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Comparison on a SCC defect morphology by using destructive and nondestructive methods

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1. Introduction

Thanks to its rapid inspection, safe and easy operation, an eddy current testing (ECT) is one of the nondestructive techniques to measure defect morphology on steam generator (SG) tubes in nuclear power plants. In this paper, we reviewed the results of a destructive test and a nondestructive inspection of a laboratory produced SCC by using the MPA (Multi Parameter Algorithm) which was developed by Argonne National Laboratory (ANL) and operated in the MATLAB.

2. Experimentals

2.1 Production of SCC specimen

Test specimen of a laboratory produced Stress Corrosion Cracking (SCC) was an Alloy 600 tube of which the outer diameter was 7/8". The tubes were sensitized at 600 ^{o}C for 48 hours in an inert gas atmosphere to make the cracks easily. Then the outside of the tube was exposed to a 1 M sodium tetrathionate solution at room temperature by pressurizing the inside of the tubes.

2.2 Data acquisition

The ECT data was acquired by using the MIZ-30 acquisition system with a magnetically biased rotating pancake coil (RPC) probe. Two copper pieces were attached on to the tube surface to identify a position of the flaws and the motion of the probe. To prevent a distortion of the ECT signals by the sensitization heat treatment, we used a magnetically biased MRPC (Motorized Rotating Pancake Coil) probe. The sensitivity of this probe is less than the normal probe, but it has a benefit for tubes where the EC data was corrupted by a noise.

3. Result and Discussions

3.1 Data analysis by MPA

The data was acquired through channels with various frequencies. We have analyzed only one of the data sets which was acquired with a pancake coil at 400 KHz. Figure 1 is a part among the several processing stages in a MPA when analyzing defects. From Figure 1, we can confirm the position of a defect in the axial direction and the motion of a probe. The defect depth, however, cannot be estimated accurately in Figure 1. The defect depth can be analyzed by comparing many assessment results. Figure 2 is an image display and defect depth profile. To obtain a depth profile, the cross-bar was positioned on the defects. From the depth profile, the defect has an 83% tube wall (TW) penetration in depth and 9.6 mm in length. However it is difficult to obtain the depth profile when the defect shape is a complicated case. In this case, we examined several results such as the axial and circumferential direction profiles with 3D terrain plot.

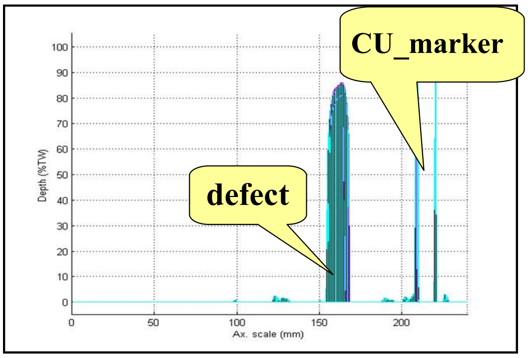

Figure 1 Defect profile observed from axial direction

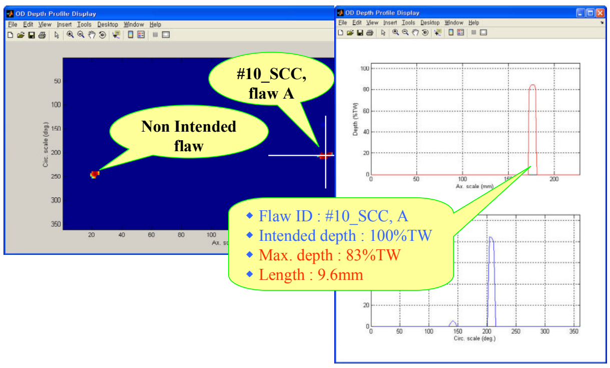

Figure 2 Image display and estimated depth profile by positioning the cross-bar on the defect.

3.2 Destructive examination of SCC

Before examining a cross-section of a defect by using a scanning electron microscopy (SEM), we estimated the defect position with a nondestructive technique. Figure 3 shows the SCC fracture surface of the specimen, which has a 100%TW in depth.

3.3 Comparison with Fractography and EC NDE

In order to confirm the MPA reliability, we compared the fractography with the EC NDE result. Figure 4 shows the depth profile of both the fractography and the EC NDE. Even though the cracks were penetrated by 100 % through wall of the tube under the SCC developing procedure, it was hard to quantify the depth. It is because the outside of the cracks were closed just after the pressurization, and they did not show an enough crack opening to be ensured by the ECT. Generally, ECT signals show a longer defect length than a fractography, because the EC signals can be detected from when the rotating probe reaches the flaw until the probe passes by the flaw. Due to this reason, we can also understand the difference in the length between the fractography and the EC NDE.

4. Conclusions

- We acquired data with a magnetically biased probe to compensate for the distortion of an ECT signal.
- The multi parameter algorithm was utilized to analyze the ECT data of laboratory developed SCC flaws.
- At the moment, the cracks do not show an enough crack opening to be ensured by the ECT because of the tightness of the cracks.

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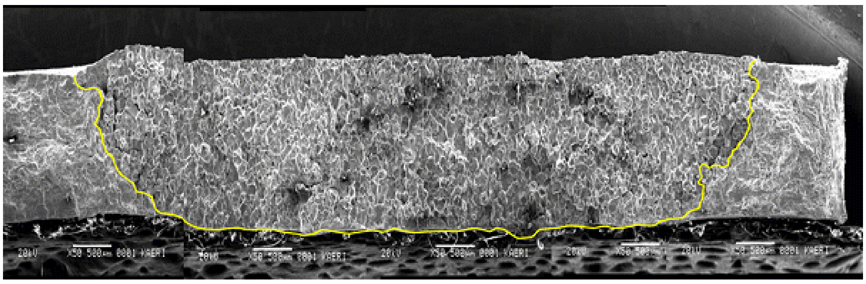

Figure 3 Cross-section of a SCC defect examined by SEM

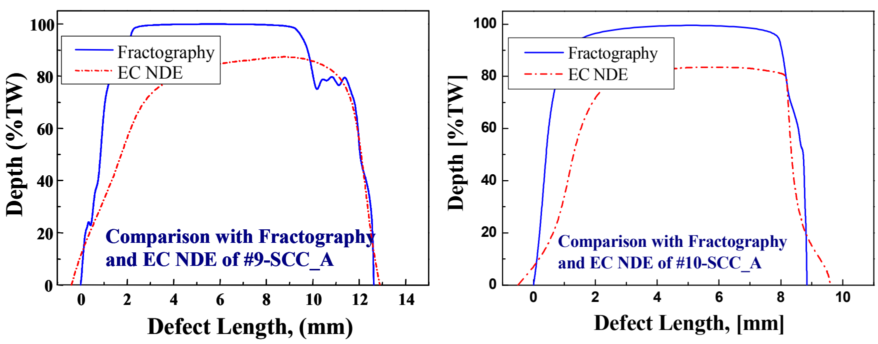

Figure 4 Comparison with fractography and EC NDE of laboratory produced SCC