



Fundamental Physics for Food Technology and Innovation (4011106)

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Momentum and Collision in Food Processing

"Momentum and Collision Applications in Food Industry"

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Overview of topics to be covered:

- A. Understand basic concepts of momentum and collision
- B. Apply momentum principles to food processing operations
- C. Analyze collision types in food manufacturing equipment

What is Momentum?

- Linear momentum (p) = mass (m) \times velocity (v)
- SI Units: $\text{kg}\cdot\text{m/s}$
- In food processing: Important for:
 - *Conveyor belt operations*
 - *Mixing processes*
 - *Material handling*

Equation: $p = mv$



Figure 1: Conveyor belt food industry

Conservation of Momentum

- Total momentum remains constant in an isolated system
- Before collision = After collision $p_1 + p_2 = p_1' + p_2'$
- Application:
 - *Mixing operations in food processing*



Figure 2: Industrial food mixer momentum

Types of Collisions

1. Elastic Collision

- *Kinetic energy is conserved*
- *Example: Sorting machines for fruits*

2. Inelastic Collision

- *Some kinetic energy is lost*
- *Example: Food packaging impact*

3. Perfectly Inelastic

- *Collision Maximum energy loss*
- *Example: Food compaction*



Figure 3: Fruit sorting machine collision

Coefficient of Restitution (e)

- Measures "bounciness" of collision
- $e = -(v_2' - v_1') / (v_2 - v_1)$
- Where:
 - $v_1, v_2 = \text{initial velocities}$
 - $v_1', v_2' = \text{final velocities}$
- Range: $0 \leq e \leq 1$
 - $e = 1$: perfectly elastic
 - $e = 0$: perfectly inelastic



Figure 4: Food impact testing

Applications in Food Industry

- Impact Forces in:
 - *Cutting operations*
 - *Grinding processes*
 - *Packaging systems*
- Quality Control:
 - *Fruit ripeness testing*
 - *Texture analysis*
 - *Package integrity testing*



Figure 5: Food processing impact testing

Practical Examples

Case Study: Fruit Sorting System

- Momentum principles in:
 - *Movement on conveyor*
 - *Sorting mechanism*
 - *Impact protection*
- Energy considerations for product safety



Figure 6: Automated fruit sorting system

Safety Considerations

- Impact force control in:
 - *Material handling*
 - *Product transfer points*
 - *Packaging operations*
- Minimizing product damage



Figure 7: Food conveyor safety systems



References.

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2. Fellows, P. J. (2017). Food Processing Technology: Principles and Practice. Woodhead Publishing.
3. Barbosa-Cánovas, G. V., et al. (2012). Food Engineering: Integrated Approaches. Springer.

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