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Measurement of wall thinning in the insulated pipe using PEC and UT

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1. Introduction

Eddy current technology has been used widely in the in-service inspection identify the corrosion for the safe and economical management of nuclear power plant. Although the detection of corrosion by ultrasonic and eddy currents is not inherently difficult, there are problems with identification and characterization apply in the test of structural materials. Pulsed eddy current (PEC) is invented for the complement of the limitations of these technologies. The PEC system was designed and manufactured in order to detect the local wall thinning such as corrosion under insulation (CUI) and flaw accelerated corrosion (FAC). Local wall thinning is a point of concern in almost all steel structures such as pipe lines covered with a thermal insulator made up of materials with low thermal conductivity (fiberglass or mineral wool). The purpose of this study is to develop the new technology which identify these defects without removing the insulation. The actual thickness of the test piece was measured using an Olympus ultrasonic equipment. Experimental results showed that the pipe thickness data measured by PEC and ultrasonic are well correlated with each other.

2. Experimental

The specimens were machined with A106 Gr-B pipe len gth of 1500 mm and a thickness of 12.85 mm, with step as shown in Fig.1. The specimen was covered with plastic insulation of thickness 50mm, and 0.5 mm stainless steel cladding was installed outside the insulation. The PEC measurements were performed with prototype machine developed in the laboratory as shown in Fig. 2. The thickness of machined specimen were measured using commercial UT equipment (Model: Olympus 38DL+) as shown in Fig. 3. The specimen were indicated with axial and circumferential direction considering the irregularities according to the measuring points, the axial direction were indicated with positions (x-axis), and the circumferential direction were divided 8 sects (A, B, …H).

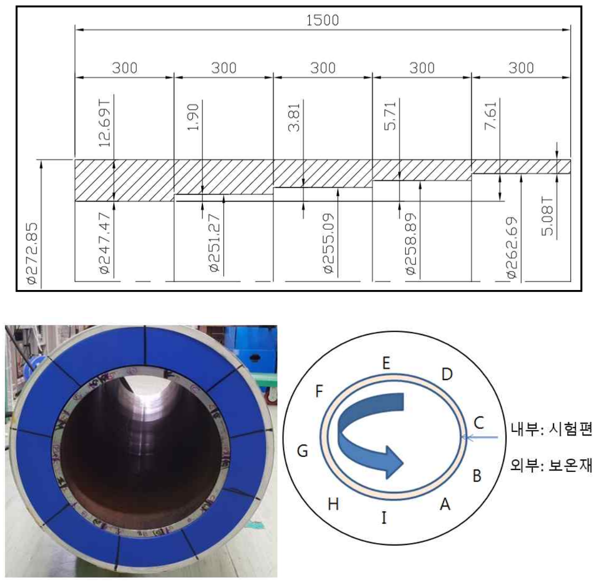

Fig.1 Test Specimen drawing

Fig.2 Pulsed eddy current test equipment.

Fig.3 Ultrasonic test equipment

3. Results and discussion

The PEC parameter measured outside of insulation linearly decreased with decreasing sample thickness (designated with position (x-axis)), and nearly constant with circumferential direction at the same thickness (A, B, …H) as shown in Fig. 4. The zero cross time was selected as PEC parameter, which reflects the induced sensing signal in PEC experiment crossing with time axis (zero crossing time). The result shows that the zero cross time is well correlated with pipe thickness. The zero cross time decrease with decreasing sample thickness, which means that the reflection time of induced signal at the sample boundary decrease with thickness.

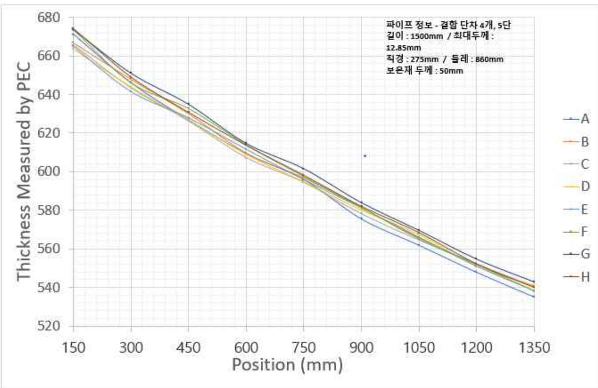

Fig.4. PEC parameter (zero crossing time) with pipe position (step thickness). Pipe thickness decrease with increasing coordinate number.

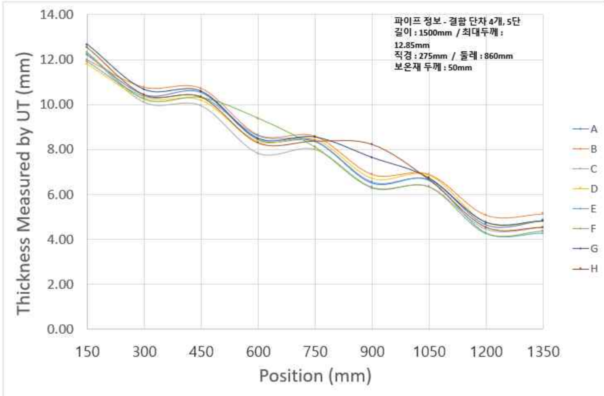

Fig.5 Pipe thickness measured by UT equipment.

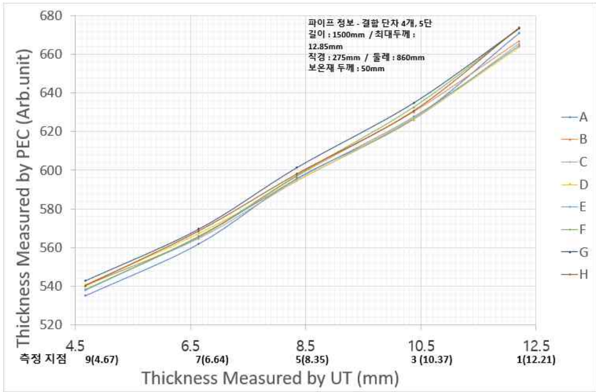

Fig.6 PEC parameter with sample pipe thickness measured by UT equipment.

Fig.5 shows that real thickness change of sample pipe measured by UT equipment. The pipe thickness gradually decreased with increasing pipe position coordinates, which means thickness measured by UT reflects the machined sample thickness. Compare with the machined thickness and UT measurement, the thickness measured by UT gives slightly small value than machined sample thickness. It may be attributed to the ultrasonic velocity used in the thickness measurement. Fig. 6 show the correlation between PEC parameter and sample pipe thickness measured by UT. The PEC parameter is well correlated with sample thickness measured by UT, which means that PEC can be used as a measurement of wall thinning in the pipe covered with insulation. In order to measure the thickness using UT, couplant is needed for the complete contact between probe and specimens. But PEC is no need to contact probe and specimen, which is merit of PEC. That is how PEC technology can be used effectively in the field.

4. Conclusion

The wall thinning of mockup pipe under insulation was measured using PEC and UT. The thickness of wall thinned pipe measured by PEC without removing the insulation is well accord with UT measurement in the bare pipe. The experimental result shows the performance of PEC system developed in this study is sufficient to apply in the industry such as oil and power plant. To improve the PEC performance, it needs to compensate additional techniques such as database and processing technology of PEC signal.

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