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Reflection of Ultrasound Waves

The strength of the reflected sound wave depends on the difference in "acoustic impedance" between adjacent structures.

Acoustic impedance (Z) is defined as the product of **density** (ρ) and the **velocity of the sound in that material** (c).

reflective boundary

medium 1 | medium 2

incident intensity I_i

transmitted intensity I_t

reflected intensity I_r

velocity of ultrasound = c_1

velocity of ultrasound = c_2

density ρ_1

density ρ_2
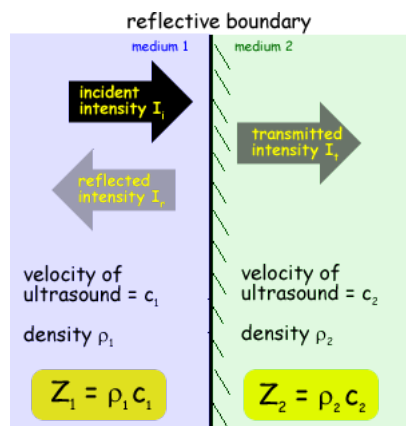
$$Z_1 = \rho_1 c_1$$

$$Z_2 = \rho_2 c_2$$

The fraction of the incident intensity that is reflected is given by the equation:

$$\frac{I_r}{I_o} = \left(\frac{Z_2 - Z_1}{Z_2 + Z_1}\right)^2$$

where

- I_r = reflected intensity
- I_o = incident intensity
- $Z_2 = \rho_2 c_2$ = acoustic impedance of medium 2
- $Z_1 = \rho_1 c_1$ = acoustic impedance of medium 1

The greater the difference in acoustic impedance between two adjacent tissues the more ultrasound energy the boundary will reflect .

Sound waves are propagated at a speed of approximately 340 m/s in air and 1540 m/s in soft tissues. This big difference means that if a **coupling gel** is needed between the body of the patient and the ultrasound transducer. The gel forces out the air between the body and the transducer window and replaces it with a medium that allows ultrasound to travel through it at a speed closer to that of the body.

The difference in acoustic impedances of two soft tissues is small and only about one per cent of the energy of theultrasonic beam is reflected. However, this is sufficient to produce a detectable echo. More intense echoes are produced at **'bone-soft tissue' boundaries** since the impedance difference is large. Similarly, an **'air-soft tissue' boundary** reflects almost all of the incident pulse because of the large impedance differences. Therefore the presence of air within the body (ie in the lungs) prevents structures behind it from being examined.