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강자성체 배관의 원거리장와전류 탐상

고등기술연구원 김형진*, 정진오, 이재경

Remote field eddy current inspection of the ferromagnetic cast iron pipes

Institute for Advanced Engineering H.J. Kim*, J.O. Jeong, J.K. Yi

1. Introduction

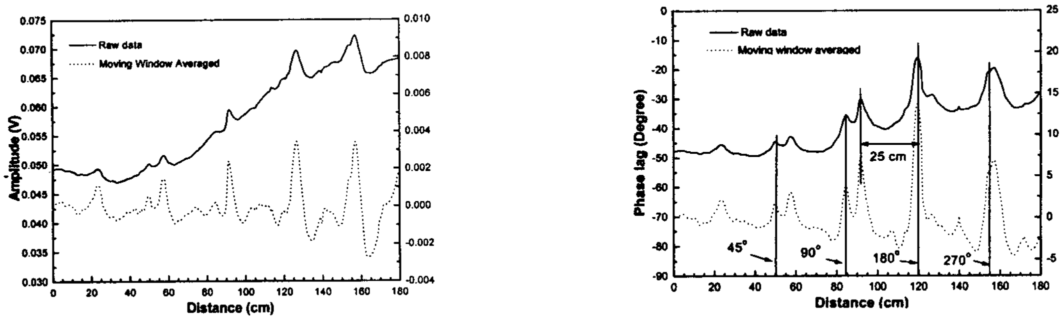
When the low frequency AC current is applied in a coil inside conducting metal pipes, the indirect magnetic field is formed at a certain distance from the coil. This phenomenon is known as remote field eddy current (RFEC) and may be used to nondestructively detect and evaluate the abnormalities of conducting pipes[1]. This paper describes the application study of RFEC to water supply pipes and discusses on the noise removal and quantitative evaluation methods[2].

2. Experiment

RFEC experiments were carried out on five water supply pipes machined with various defects. The length of the pipes is 2.5m and various shapes, positions and numbers of defects are present in pipes. Background noise must be eliminated to clearly detect the signals from defects. Moving window average (MWA) method was used to remove the long-range noise which comes from wall-thickness variations of the pipes due to large allowable errors in the manufacturing processes and magnetic properties' changes like μ and σ in the pipes. Since the signals by this kind of noises are slowly changing over the full length of pipes, the MWA is effectively used to process the measured signals. Voltage polar plane plots (VPPP) method, which is used exclusively in RFEC, was also applied to quantitatively evaluate the defect signals from bobbin type detector.

3. Results and Discussion

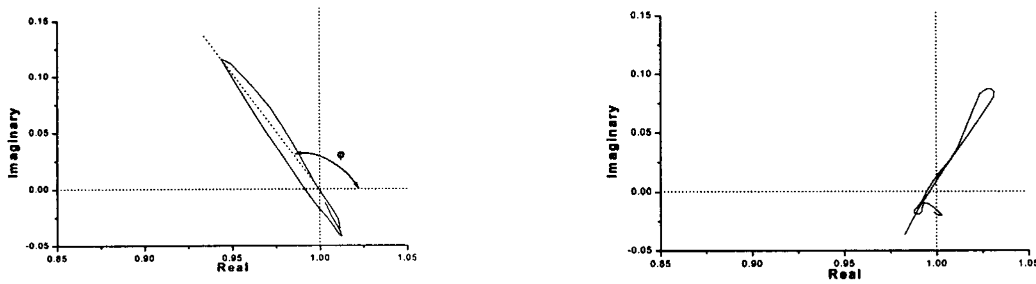
Fig. 1 compares the RFEC raw data with those treated with MWA method on sample #3. Sample #3 has 45° , 90° , 180° , 270° , 360° circumferential defects with the same depth and width. As shown in Fig. 1, 45° defect has the smallest signal and 360° defect has the largest one. It shows that MWA method can effectively eliminate the long-range signal drift caused by the irregularities in pipes.



(a) RFEC amplitude (b) RFEC phase-lag

Fig. 1. RFEC raw signal and moving window averaged results on sample No. 3

Fig. 2 is some of results of RFEC signals treated by VPPP method. As the defects deepen, the angle between the signature and X-axis becomes larger. As the circumferential range of defects increases, the amplitude of signatures also increases.



(a) depth 5.44mm (b) 180° circumferential range

Fig. 2. VPPP signatures from the full and partial circumferential defects

4. Conclusion

RFEC signals from ductile cast iron pipes with 100mm nominal outer diameter, which were machined with various defects, were processed with moving window average and voltage plane polar plots method. We found the RFEC inspection is promising technique for underground water pipeline and quantitative evaluation of defects was successfully carried out using these two methods.

5. Reference

[1] T. R. Schmidt, "The remote field eddy current inspection technique", Materials Evaluation, Vol. 42, No. 2 (1984) 225.

[2] D. L. Atherton, D. D. Mackintosh, S. P. Sullivan, J. M. S. Dubois and T. R. Schmidt, "Remote-field eddy current signal presentation", Materials Evaluation, Vol. 51, No. 7 (1993) 782.