Neutron Radiography with Kyoto University research Reactor (II) : Defect Detection in Metals and Metal-Plastic Composites

Neutron Radiography with Kyoto University Research Reactor (II) Defect Detection in Metals and Metal-Plastic Composites

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Studies for the evaluation of detection limit of defects in composites were carried out by using neutron radiography with Kyoto University Research Reactor (KUR). Nylon wires of diameters from 52 to 390 μm embedded in metals and plastics composite plates were used. It was found that the detection limit was about 390 μm for a composite made of an iron plate of 25-mm thickness and a plastic plate of 6-mm thickness, and was about 290 μm for a composite made of a lead plate of 25-mm thickness and a plastic plate of 6-mm thickness. The detection limit is better for composites of iron and plastic than for those of lead and plastic.

1. Introduction

In recent years considerable attention has been paid to neutron radiography in the industrial world. Further development of its technique is being waited for eagerly because of its high inspection ability for defects as well as hydrogeneous materials in complex matrix and for defects in spent nuclear fuel capsules emitting ionizing radiation. The soundness of composite materials as well as fine ceramics and metals, plastics and glass fibers, etc. has been checked by neutron radiography tests. The neutron radiography has progressed in industry. In neutron radiography, the characteristics of neutron beams and the radiographic image quality are evaluated with both the "Beam Purity Indicator" and the "Sensitivity Indicator" approved by ASTM.[1] Furthermore, the characteristics of the neutron

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beams are checked precisely by using the "System Image Quality Indicator" devised by Barton.[2,3]

An evaluation of detection limit for defects in composites has been tried in this work by using neutron radiography with Kyoto University Research Reactor (KUR).

2. Experimental and Results

KUR is a swimming pool type research reactor with the maximum power of 5 MW. The neutron flux at the exposure position is about 1.2×10^6 n/cm^2/sec. The neutron radiographic images of test pieces were photographed by the use of a conventional gadolinium (Gd) film system. The photographs are obtained with an X-ray film and a Gd foil converter in an evacuated cassette. The Gd foil converter is a metal sheet made by vapor-phase deposition (25 μm in thickness). The X-ray film is a single-coated film (Kodak SR). Two kinds of composite plates (iron and plastic, lead and plastic) were employed in this experiment. Image quality indicators which consist of several nylon wires having diameters from 52 to 390 μm embedded in composites of metals and plastics were used to evaluate detection limits for defects in materials. The minimum diameter sizes of nylon wires in an image quality indicator were obtained from these photographs. Figure 1 shows the relationship between thickness of plastic plates in iron and plastic composites and detectable minimum diameter of nylon wires. The parameter attached to each curve in Fig. 1 show the thickness of iron plates in the composites. Figure 2 shows the relationship between thickness of plastic plates in lead and plastic composites and detectable minimum diameters of nylon

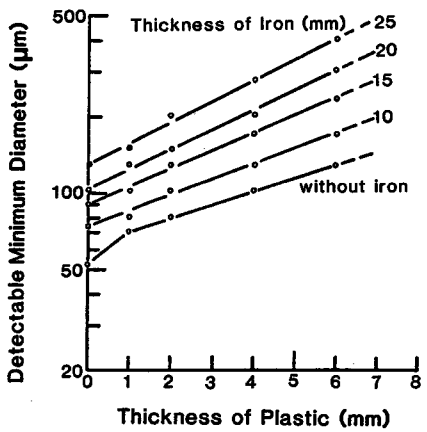

Fig. 1 Relationship between thickness of plastics in iron and plastic composites and detectable minimum diameters of nylon wires.

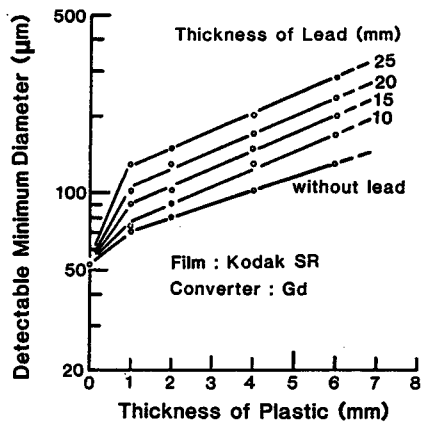

Fig. 2 Relationship between thickness of plastics in lead and plastic composites and detectable minimum diameters of nylon wires.

wires. From these figures, it is clear that the detection limits of nylon wires in iron and plastic composites were better than those in lead and plastics composites. Figure 3 shows the exposure curves at density of D=2.0 in films, for various materials with our neutron radiography system.

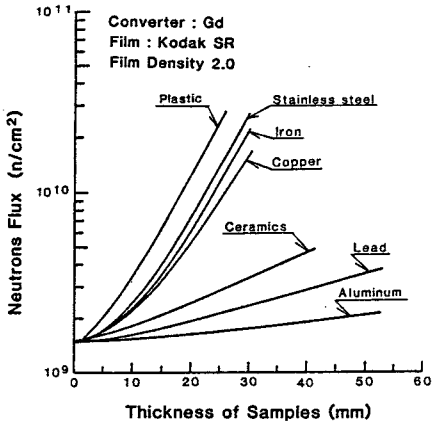

Fig. 3 Exposure curves at D=2.0 for various materials with our neutron radiography system.

3. Conclusion

An evaluation of detection limit for defects in two kinds of composites by experiment was tried by using neutron radiography with Kyoto University Research Reactor (KUR). The results can be summarized as follow : It was found that the detection limit was about 390 μm for composite made of an iron plate of 25-mm thickness and a plastic of 6-mm thickness, and about 290 μm for the composite with a lead plate of 25-mm thickness and a plastic plate of 6-mm thickness. The detection limits is better for composites of iron and plastic than those of lead and plastic.

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