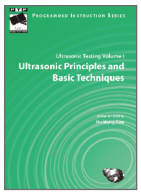

Programmed Instruction Series: Ultrasonic Testing Volume I: Ultrasonic Principles and Basic Techniques

Errata – 1st Printing 07/13

The following text correction pertains to the first edition, Vol. 1, of the *Programmed Instruction Series: Ultrasonic Testing*. Subsequent printings of the document will incorporate the corrections into the published text.

The attached corrected page applies to the first printing. In order to verify the print run of your book, refer to the copyright page.

Page	Correction
82	In the first paragraph, the text should read: The reflection ratio from PZT to steel is 0.048. In the second paragraph, the text should read: The reflection ratio from PZT to water in a contact test is 0.814.

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As an example, a PZT material used in a piezoelectric transducer has a density of 7.65 g/cm^3 and longitudinal wave velocity of 3.79 mm/μs. Its acoustic impedance is 28.99×10^6 kg/(m^{2}s). The acoustic impedance of steel is 45.24×10^6 kg/(m^{2}s). The reflection ratio from PZT to steel is 0.048.

The acoustic impedance of water is 1.49×10^6 kg/(m^{2}s). The reflection ratio from PZT to water in a contact test is 0.814. The transmission ratio is 0.0978. Here, the negative sign indicates the change of phase at reflection. In other words, the reflected wave has a phase lag of 180° from the incident wave.

In order to improve transmission efficiency, a **matching layer** is added in front of the piezoelectric material. The thickness of the matching layer is chosen to be a quarter of the wavelength (λ/4) in the matching material to ensure the constructive interference between multiple transmitted signals. The ideal value of acoustic impedance of the matching layer (Z_m) is:

$$Z_m = \sqrt{Z_1 \cdot Z_2}$$

where

Z_1 = the impedance of the piezoelectric material
Z_2 = the impedance of the material in front of the transducer

As an example, in order to establish a matching layer between PZT and water, we need to plug in the acoustic impedance values of each material as follows:

$$\begin{aligned} Z_m &= \sqrt{28.99 \times 1.49} \times 10^6 \\ &= \sqrt{43.2} \times 10^6 \\ &= 6.57 \times 10^6 \text{ kg/m}^2\text{s} \end{aligned}$$

After using the matching layer, the transmission ratio can be calculated by considering the multiple reflections and transmissions at the two interfaces. Although the detailed calculation process is beyond the scope of this book, it is very worthwhile to mention that the overall transmission ratio is 0.2267, which is a significant improvement compared to the case without a matching layer.