Comparison between two techniques of neutron radiography in Argonauta research reactor

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An important tool for non-destructive material inspection is the radiography by neutron or gamma emission in nuclear reactors. The Argonauta research reactor – with thermal neutron flux of $4{,}46 \times 10^5$ $n.cm^{-2}.s^{-1}$ – can be an excellent source of thermal neutrons for this kind of application. A traditional method for image obtainment is using radiographic films. Due the fact that radiographic films are not sensible by thermal neutrons, there would be a converter, which could be capable of convert a neutron into an electron. The most common converter used in researches is made of Gadolinium. This element was chosen because it has an enormous cross section for thermal neutrons – approximately 46000 barns. In comparison to Boron, for example, Gadolinium gets a cross section approximately 12 times bigger. The conversion happens instantaneously and the process is called "internal conversion". The radiographic film and converter go into a cassette – a chassis completely light sealed.
An alternative and new method for image obtainment is using a Phosphor film, called Imaging Plate. This film is also mixed with Gadolinium and placed inside a cassette (Figure 1). This method is called "Digital Neutron Radiography".

Figure 1. Cassette for Digital Neutron Radiography using Imaging Plate

The material, which is going to be inspected is placed between the irradiation channel of Argonauta research nuclear reactor and the cassette. Using the conventional method, the time of exposure is about 60 minutes. This time decreases to 3 minutes by using Imaging Plate. After exposure, the conventional film must pass throughout four processes: development, fixing, washing and drying. These processes spend from 20 to 30 minutes. By using Imaging Plate, the quantity of processes is only two: development and cleaning. It takes less than 30 minutes. These processes are made at a new laboratory in Argonauta research reactor's building (Figure 2).

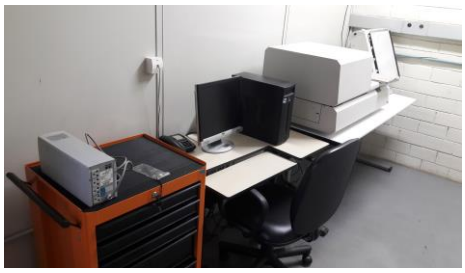
Figure 2. The new Digital Neutron Radiography Laboratory from Argonauta research reactor.

The image from Digital Neutron Radiography method goes directly to a computer, where quality optimization could be made. It also shows a better logistic to share the results of the inspection by sending the image by email, for example.
In conclusion, the most advantage of using Imaging Plate is the total time to obtain an image. While in conventional method, this time is, at least, 1 hour and 20 minutes, in Digital Neutron Radiography it is, at least, 30 minutes. Although, in terms of resolution, the conventional method has a better one, in order of 40 to 100 μm. The fact of being reusable, having less time to get the image and being easier to share the results make Digital Neutron Radiography a better method for neutron image obtainment.

References

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