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The Property Experiment for the Bobbin Probe of Eddy Current Test

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1. Introduction

Korea Electric Power Research Institute(KEPRI) has been developing the bobbin probe for eddy current test for steam generator(S/G) tube in NPP since last year. The S/G tube is the most sensitive pressure boundary in NPP. Because the S/G tube leakage could release the radioactivity materials to the atmosphere, it is legislated to verify the integrity during the in-service inspection(ISI) period by the method of non-destructive tests(NDT). Most NPP licensees have developed their own bobbin probe for the most effective testing. However, designing and fabricating the bobbin probe have never been tried in Korea. In order to prevent the wastage of the foreign currency and to inspect for the tube reliably using optimized probe, KEPRI set to work developing the bobbin probe.

2. Methods and Results

2.1 Bobbin Probe Type in domestic NPP

The bobbin probe for S/G tube used in domestic NPP is MULC(Magnetic-biased U-bend Long Cone) type, which is more advanced probe containing permanent magnetic than ULC(U-bend Long Cone). About 280 ~ 560 pieces of this probe type are consumed every year in the whole domestic NPP's.

2.1 Application Code of the Probe

The examination category of NDT of the S/G tube is "B-Q" of ASME sec.XI. The NDT for the integrity assessment of straight and u-bend tubes is regulated by the volumetric inspection method(ASME sec. Ⅴ, Art.8). These application codes are reflected to the design of reference standard and its special examination.

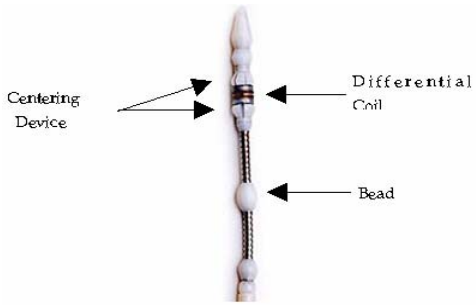

Figure 1. A Shape of Bobbin Probe

2.2 Resonance Frequency

A probe has its own frequency to give the signal efficiently which is known as the resonance frequency depended on the circumstances of the probe such as coil, tube material and etc. The resonance Frequency of the probe is 400 ~ 600 kHz generally.

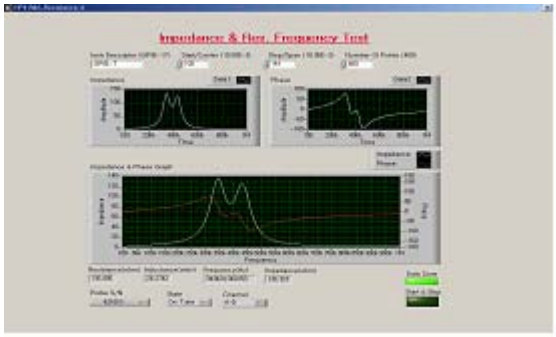

Figure 2 Probe Impedance and Resonance Frequency

2.3 Phase Angle Spread

The phase angle spread of the eddy current signal is measured in the differential and absolute mode. The difference of phase angle is measured between 100% and 20% hole of ASME standard tube and it has to be ranged 50 ~ 120°.

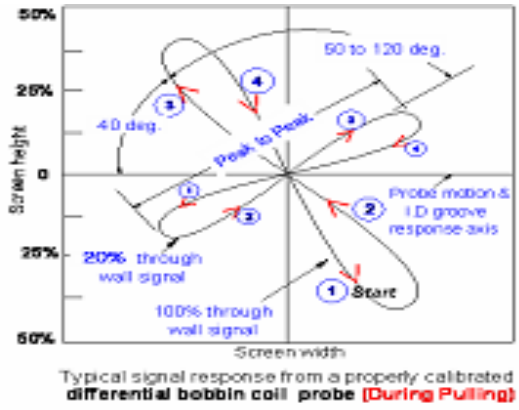

Figure 3 Phase Angle Spread

2.4 Symmetry in Differential Mode Signal

The Signal unbalance(Ds) in the differential mode is the difference amplitude between the first and the second rob and is calculated as following formula.

$$D_S = \frac{200 \times (A_1 - A_2)}{(A_1 + A_2)}$$

A_1 : The ratio of Zero to peak amplitude of the first rob(volts)
A_2 : The ratio of Zero to peak amplitude of the second rob(volts)
D_S : Signal Unbalance(%)

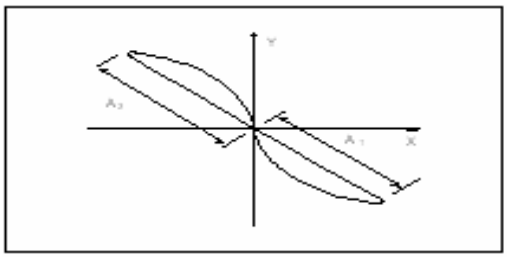

Figure 4 Symmetry of Differential Mode Signal

If the amplitude is the same between two robs, the signal unbalance is 0. The acceptance criteria of the signal unbalance is less than 20%.

2.5 Electric Property Analysis System

The electric properties of the probe have much influence on the quality of the probe. For this reason, one should be consider the properties to design the probe. These data could be obtained by the impedance analyzer with computer program.

2.6 Calibration Standard Tube

Several calibration standards per each S/G tube type are necessary to develop the bobbin probe. Those standards are ASME FBH Standard, Wear Scar Standard, EDM Notch Standard and Reference Standard.

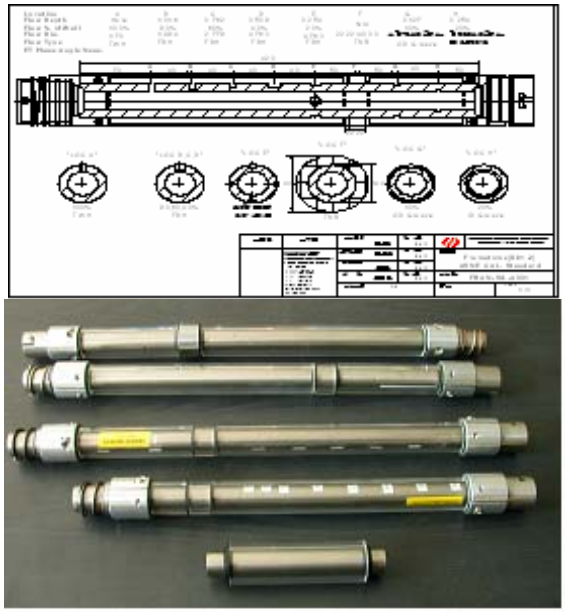

Figure 5 Calibration Standards

3. Conclusion

As above methods and results, we have a complete set-up to develop the bobbin probe. During 2nd year, we will make the S/G mock-up and trial bobbin probe. If the bobbin probe is developed successfully within 2~3 years, the S/G tube inspection will be more reliable using the optimized probe.

REFERENCES

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