1.5.24. SOLUTIONS ALTERNATIVE TO TRADITIONAL TECHNIQUES IN NON-DESTRUCTIVE TESTING OF WELDED JOINTS

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Modern infrared testing systems allow detection of subsurface discontinuities in composites, metals and ceramics, determination of sample thickness and thermal diffusivity. The system allows simultaneous testing of large areas and is suitable for curvilinear surfaces.

Infrared cameras are very useful for remote evaluation of object surface quality and detection of hot or cold points.

Modern thermography is highly sensitive, provides a quantitative estimate and is reproducible, and for many applications this is an alternative to many traditional solutions in the NDT filed.

Heat sources can be diverse – from regular pulse lamps to powerful induction systems. The most widely applied source is the flash lamp, providing a high power pulse of the duration of several fractions of a second. Monitoring the process of surface cooling allows analyzing the physical properties of the surface, depth of discontinuity and change of part thickness.

Filming with thermovision camera of TH 5100 model of NEC Company, Japan with the resolution of 0.1 C, was conducted in an operating cement kiln (117 m, 4 m diam.) without shutting it down.

Thermovision filming allowed:

– determination of the lining condition along the entire furnace length;

– detection of base metal and weld areas, which were exposed to temperature higher than the admissible values;

– determination of elevated temperature zone in the areas of concentration of welded joint defects.

Further examination of the above-mentioned areas by other NDT techniques after the kilns shutting down, revealed cracks, lacks-of-penetration and various discontinuities in marked technological zones.

Over the recent years, silicon, phosphorus reusable wafers, having a wider dynamic radiographic range, began to be used as an alternative to X-ray films. Where earlier 5 – 10 photos had to be taken because of difference in the part thickness, it can be done now in one exposure and at lower energies.

In terms of its dynamic range, this method is superior not only to X-ray TV, but also to radiography. It enables recording images of an object with a large thickness gradient in one exposure with subsequent viewing of sections of different optical density, using image brightness and contrast adjustments. This opens up new technological possibilities, for instance, it is now possible to realize tangential examination of bodies of revolution (vessels, pipelines, etc.) which is practically unfeasible in traditional radiography. Tangential examination can provide information on metal delamination, its thinning, presence of low-density extraneous media inside the object, etc.

In view of rapid advance of digital photography and technologies of growing fluorescent single-crystals, there is good reason to believe that in the next decade traditional radiography in all its aspects will be strongly pressed out. Now already it is quite feasible to develop portable radioscopic, and X-ray TV instrumentation, which is by an order of magnitude more compact than the currently operated units.

The dimensions of CCD-matrix are about 1 cm^2, so that the image on the reverse side of the scintillation crystal of the size of about 100 cm^2, is concentrated by an optical lens. CCD matrix has about several million pixels, so that the achieved resolution is also much higher than at X-ray TV testing with other systems.

In addition to elimination of an intermediate carrier (detector) in the form of film or phosmatic plate, in the case of such an X-ray TV testing, beside the high resolution, also a considerable time saving is achieved, owing to the fact that only welded joint sections with inadmissible defects are documented. Images of weld sections with non-hazardous discontinuities are not recorded.

In the field of ultrasonic testing of extended objects interesting solutions alternative to the traditional ones and based on low-frequency testing have appeared in the recent years. Low-frequency UT does not require cleaning the entire surface of the object. Just a small area is sufficient to mount the low-frequency UT-array. This allows diagnosing sections of up to 200 m length.

The US TNT journal for practical NDT engineers published a paper on "Alternative NDT Techniques for Prudhoe Bay Pipeline Failures". Accident data made the US government search for non-traditional methods of pipeline diagnostics, which was surprisingly in line with the work of PWI Department #4 on EMA and low-frequency ultrasonic techniques. If a successful alternative low-frequency UT technique had not been found, then testing of 52000 sections of this pipe would have taken more than half a year, i.e. 184 days.

Whereas EMAC-technology is widely accepted in the USA, and recognized in ASTM E1816 document, the technologies of both piezoelectric low-frequency UT and electromagnetoacoustic low-frequency testing have no standards in the USA so far, but, nonetheless, they were used for diagnostics of this pipeline.

Before appearance of low-frequency electromagnetic testing, which is an alternative to the traditional NDT technologies, hundreds of insulation removers and UT technicians worked simultaneously for 24 h per day. New alternative EMAC and LFEMT techniques were approved by the US Department of Transportation, and in three weeks it was changed by a regulation of the US government on diagnostics of the damaged oil pipeline in Prudhoe Bay in favour of the low-frequency methods.

Magnetooptical visualization (MOV) based on Faraday effect is an alternative for numerous magnetic techniques (magnetography, magnetic powder, fluxgate, etc.). Without an intermediate carrier the crack sensitivity of this technique can reach fractions of a micron. At high-frequency magnetization defects undetectable by magnetic powder or die penetrant techniques, are found. In addition, this method involves digital processing of images with all of its known capabilities.