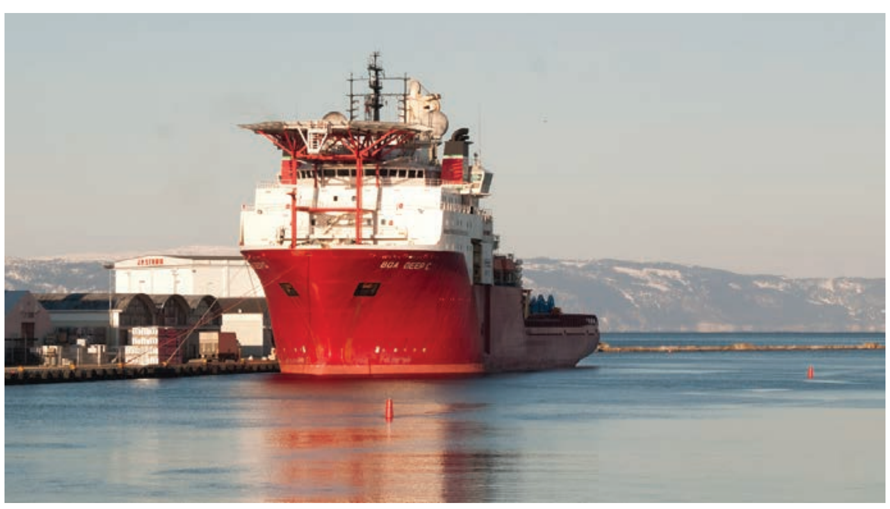
Thermal Imaging Cameras Monitor the Quality of Vessel Constructions

FLIR Systems

In the world of shipbuilding advanced, non-destructive testing methods are used to make sure that the quality of the construction and therefore the quality of the fleet is reliable. At the renowned Masdar Institute of Technology in Abu Dhabi, specific research into the use of thermography for the construction of mobility vehicles is being carried out. There, researchers see this technology as particularly useful due to its fool-proof implementation.

Figure 1. The Masdar Institute has used different types of FLIR cameras, ranging from thermal cores integrated into a spraying gun to FLIR's SC-Series for science and R&D applications.

The Masdar Institute of Science and Technology is the world's first graduate-level university dedicated to providing real-world solutions to issues of sustainability. The Institute's goal is to become a world-class research-driven graduate-level university, focusing on advanced energy and sustainable technologies. At the institute's Department of Engineering Systems and Management (ESM) Dr Mohammad Omar is researching, among other things, the application of Nondestructive Testing (NDT) and monitoring of processes and products.



Vessel Construction

"Before joining the Masdar institute, I worked with thermal imaging in a wide range of application fields, including online inspections, automation and process control," said Dr Omar. "Already in these applications, I experienced that thermal imaging is very reliable and easy to implement. The same is true with thermal imaging for vessel construction monitoring."

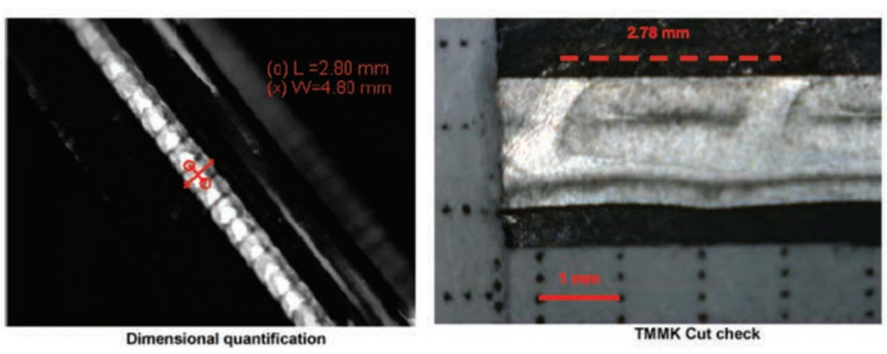


Figure 2. Monitoring the temperature of the weld can be a good indicator of weld strength [1].

The harsh operating environments of marine vessels and fleets require advanced, non-destructive testing technologies and rigorous testing routines and protocols to help ensure construction quality. This quality ultimately determines operating life, maintenance frequency and overall fleet cost and reliability. Thermal-based imaging is such an NDT tool that will not only improve the detectability and quantification of defects, but also lends itself to foolproof implementation. It can also be used in a wide array of marine and naval applications covering the interiors and exteriors of vessels.

Thermal Imaging for Welding Quality Control

A first application that is relevant in the field of vessel construction is welding quality control. Be it spot welding, MIG welding or friction stir welding, the technique is a reliable way of joining two pieces of metal. In highly critical applications like vessel building, strict quality control of the weld is essential. Traditionally, a weld is tested by visual inspection and by tapping it with a hammer to check that the two metal edges have fused properly. However, this way of testing is subjective.

Thermal imaging offers a more objective way. Basically, a good weld requires the metal to be heated uniformly to melting temperature. That is why monitoring of the temperature of the weld can be a good indicator of the strength of the weld. By capturing a thermal image of the weld, a thermal map can be generated that shows how the temperature varies across and along the weld.

Thermal Imaging for Painted Surface Inspection

"A big advantage of thermal imaging is that it can immediately present the temperature profile of large surfaces of ships. This makes it ideal for monitoring the painting process of a vessel," said Dr Omar.

The use of thermal imaging for painted surface inspection has already been successfully applied in the automotive sector. There, thermal cameras monitor a robotic painting process dedicated for coating automotive type fuel tanks with around 500 micron thickness of protective, water-based films. In this application, the thermal images are correlated with the thickness of the paint layer to build up a thickness map for each tank in real time while the paint is still wet. This facilitates any needed repairs to the coated tanks and further enables the robotic manipulator to adjust its flow settings based on feedback from the thermal imager.

Also, in marine vessel construction, thermography has been used to detect unpainted spots in ballast tanks. In this application, thermography detects unpainted spots in different sizes because of their different emissivity and thermal properties. Thermography can also be used to complement other imaging-based techniques, such as fluorescent imaging, where the paint material formulation contains fluorescent pigments that shine under ultra-violet light.

"The big advantage of thermal imaging over other methods is that you can integrate thermal monitoring into the painting process," said Dr Omar. "We have worked with thermal cores from FLIR that are mounted on a painting gun. This way, you can immediately see which surface parts need to be reworked and which parts are already

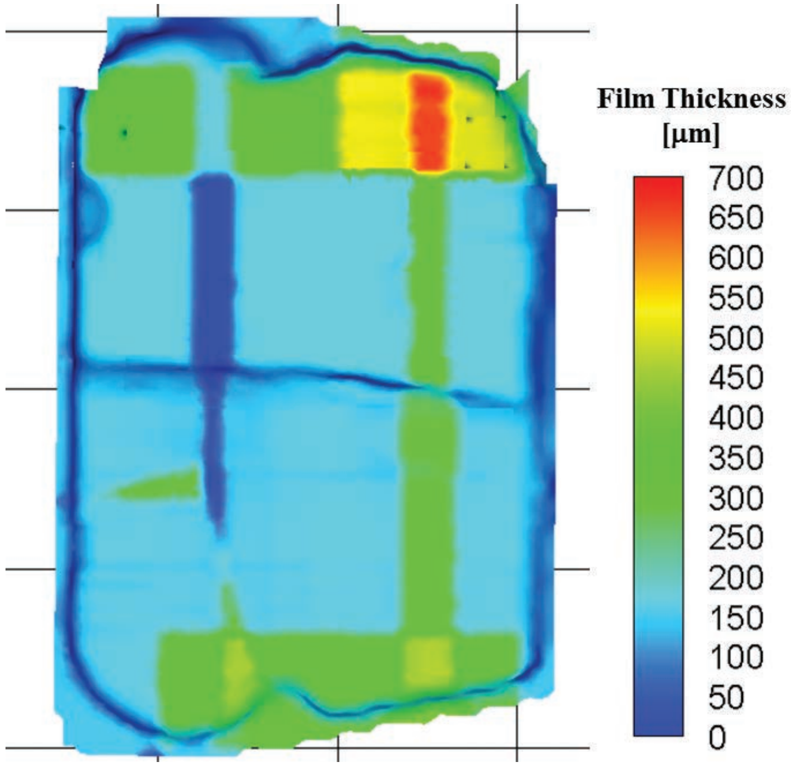


Figure 3. Thermal images provide information on the thickness of the paint layer to build up a thickness map for each tank in real time while the paint is still wet [2].

painted. This is much more efficient than using ultrasound for example, where you have to paint first and monitor afterwards."

Thermal Imaging Detects Undercoat Corrosion

Additional benefits of using thermal-based imagery for painted surface inspection stems from the fact that certain paint formulations are transparent in the 2-5μm infrared band. This makes it possible for thermal imaging to scan the substrate for any damage or undercoat corrosion without removing the paint.

"We have examples of FLIR thermal cameras being used for maintenance inspections of ballast tanks," said Dr Omar. "Tankers sometimes have ballast tanks full of oil when returning from the Middle East. But when heading towards that destination those same tanks are filled with salt water, just to keep the vessel in balance during its outward journey. The problem is that salt water is highly corrosive and that it might damage the painting. With thermal imaging cameras we can see where the corrosion spots are without removing the painting."

Detect in Hard to Reach Places

Very often, inspections at shipyards need to be performed in badly lit and hard to reach places. Thermal imaging is ideal for this, because it can be applied in a contactless fashion and allows inspecting hard-to-reach areas and structures very efficiently. The two-dimensional scanning characteristic is extremely advantageous in marine vessels and structures due to their large size. In addition, thermography testing requires no surface and sample preparation and it can be applied to many types of host materials and paint formulations, so it is not limited by certain bulk material properties, such as electromagnetic permeability.

Another advantage of thermography is the ability to control the resolution of detection by controlling the lenses and the spatial dimensions of the focal plane array, so there is a camera solution for many different vessel inspection jobs.

"At the Masdar Institute, we have experience with different types of FLIR cameras, ranging from thermal cores integrated into a spraying gun to FLIR's SC-Series for science and R&D applications," said Dr Omar. "We like FLIR cameras very much, because of the wide range of products offered to suit different applications and usages, in addition to the level of support provided in terms of camera calibration and software improvements."

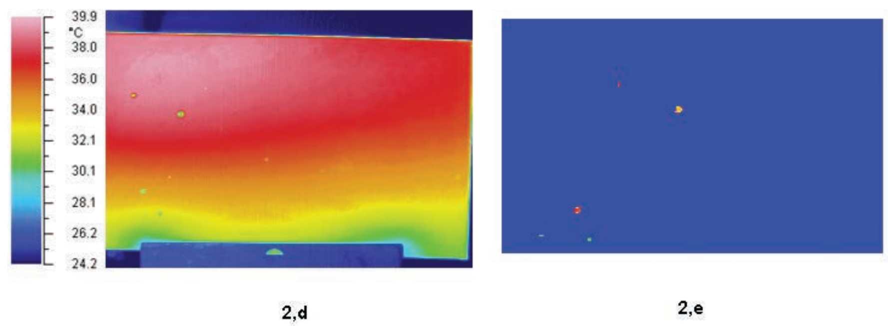


Figure 4. Sample coated with marine grade protective coating, with several artificially applied pinholes (top), and (bottom) the thermal image and the processed images showing the pinholes [3].

For further information contact FLIR Systems or visit www.flir.com/cs/emea/en/view/?id=41702.

Image references:

1. *[M. Omar, R. Parvataneni, Y. Zhou, 'A Combined Approach of Self-Referencing and Principle Component Thermography for Transient, Steady and Selective Heating Scenarios', J. Infrared Physics and Technology, 53, (2010) 358-362].*
2. [M. Omar, V. Viti, K. Saito, J. Liu, Self-adjusting Robotic Painting System, J. of Industrial Robot, 33, (2006), 50-55].
3. *M. Omar, B. Gharaibeh, A. Salazar, et al, 'Infrared Thermography and Ultraviolet Fluorescence for the Nondestructive Evaluation of Ballast Tanks Coated Surfaces', Intl. J. NDT&E, 40, (2007), 62-70]*