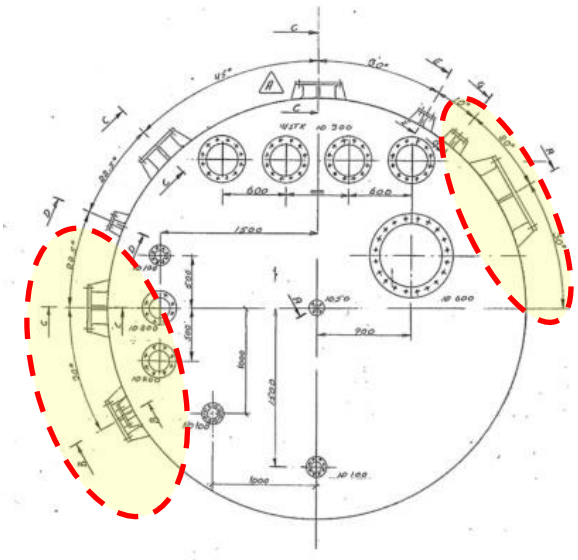


Fig 3. GA drawings are handy for inspection point verification and documentation.

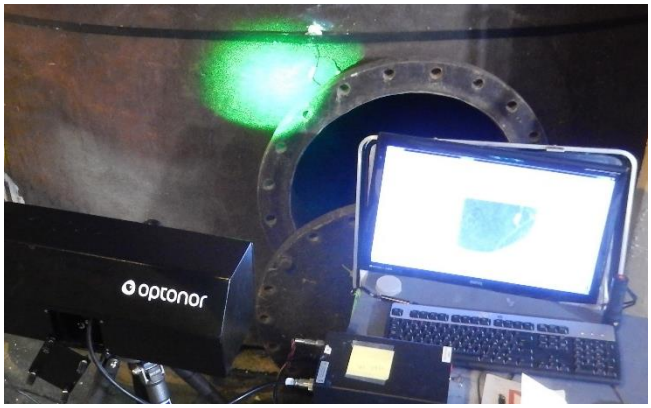


Fig 4. Complete system with instrument, computer and excitation solution is established at the designated inspection site in few minutes. A frequency scan is performed to reveal response modes in analyzed object configuration. Based on the results the frequency range for Defect Detection Mapping is defined.

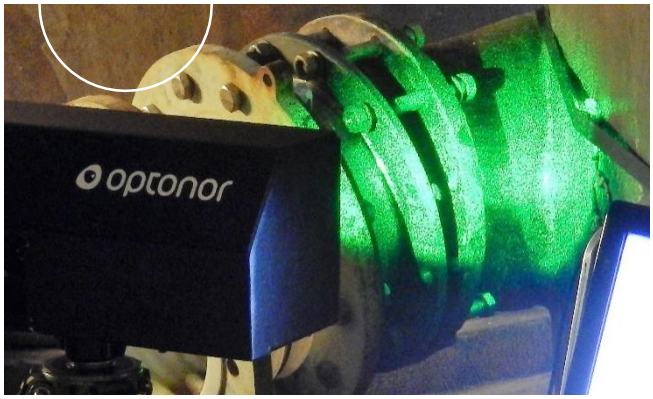


Fig 5. Complex geometries are inspected by the non-contact, camera-based system.

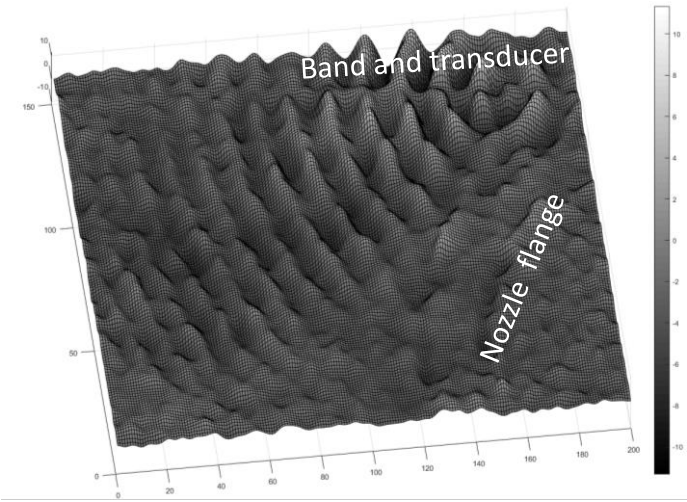


Fig 6. Larger areas of several square meters are covered in one recording and vibration pattern shows where an acceptable signal is achieved.

INSPECTION EXECUTION

The inspection points are inspected 100% according to the inspection plan . The most significant defect is located in vessel shell beside one of the nozzles. The defect is critical to vessel integrity and a repair will have to be carried out.

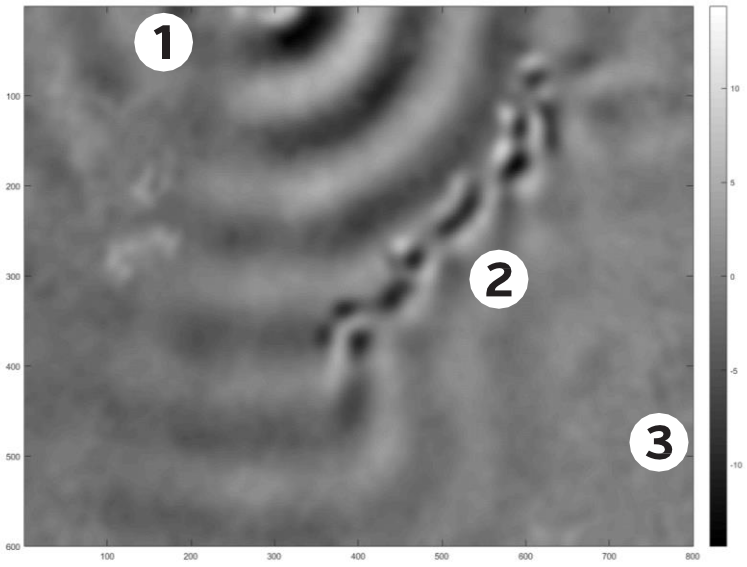


Fig 8. Numerical recording of defect area (fiber cracking and delamination in shell).
See detailed description below.

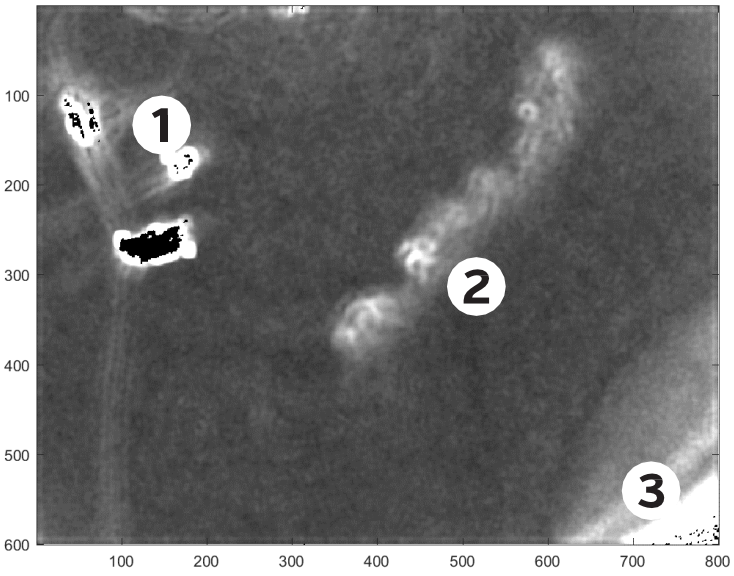


Fig 9. Defect detection map
1: Transducer and excitation point
2: Material sub-surface defect
3: Nozzle pipe and flange

Fig 10 (right side picture).
Photo of damaged area.

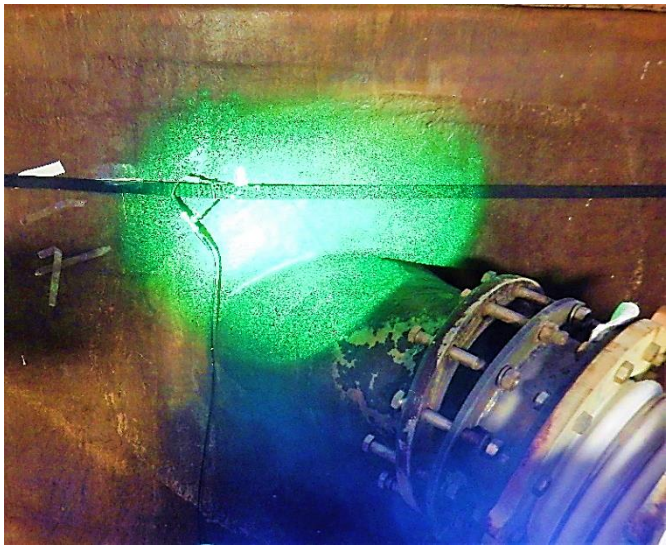
INSPECTION REPORT

Defect Detection Scan is stored as conventional picture file for implementation in inspection report. Raw data from the acquisition process can also be stored and exported for future evaluation and comparison. As inspection parameters and defect position is known, the inspection parameters can be reproduced to monitor development and integrity in future inspections.

FEATURES & BENEFITS

The special features of the SNT 410, making it an ideal solution for inspections of composite vessels are:

- Fast, accurate and efficient
- High resolution and probability of detection
- Technology adapted to challenging plant environments
- User friendly hardware and software
- Applicable to a wide variety of materials:
    - Fiber reinforced plastics
    - Ceramic and metallic composites
    - Sandwich and honeycomb structures



SPECIFICATIONS

•HOIS GP1, *"HOIS Good Practice Guide on In-Service inspection of Offshore Composite Components"*

• DNV-RP-G103, *"Non-Intrusive Inspection"*

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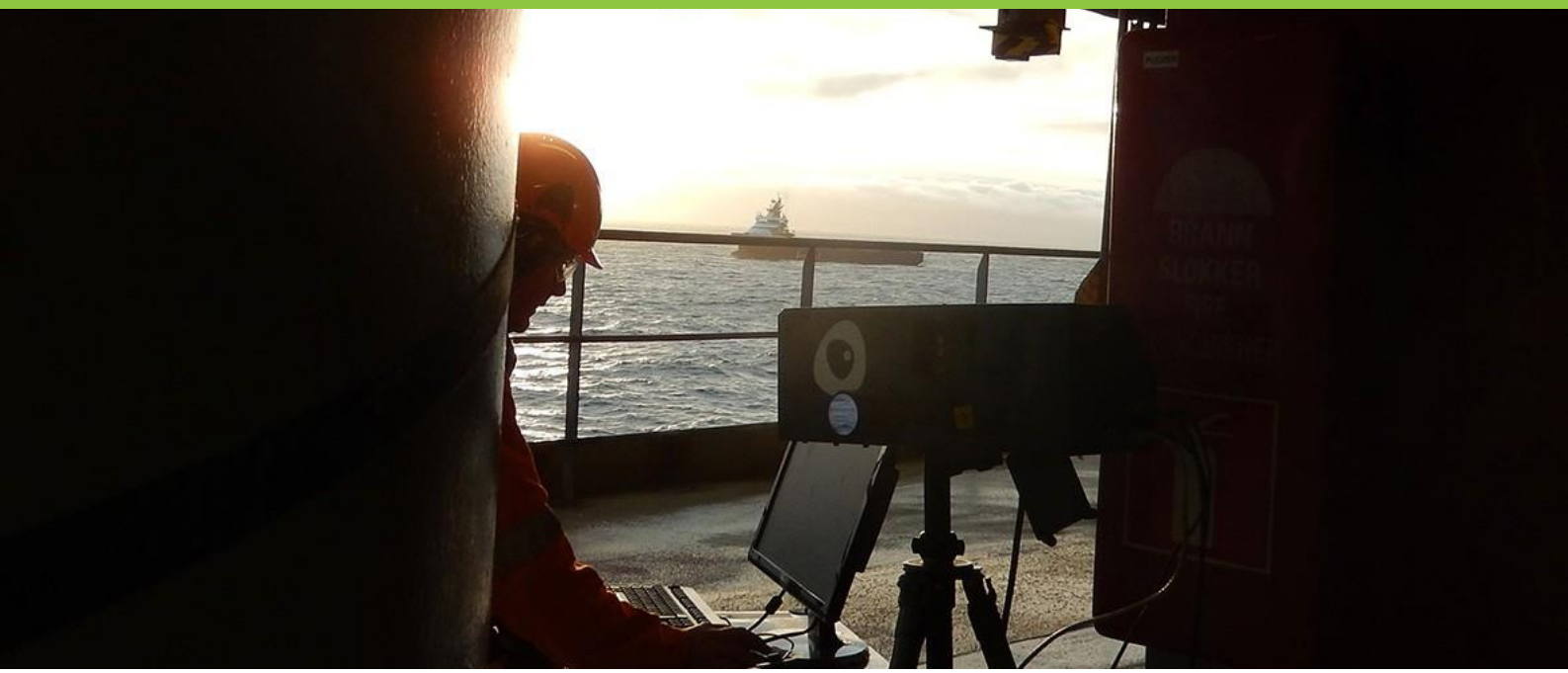
OPTICAL TESTING & METROLOGY



Optonor AS has delivered full-field laser systems for more than 20 years. The systems are based on modern interferometric technologies which are used in a large range of applications within the aerospace, automotive, audio and electronic industries. In addition to commercial customers, many research and educational environments and organizations use Optonor's systems.

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