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Characterization of Guided Wave Signals from Hole Defects in a Carbon Steel Mockup Pipe

Dae-Seo Koo, Shin Kim, Yong-Moo Cheong
Korea Atomic Energy Research Institute, 1045 Daedeok-daero, Yuseong-gu, Daejeon, 305-353, Korea,
ndskoo@kaeri.re.kr, kimsin96@nate.com, ymcheong@kaeri.re.kr

1. Introduction

A pipe leak takes place from a corrosion, or erosion of nuclear power plant pipes under a high temperature and pressure. Accurate inspection of a corrosion and cracking in a pipe is required because a leak from primary pipes leads to a diffusion of a radioactive activity. A thinning of a pipe in a nuclear power plant is believed to be due to a flow-accelerated corrosion(FAC). FAC is affected by environmental factors such as the temperature, pressure, and pH. Thus, nondestructive techniques are required for a corrosion inspection of the pipes in a nuclear power plant[1]. All the vibration modes can be generated and received by using a magnetostrictive strip sensor technique. Torsional vibration modes, longitudinal vibration modes and flexural vibration modes can be possible by a combination of a direction of a DC magnetic bias and an alternative magnetic field[2].

In this study, two mockup pipes, one is made of carbon steel and the other stainless steel, were fabricated. The guided wave signals from a hole defect with a diameter of 4mm were analyzed.

2. Fabrication of an Mockup Pipe with Artificial Defect and Experimental Details

Two mockup pipes, one was made of carbon steel and the other stainless steel, with a diameter of 6 inch, schedule number of 80, and a thickness of 11mm were manufactured. The hole defects were fabricated at 17m from the end of the mockup pipes. A 49Fe-49Co-2V alloy strip sensor and a Ni strip were bonded on the circumference of them at 7.5m from the end of the mockup pipes. The guided wave signals from the mockup pipes were collected atl a torsional vibration mode with frequencies of 32 and 64 kHz using MsS 2020 equipment. The guided wave signals from the hole with a diameter of 4mm were analyzed with the frequency. Figure 1 shows a schematic drawing of a carbon steel mockup pipe.

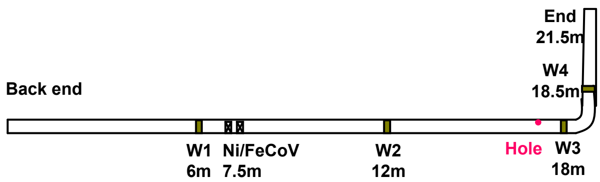

Figure 1. A schematic drawing of a carbon steel mockup pipe.

3. Results and Discussion

Figure 2 shows the amplitude due to various hole diameters from 2 mm to 5 mm in the mockup pipe. As the hole diameter increases, the amplitude of the guided wave signals increases.

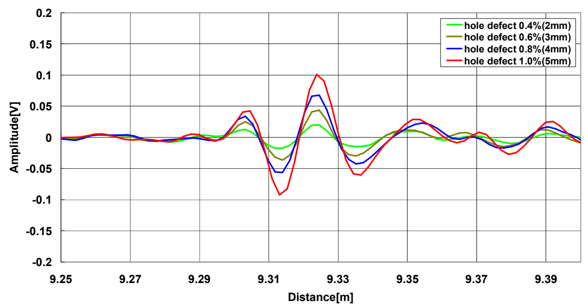

Figure 2. The signals of hole defects in a carbon steel mockup pipe.

Figure 3 shows the signals of the guide wave on a mockup pipe of carbon steel at a frequency of 64 kHz using a FeCoV alloy strip. The signal of a hole with a diameter of 4mm was detected at a distance of 9.5m.

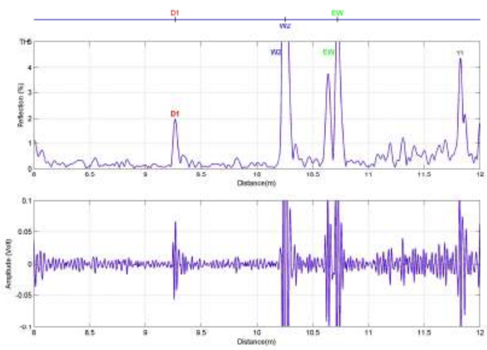

Figure 3. Guided wave signals from a carbon steel mockup pipe with frequency of 64 kHz.

Figure 4 shows the guided wave signals from a carbon steel mockup pipe at a frequency of 32 kHz using a FeCoV alloy strip. The signal of a hole with a diameter of 4mm was detected at a distance of 9.5m.

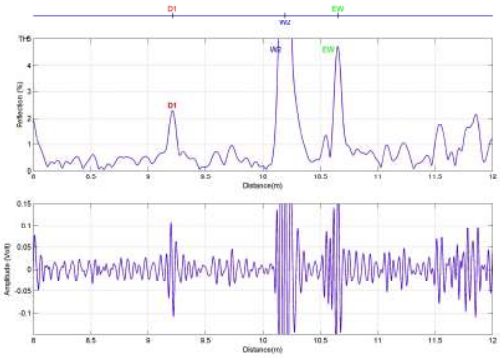

Figure 4. Guided wave signals from a carbon steel mockup pipe with frequency of 32 kHz.

Figure 5 shows the signals of the guide wave on a mockup pipe of stainless steel at a frequency of 64 kHz using a FeCoV alloy strip. The signal of a hole with a diameter of 4mm in a stainless steel mockup pipe was detected at around 9.5m. The signal-to-noise ratio is smaller than that of carbon steel in Figure 3. The noise level is higher than that of carbon steel in Figure 3.

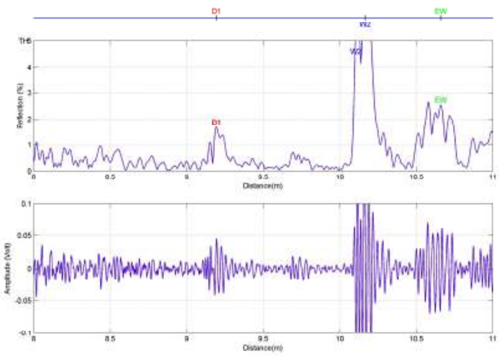

Figure 5. Guided wave signals from a stainless steel mockup pipe with a frequency of 64 kHz.

Figure 6 shows the signals of the guide wave on a mockup pipe of stainless steel at a frequency of 32 kHz using a FeCoV alloy strip. The signal of a hole diameter of 4mm in a stainless steel mockup pipe contains a high noise level at around 9.5m. The signal-to-noise ratio is smaller than that of stainless steel in Figure 5. The noise level is higher than that of the 64 kHz frequency in Figure 5.

Thus, the signal-to-noise ratios of the guided wave from a hole with a diameter of 4 mm on the carbon steel mockup pipe at a frequency of 64 kHz using an FeCoV alloy strip were larger than those from the stainless steel mockup. Also the signal-to-noise ratio of the guided wave from a hole with a diameter of 4mm at a frequency of 64 kHz using an FeCoV alloy strip was larger than that of the 32 kHz frequency.

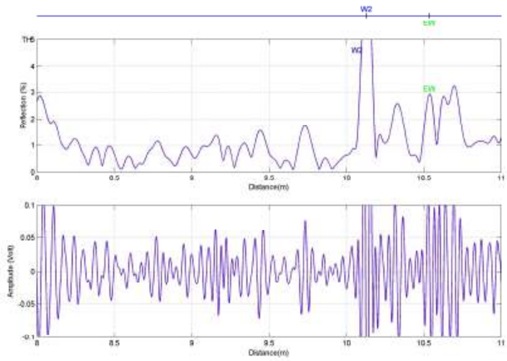

Figure 6. Guided wave signals from a stainless steel mockup pipe with frequency of 32 kHz.

4. Conclusions

1. A carbons steel mockup pipe with a diameter of 6 inch, schedule number of 80, and a thickness of 11mm was fabricated. The guided wave signals from a hole with a 4mm diameter were analyzed with the frequency.
2. The signal-to-noise ratio of the guided wave signal from the hole on the carbon steel mockup with a frequency of 64 kHz was higher than that from the stainless steel mockup.
3. The signal-to-noise ratio of the guided wave signal from the hole with a diameter of 4mm on the mockup pipe of carbon steel with a frequency of 64 kHz was higher than that with a 32kHz frequency.

REFERENCES

[1] Most, "Development of Advanced Ultrasonic Wave Application Technology for Real Time Evaluation of Nuclear Pipe Corrosion under high Temperature and Pressure in Nuclear Power Plant", Busan National University, 2004.
[2] Yong-Moo Cheong, "Flaw Detection in Pipe by Magnetostrictive Guided Wave Technique", KAERI/TR-2927/2005, 2005.