Application of Eddy Current Method to ITER First Wall mock-up tubes

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1. Introduction

The first wall(FW) of International Thermonuclear Experimental Reactor (ITER) consists of Be layer as a plasma facing material, Cu layer which is composed of stainless steel tubes surrounded by Cu alloy plate as a heat sink, and stainless steel plate as a structure material. [1,2] During the fabrication of FW by using hot isostatic pressing (HIP) bonding method, the laminar type defects could be occurred between STS tube and Cu plate. To detect that kind of defects, we applied an eddy current testing (ECT) method and checked the detectability of the ECT system. Also we checked the signal amplitude of the small laminar type defects by using ECT signal simulation code VIC 3D. Fig. 1 shows the bended area of the FW mock-up model. Eddy current probe was selected as beaded(BJF) type so that it should pass the bended tubing area.

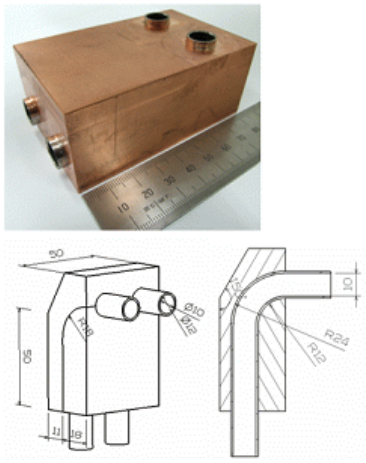


Fig. 1. The bended tubing area on FW block.

2. Eddy Current Testing System

The ECT system for the inspection of the tubes in the FW block consists of beaded bobbin differential type(BJF) probe, MS-5800 multi-frequency ECT digital equipment and Multi-view data analysis software.(Fig. 1)

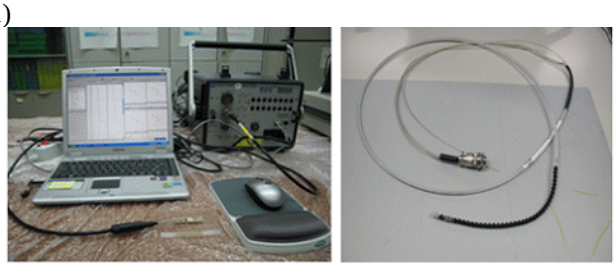


Fig. 1 MS-5800 ECT equipment and beaded bobbin type probe

The inspection frequencies were 400, 200, 100, 50 kHz.

3. Modeling

For the preliminary estimation of application of ECT to detect the small laminar type defects, a computer simulation software for eddy current signal ; volume integral code VIC 3D was applied.[3] Modeling condition is described in Fig 2. On this modeling, a simulation was done for the 2 mm x 2mm in width x 0.1 mm in depth.

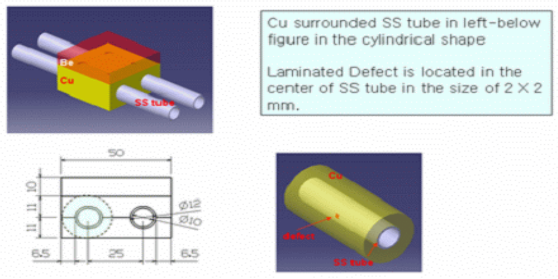


Fig. 2 Modeling condition for a laminar type defect.

The results of VIC 3D calculations get about 0.04 volts of the signal amplitudes for the typical laminar flaw.

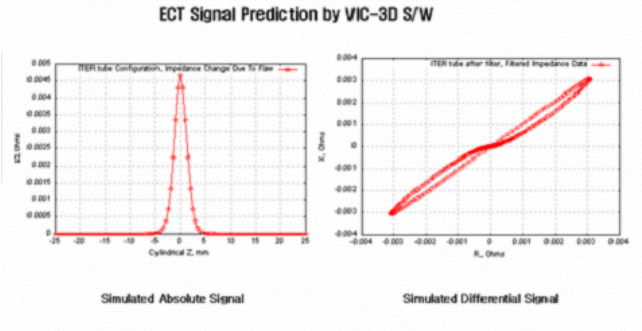


Fig. 3 A simulation signals of a laminar type flaw.(Absolute signal and Differential signal)

4. Investigation of Detectability

For the investigation of detectability, artificial defects were fabricated on the Cu block side as shown in Fig. 4. The diameters of artificial defects were 2 ~ 8 mm in diameter and 1.5 mm in depths or 1 mm in diameter and 0.25 ~ 1 mm in depths.

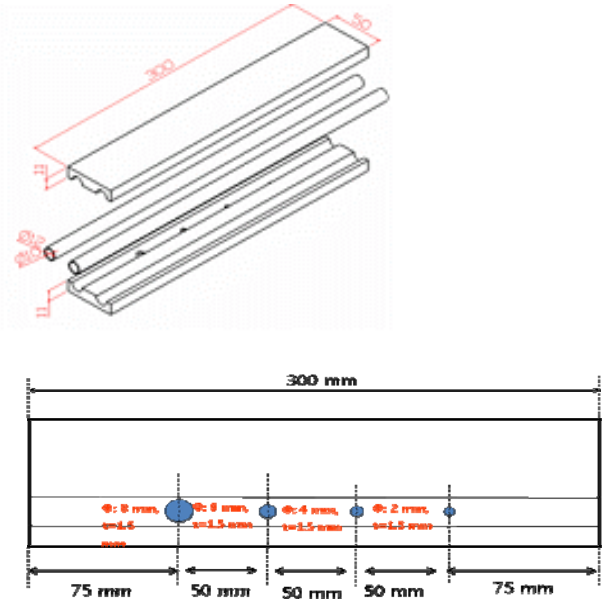
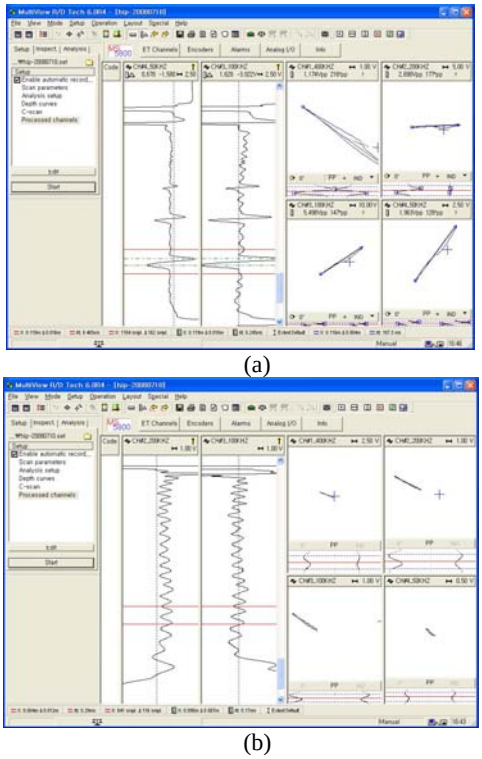


Fig. 4 The schematic drawing of a specimen with artificial defects.

Fig. 5 (a) shows ECT signals from the 2 ~ 8 mm in diameter defects could be easily detected, but the signals from 1 mm in diameter defects could not easily detected by using this ECT system.



(a)

(b)

Fig. 5 (a) ECT signals from the 2 ~ 8 mm in diameter defects and (b) the 1 mm in diameter defects

4. Conclusion

For the inspection of FW block integrity, the multi-frequency eddy current method was introduced and the detactability of a laminar defect was checked. This results show that a laminar type artificial defect whose size is 2 mm in diameter can be easily detected using this ECT system, but 1 mm hole in diameter cannot be detect easily and also shows the possibility of an application of the ECT method to check the integrity of FW, but it needs to be developed a highly sensitive eddy current probe for more effective inspection on FW of ITER.

Acknowledgements

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