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Thermography

Description

Thermography makes use of a camera containing large numbers of sensors sensitive to infrared radiation, which can produce an infrared image and can detect and measure small temperature differences. The image showing these differences can be downloaded to and displayed on a PC, normally as a colour or grey-scale map.

There are two basic types of thermography – passive and active. In passive thermography, the camera is simply pointed at the test piece and from the thermal image a temperature map is constructed.

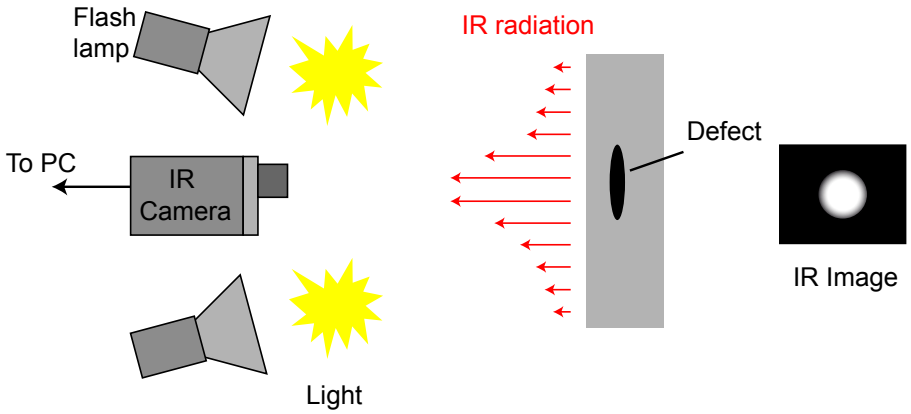
Active thermography involves heating the surface of the object rapidly using an external heat source and observing how the temperature decays with time. Flaws in the material show up by variations in the temperature decay rate. TWI owns systems of both types.

- Passive thermography - Fluke Ti30 infrared camera.
- Active thermography - Thermal Wave Imaging EchoTherm™ Pulsed Thermography (PT) system.

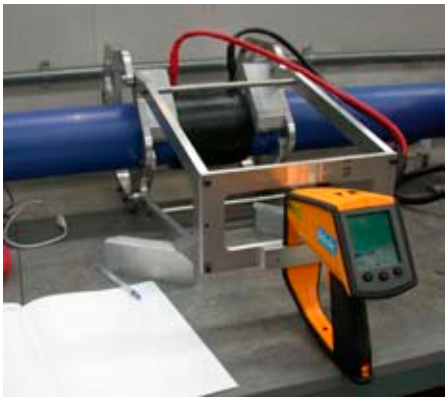
Passive Thermography

Although the Fluke Ti30 is passive - having no method of inducing a thermal pulse - the data collection system can record temperature changes with time. An application of thermography is to study heat flow during joining.

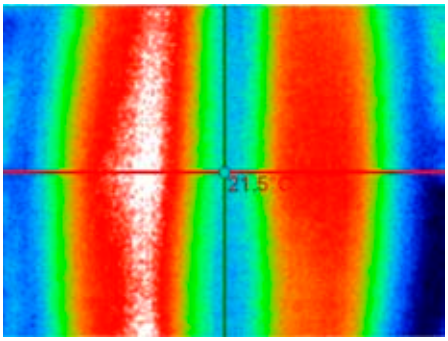
TWI has used the Fluke Ti30 camera to study electro-fusion welds in polyethylene pipe. A potential defect in such welds occurs when one of the pipes is not pushed fully home in the coupler (so-called short-stab or under-penetration). In such joints the temperature of the coupler in the under-penetrated region will be higher after welding and will decay more slowly.



Principle of pulsed thermography



The Fluke Ti30 camera focused on an electro-fusion pipe joint. The camera is located opposite the electro-fusion coupler.

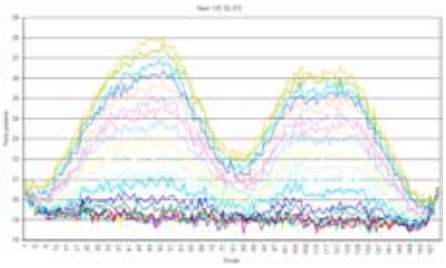


Thermographic image of electro-fusion joint showing under penetration or 'short-stab'. Areas of high temperature indicate the positions into which the pipe should have penetrated.

Pulsed thermography (PT)

PT is an active thermography technique for the assessment of composite materials. It is a high-speed, portable, non-contact and large area inspection technique.

The surface to be inspected is heated by one or more intense light source(s) (~1kW) for periods of 1-25ms. Heat



Graphs showing change in temperature with time for a 'short-stab' joint. Images were captured every 30 seconds after welding and the separate graphs show how temperature decays with time. Under-penetration is confirmed by the fact that the high temperatures in the under-penetrated region decay more slowly.

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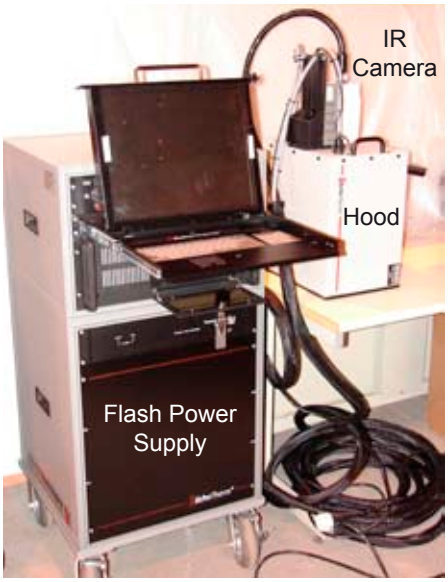
flow into the sample is altered by the presence of any sub-surface flaws (disbonds, voids or inclusions), creating a temperature variation at the surface, which changes with time. These changes are recorded by the infrared camera system, which collects images at a frame rate of up to 60Hz. The software enables the data to be analysed in the following ways.

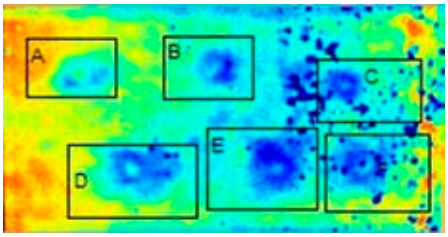
- Time plots of temperature recorded at a single pixel or group of pixels.
- Line profiles.
- 3-D colour or greyscale plots to reveal subtle image features.
- Reconstructed 1st and 2nd order time derivatives.

TWI's EchoTherm™ system is shown on the right above. Inside the hood there are two xenon flash lamps. The hood is placed over the component to be inspected, the lamps are flashed and the camera takes image sequences and the decay data are processed and displayed by the PC.

One of the potential applications is to detect impact damage to wind turbine blades. The image below shows a thermal map of a blade with a number of damage locations being readily detected.



EchoTherm PT system



Thermal map of wind turbine blade showing damage locations

Applications

Aerospace:

- Sandwich panels
- Teflon inserts in graphite/aluminium honeycomb panel
- Carbon / epoxy composites
- Skin-to-core disbonds of Inconel panel
- Delamination / impact damage

Automotive:

- Composite structures
- Paint adhesion
- Spot welds
- Impact damage on composites
- Adhesive bonds

Power:

- Wind turbine blades and vanes
- Thermal barrier coatings for disbonds
- Delamination in composites
- Impact damage
- Coating uniformity

For more information on the services offered in this leaflet, contact:

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