Development of PVDF Ultrasonic Array Transducer for Thickness Measurement of the PHWR Feeders.

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1. Introduction

The feeder pipes in a Pressurized Heavy Water Reactor (PHWR) are installed with a very complicated form in close order as shown in Fig. 1. As corrosion and erosion occurs in the bent region of the feeder pipe, inspection of the pipe is required. However, there are two problems for the thickness measurement. One is accessibility and the other is the high radiation environment. In the field, the conventional ultrasonic thickness measurement was applied manually to check the nine points in the bent region. One possible approach under the high radiation environment is to use the special robot for inspection. [1] Furthermore, it is not easy to access because of the narrow gap among the pipes, it is also necessary to move freely on the pipe with the thin transducer.

Figure 1. Feeder pipes in PHWR Reactor.

In this study, we have fabricated the PVDF array transducer to meet the dimension requirement passing smoothly along the pipe and have evaluated the signals in order to investigate the accuracy of measurement.

2. Experiment and Results

2.1 Fabrication of PVDF array transducer

PVDF has high dielectric and internal mechanical losses and dielectric properties that vary with both frequency and temperature. [2] Unlike piezoelectric ceramic materials, PVDF film is flexible and can be formed into a variety of shapes to suit special applications.

Fabrication of contact transducer was conducted on commercially available PVDF film samples obtained from Amp Flexible Film Sensors. LDT0-028K is used for the array element. This film has an active sensing area of approximately 13mm by 25 mm, an overall thickness of 0.2 mm including 28 μm PVDF film with screen printed silver ink electrodes. [3] Cable connections were made to the sensors with BNC terminal. Contact thin transducer can be made by adhering 8 PVDF films in a parallel pattern to a suitable backing substrate.

2.2 Performance test

To evaluate the contact transducer performance of the commercial films, each was adhered to a magnetic rubber strip with the tightening bolt to assure a smooth and planar front surface of the transducer. The array transducer consisting of 8 films was applied to the feeder pipe shown in Figure 2.

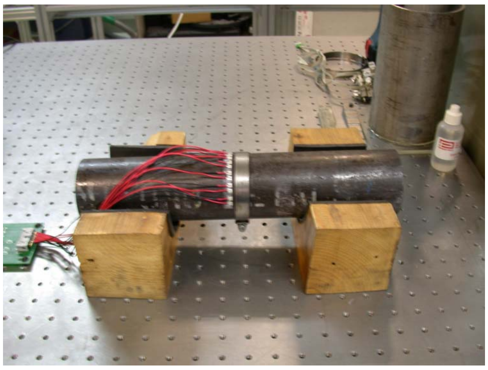

Figure 2. PVDF array transducer for the feeder pipes

Each pulse echo waveform was acquired and analyzed with the UTEX 340 pulser/receiver. The transducer did demonstrate useful contact transducer performance. Pulse echo reflections from a back-wall of feeder pipe are shown in Figure 3. This response exhibited a center frequency of 6.2 MHz, -6dB pulse width of 1.5 MHz and -20dB pulse width of 0.45 μs. The relatively broadband response is typical of a PVDF transducer.

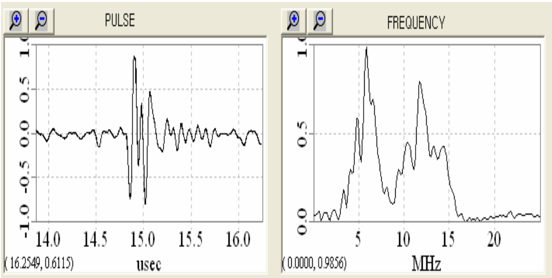

Figure 3. Ultrasonic back-wall signal from the Feeder pipe.

3. CONCLUSIONS

PVDF array transducer for thickness measurement was developed to apply the feeder pipes in PHWR. This array transducer has a thin and ring shape and shows a wideband signal in the test piece of pipe.

PVDF transducer as the sensing module will be adapted in feeder pipe inspection robot for the safety enhancement in PHWR plants. However, the radiation effect on PVDF film may be happened and it will be discussed in the near future.

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References

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