How to Perform Active Thermography Testing Design Using Flux®

I. Gorosmendi & I. Castro - IK4-IDEKO Technology Centre.

Nowadays, a large number of industries are interested in new non-destructive techniques which permit the replacement of magnetic particle and dye penetrant inspections. Induction Thermography (IT), used for inspecting metals, has the ability to analyse complex geometries, providing excellent surface cracks detection sensitivity. The potential of finite element simulation software applied to IT is of great utility for the coil design or for modeling the distribution of induced currents and consequently, temperature gradients behaviour. Thus, Flux® contributes to analyse the detectability of surface cracks of specimens before lab trials.

Induction thermography

A heat source is used to heat the part to be inspected and detect temperature variations with an infrared camera. When the heat flow in a material is altered by the presence of discontinuities (such as cracks, pores, etc.), causes surface temperature contrasts which can be detected by the camera.

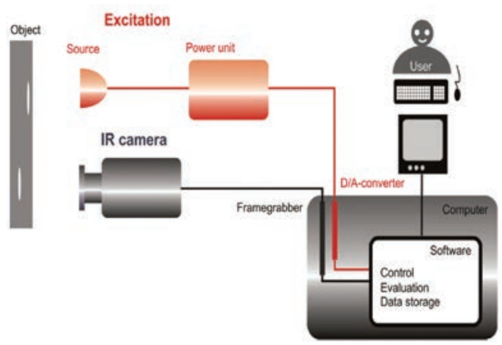

Figure 1: Set-up of an active thermography system.

Depending on the heat source, different techniques can be used. IT is one of the most suitable techniques for superficial inspection of metals which is based on the heating of the workpiece with induced currents (Eddy Currents) generated by coils.

Model development

In order to test the ability of Flux as an effective tool for thermography testing optimization, simulation and real test have been compared. The inspected piece was a steel plate with a surface crack. Plate features are summarised below in Table 1.

Material	Carbon steel
ρ (Ω.m)	ρ: 1.43.10^{-7}
μ_0 (H/m)	μ_0: 4π.10^{-7}
μ_r	μ_r: 100
f_{ind} (kHz)	f: 10
δ (mm)	δ=0.19032
Dim. (mm)	120 x 120 x 14
Crack dim. (mm)	5 x 0.605 x 1.558

Table1: Test specimen characteristics.

In Figure 2, Flux model and experimental setup are shown, both composed of the piece and the coil used for the induction heating.

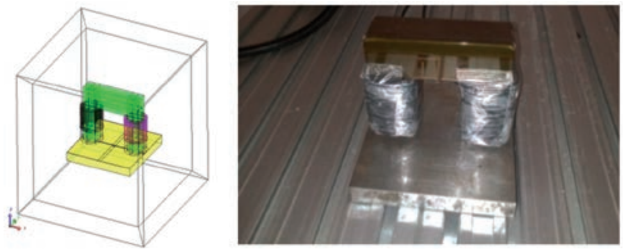

Figure 2: Flux model and experimental setup of the plate.

After a 0.1s pulse with the inductor coil, the temperature distribution around the crack can be visualised using Flux in Figure 3. Whereas the highest temperatures are obtained at the tips of the crack, the coldest areas are located in the edges of the crack.

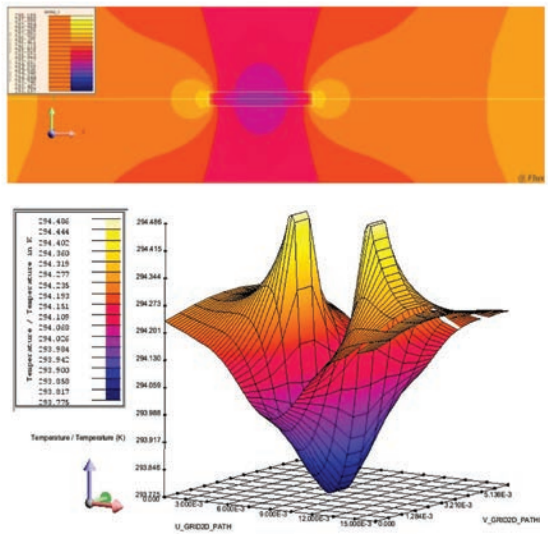

Figure 3: Temperature distribution around the crack.

Moreover, the experimental and simulation images have been processed using Thermal Signal Reconstruction (TSR). In Figure 4, 2nd derivative images are shown, using experimental and simulation thermal sequences, with great similarities between them.

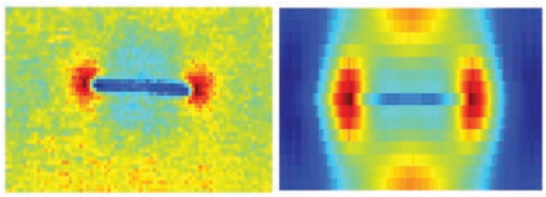

Figure 4: Experimental and Flux results using TSR image processing technique.

IK4 IDEKO Research Alliance

(see continued on page 21)

> *The potential of finite element simulation software applied to IT is of great utility for the coil design or for modeling the distribution of induced currents and consequently, temperature gradients behaviour.*

Validation

In order to validate the potential of Flux as a simulation tool for inductive thermography, two cases have been analysed: automation pieces of aluminium and cast iron which have surface cracks. Flux has been used to design the induction coils by taking into account the distributions of induced currents and temperatures around the cracks. Simulation and experimental results are shown in Figure 5 and Figure 6.

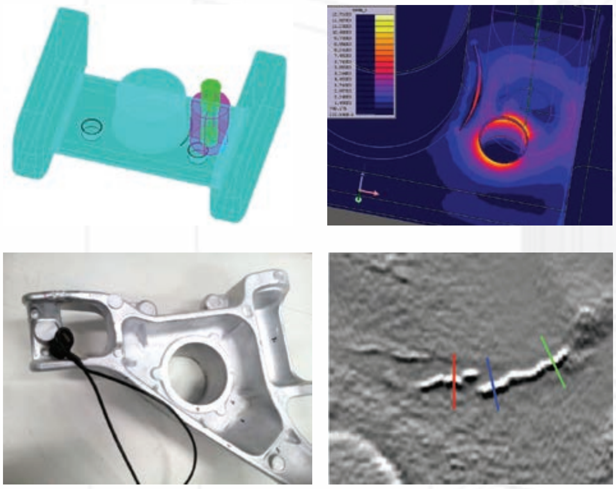

Figure 5: Flux model and experimental results in aluminium piece.

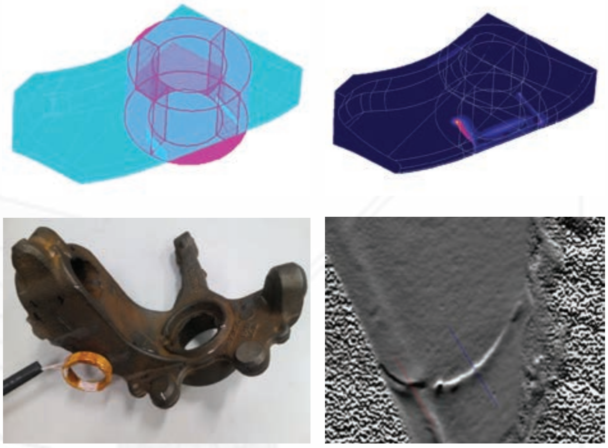

Figure 6: Flux model and experimental results in cast iron piece.

As can be seen in the figures, Flux has allowed an optimal design of the induction coils and test parameters. Hence, satisfactory results have been obtained in lab trials.

Conclusion

Experimental results have demonstrated the capability of Flux for induction thermography simulations. It has provided adequate coil design and test parameters for a satisfying induction thermography testing optimization.