

Acoustic Variables

Pressure (Pascals (Pa)):	concentration of force in an area
Density (km/cm ³):	concentration of mass in a volume
Distance (cm or mm):	refers to the distance a particle moves.

Used to differentiate between the different types of waves (heat, light, sound etc). If one of the 3 variables have rhythmic oscillations then it is a sound waves.

Basic Review

All waves carry what?

Energy

Sound must travel in a _____ line

Straight

ALL sound waves are _____ and _____

Longitudinal and mechanical

Sound (mechanical waves) need a _____ to travel through

Medium

Molecules in a sound wave are _____ and _____.

Compressed and rarefied

Acoustic Propagation Properties

The effect medium has on sound waves.

Bioeffects

The effects sound waves have on body tissue.

What are 2 types of mechanical waves?

Transverse and longitudinal.

What is the average speed of sound in soft tissue?

1540 m/s OR 1.54 mm

Another word for stiffness is?

Bulk modulus

Basic Review (cont)

Stiffness and speed are _____ related.

Directly; increased speed = increased stiffness.

Speed and density are _____ related.

Inversely; increased speed = decreased density.

Sound travels the same speed no matter what _____.

Frequency; 5Mhz probe and 15 Mhz probe will travel at the same speed.

Acoustic Parameters

Period (microseconds):	Time it take to complete one cycle.	Source, NO
Frequency (MHz):	# of cycles per second.	Source, NO
Power (Watts):	Rate of energy	Source, YES by adjusting output power.
Intensity (W/cm ²)	Concentration of energy.	Source, YES by adjusting output power.
Amplitude (Pa):	The difference between the baseline and peak of a wave (bigness).	Source, YES by adjusting output power.
Wavelength (mm):	Distance to complete one cycle. (1.54m-m/frequency)	Source AND medium, NO

Acoustic Parameters (cont)

Propagation speed (m/s)	How fast a sound wave travels through a medium.	Medium, NO
-------------------------	---	------------

Used to define characteristics of a continuous wave (wave that is unable to produce an image).

- Period and frequency are reciprocals.
- Frequency is inversely related to period and wavelength.
- Wavelength and period are directly related.
- Propagation speed is determined by stiffness and density.

Intensity

Used to evaluate tissue exposure to sound energy

Determines the effects sound has on tissue.

Intensity is important when studying what?

Bioeffects

The strongest intensity is at they _____ of the beam.

Center/Focus (smallest area).

What intensity is the most important when studying bioeffects?

SPTA

SPTP is the _____ intensity

Highest

SATA is the _____ intensity.

Lowest

ALL intensities have units of?

W/cm² (power/area)



By Alyssabruestle1

Not published yet.

Last updated 17th February, 2023.

Page 1 of 2.

Sponsored by Readable.com

Measure your website readability!

<https://readable.com>

5 Parameters of Pulsed Sound

Pulse duration (microseconds):	Time it takes to complete one pulse.	Source, NO
Spatial Pulse Length (mm):	Distance it takes to complete one pulse.	Source, NO
Pulse Repetition Period (PRP):	Time from the start of one pulse to the start of the next (includes transmit and receiving time).	Source, YES by adjusting depth (Directly related).
Pulse Repetition Frequency (PRF) (kHz):	# of pulses per second.	Source, Yes by adjusting depth (inversely related).
Duty Factor (%):	Percentage of time that the pulse is on.	Source, YES by adjusting depth (inversely related).

Characteristics used to define a pulse wave (wave that is able to produce an image).

- A pulse is made up of multiple cycles.
- 3 out of the 5 parameters can be adjusted using depth.

How Sound Travels Through Media

Attenuation

Decrease in power, intensity, and amplitude due to sound waves decreasing as they propagate through media.

How Sound Travels Through Media (cont)

Distance and attenuation are ____ related.

Directly; increased distance = increased attenuation.

Frequency and attenuation are ____ related.

Directly; increased frequency = increased attenuation.

3 processes that contribute to attenuation:

1. Reflection
2. Scattering
3. Absorption

2 types of reflection (energy reflected back):

1. **Specular:** smooth boundary, one direction
2. **Diffuse:** irregular border, multiple directions.

Scattering

Waves redirected in many directions due to small tissue interface; when tissue is < wavelength. Directly related to frequency.

Rayleigh scattering

When structures are MUCH smaller than the beam's wavelength. EX: RBC. Rayleigh scattering = frequency⁴. They are directly proportional; increased frequency = increased Rayleigh scattering.

Absorption

Ultrasonic energy is converted into heat. Directly related to frequency.

Attenuation Coefficient (dB/cm)

Used to compare the amount of attenuation in certain circumstances. Measured in decibels for when sound travels 1 cm.

Total attenuation = Attenuation coefficient x Distance (cm)

EX: depth = 5cm AC = 2 dB/cm then total attenuation = 10 dB.

Attenuation Coefficient in soft tissue = frequency/2

How Sound Travels Through Media (cont)

Half layer thickness (penetration depth or half-boundary layer)

The distance sound travels in tissue that reduces intensity in half; Thin half layer = attenuates more

Impedance (rayls)

Resistance to sound traveling in a medium. Impedance = density x speed.

Normal incidence

Sound beam strikes boundary at 90 degrees (orthogonal, perpendicular, right). Reflection occurs if the boundaries have different impedances.

Oblique incidence

Sound beam strikes at any other angle other than 90 degrees; angle of incidence = angle of reflection.

Incident intensity (%)

Intensity before striking boundary; incident intensity = reflected intensity + transmitted intensity.

Reflected intensity

Intensity of sound wave after striking boundary and returning.

Transmitted intensity

Intensity of sound wave after striking boundary.

Refraction

Transmission with a bend. Can only occur IF 1. oblique incidence and 2. different propagation speeds of 2 media.



By Alyssabruestle1

Not published yet.

Last updated 17th February, 2023.

Page 2 of 2.

Sponsored by **Readable.com**

Measure your website readability!

<https://readable.com>