Signal processing method of super stainless steel condenser tube using guided wave sensor

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Generally, Steel is called as any of a number of iron alloys that contain small amount of carbon and in some cases, additional elements, eg chromium, nickel, manganese, silicon, molybdenum, and which are used in the manufacture of motor vehicles, ships, bridges, machinery, tools, etc. Among them, Super Stainless Steel is mainly used in materials consisting of the condenser tubes because it is very strong and can especially bear up under pressure and corrosion that cause shot down of the power plant. Currently, eddy current test is utilized to evaluate the soundness of the condenser and heat exchanger tubes and also, the other method using guided wave is utilized in inspecting these facilities. We made an effort to detect a very small size defect within the super stainless steel using guided wave sensor of the longitudinal and torsional modes and we anticipate that these detect limits can be overcome along with the development of the signal processing technology.

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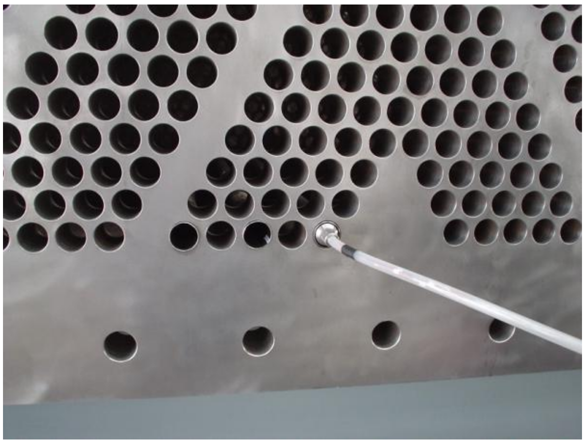
1. Introduction

Once a wave of a certain incident frequency impinges onto a solid waveguide of finite thickness at an incident angle, mode conversion of this wave occurs at the interface. Guided wave propagation along the waveguide geometry can be generated as a result of the interference phenomena and multiple mode conversions[1]. The use of guided waves in the nondestructive characterization of structural components, such as; bonded plates and composites laminates, has received considerable attention in recent years. A number of experimental rigs have been developed to facilitate the recording and interpretation of these guided waves in a laboratory environments[2]. Development of ultrasonic guided wave inspection will require a fundamental understanding of the wave propagation involved. The propagation of ultrasonic guided waves differs significantly from that of bulk waves. In particular, there can be distortion of an acoustic pulse waveform with propagation through the media. Interaction of these waves with defect regions in the material can produce further waveform distortion[3]. So, it is necessary to understand this experimental guided wave generation and how it relates to the theoretical dispersion curves. From the dispersion curves for a multi-layer plates or hollow cylinder, it is apparent that there are a large number of possible modes over the frequency range of interest with the potential for various levels of attenuation. Some methods are needed to generate particular modes of interest on the theoretical curves[4].

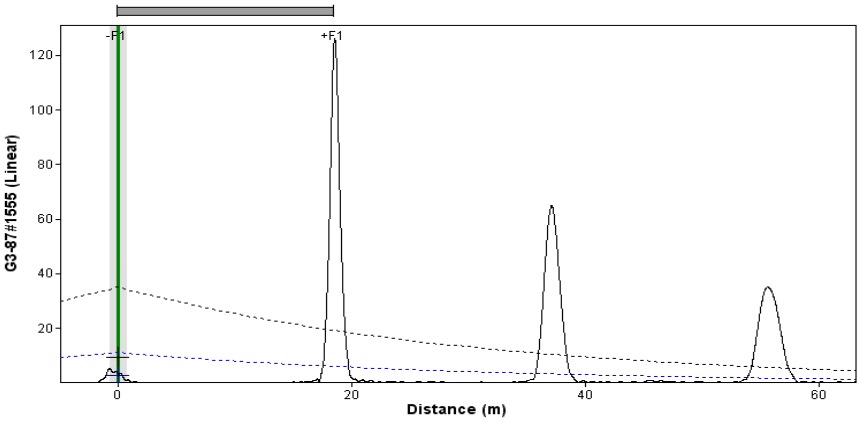
2. Test results

We performed the field test for the main condenser tubes with material of the super stainless steel based on the pre-test result in the laboratory and the field application results for the main condenser tubes are shown in (a), (b) and (c) of Fig.1. Fig.1(a) represents the side of the main condenser and Fig.1(b) represents the front side of the main condenser and also, Fig.1(c) represents the field application result signal of the main condenser tubes. In Fig.1(c), the green line of the left side means the location of the transducer to inspect the condenser tubes and the total length is 18 m, out diameter 25.4mm, thickness 0.89mm respectively. Each specimen is machined with the shape of drill hole, notch, declined notch and wear defect and also, we collected the signal adhering the tubes and support. On the basis of the test result through the artificial defect, we performed the field test for the super stainless steel condenser tubes. As a result of the test, we could have known that the defect signal could not seen from the field application result signal of the Fig. 1(c) except for the end signal of the tube because any defect was not exist within the condenser tubes.

(a) Side of the main condenser



(b) Front side of the main condenser



(c) Field application signal of the main condenser tube

Fig.1 Field application result for the main condenser tube

3. Conclusions

The inspection technology using guided wave has the many advantages of examining a wide area at a fixed position. But, it also has difficulty in predicting accurately the size of faults that are some distance away. However, we thought that this drawback could be covered through the other methods such as the eddy current test or leak test and the possibility of the defect detection would be higher than ever before with the development of the sensor manufacturing technology. Also, we obtained the test results as shown in below

1. We could not distinguish from the signal near the end of the tube through the laboratory test.
2. We obtained the clean signal from the Al-Brass condenser tube and super stainless steel tube but, these clean signals were not obtained from the titanium condenser tube and we thought that the reason why the mode conversion was generated within the tubes because the thickness of material is very thin
3. In case the defect is directly below the support plate, we could not distinguish the defect signal from the support plate signal. So, we thought that the comparison test should be periodically accomplished to distinguish the support plate signal from the defect signal below the support.

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