



Fundamental Physics for Food Technology and Innovation (4011106)

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Sound Physics in Food Technology

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Overview of topics to be covered:

- A. Understanding sound wave properties
- B. Applications in food processing
- C. Sound measurement in food industry

What is Sound?

- Mechanical waves that require a medium
- Longitudinal wave propagation
- Frequency range: 20 Hz - 20 kHz (audible sound)
- Equation: $v = f \lambda$

where:

v = wave velocity (m/s) f = frequency (Hz)

λ = wavelength (m)

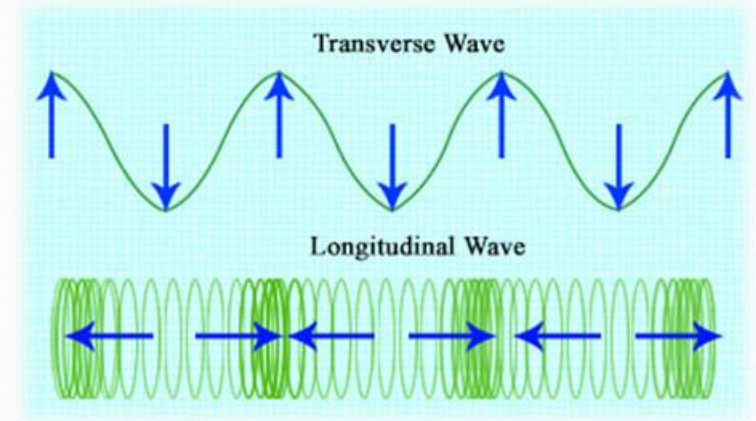


Figure 1: Longitudinal wave diagram

Properties of Sound Waves

- Amplitude
- Frequency
- Wavelength
- Speed (in different media)

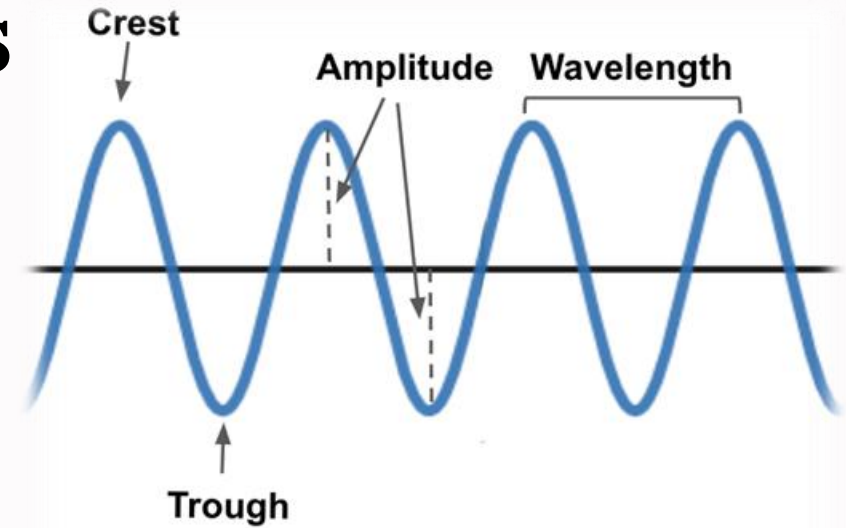


Figure 2: Wave characteristics diagram

Speed of Sound in Different Media

Table showing speed of sound in:

- Air (343 m/s at 20°C)
- Water (1,481 m/s at 20°C)
- Common food materials
- Temperature effects

Material	Temperature °F	Speed of Sound ft/sec
Air	32	1,087
Air	68	1,127
Aluminum	68	16,700
Carbon Dioxide	32	856
Fresh Water	32	4,629
Fresh Water	68	4,805
Hydrogen	32	4,219
Lead	32	4,030
Salt Water	32	4,800
Salt Water	68	4,953
Steel	32	16,410
Steel	68	16,850

Figure 3: Sound speed comparison

Sound Intensity and Decibel Scale

- Intensity equation:

$$I = P/A$$

where:

$I = \text{intensity (W/m}^2\text{)}$

$P = \text{power (W)}$

$A = \text{area (m}^2\text{)}$

- Decibel scale explanation
- Common food industry noise levels

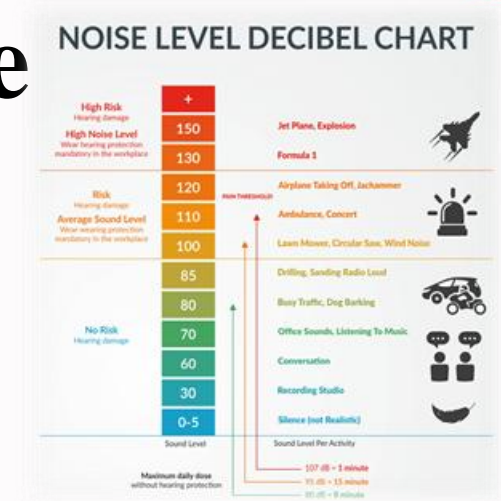


Figure 4: Industrial noise levels

Applications in Food Industry

- Quality assessment
- Processing monitoring
- Texture analysis
- Packaging integrity



Figure 5: Ultrasonic food analysis

Ultrasound in Food Processing

- Definition (> 20 kHz)
- Low-intensity applications
- High-intensity applications



Figure 6: Ultrasonic food processing

Acoustic Properties of Foods

- Acoustic impedance
- Attenuation
- Scattering



Figure 7: Food acoustic properties

Sound in Quality Control

- Non-destructive testing
- Texture evaluation
- Ripeness assessment

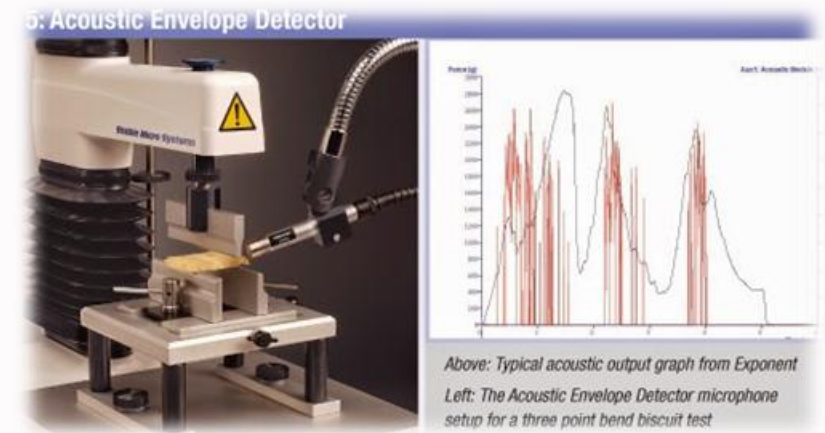


Figure 8: Acoustic food testing

Safety Considerations

- Noise exposure limits
- Hearing protection
- Equipment maintenance



Figure 9: Industrial ear protection

Case Studies

- Cheese ripening monitoring
- Bread crispness evaluation
- Fruit firmness testing



Figure 10: Acoustic food testing examples

Future Trends

- Emerging technologies
- Industry 4.0 integration
- Smart acoustic sensors



Figure 11: Future food acoustics

Summary

- Key takeaways
- Additional reading resources

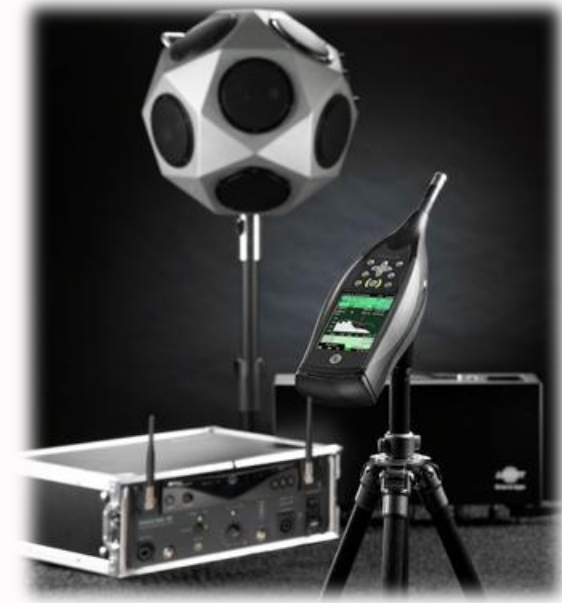


Figure 12: Acoustic measurement tools



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2. McClements, D. J. (2016). Food Acoustics and Ultrasound Applications. Annual Review of Food Science and Technology, 7, 229-255.
3. Feng, H., Barbosa-Cánovas, G. V., & Weiss, J. (2021). Ultrasound Technologies for Food and Bioprocessing (2nd ed.). Springer.

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