

#### Aerodynamic and hydrodynamic properties of

DRAG FORCE



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#### Important of Aerodynamic and hydrodynamic properties



- In the handling and processing of agricultural products, air is often used as a carrier for transport or for separating the desirable products from unwanted materials.
- Therefore the aerodynamic properties, such as terminal velocity and drag coefficient, are needed for air conveying and pneumatic separation of materials.
- As the air velocity, greater than terminal velocity, lifts the particles to allow greater fall of a particle, the air velocity could be adjusted to a point just below the terminal velocity.
- The fluidization velocity for granular material and settling velocity are also calculated for the body immersed in viscous fluid.

#### Pneumatic system for food separation

ZERO LEARNING ACADEMY



FIGURE 1. In closed-loop systems, such as this one, the conveying gas is recycled instead of being discharged to the atmosphere



## **Drag Force**

- When a particle moves steadily through a fluid, there are two principal forces acting upon it, the external force causing the motion and the drag force resisting motion which arises from frictional action of the fluid.
- The net external force on the moving particle is applied force less the reaction force exerted on the particle by the surrounding fluid, which is also subject to the applied force
- A drag force is the resistance force caused by the motion of a body through a fluid, such as water or air.
- A drag force acts opposite to the direction of the oncoming flow velocity. This is the relative velocity between the body and the fluid.
- The drag force is exerted on a body traveling though a fluid is given by.







 $F_D=rac{1}{2}
ho v^2 C_D A$ 

 $F_D$  = drag

- ho = density of fluid
- v = speed of the object relative to the fluid
- $C_D$  = drag coefficient
- A = cross sectional area



# Drag coefficient

- In fluid dynamics, the drag coefficient is a dimensionless quantity that is used to quantify the drag or resistance of an object in a fluid environment, such as air or water.
- It is used in the drag equation in which a lower drag coefficient indicates the object will have less aerodynamic or hydrodynamic drag.





Measured Drag Coefficients



# **Terminal Velocity**

- It is the limiting uniform velocity attained by a free falling body when the force of air resistance has become equal to the force of gravity.
- Acceleration = 0

Fd=Fg





## Force due to Air Resistance

The object is described as having attained terminal velocity

#### Force due to Gravity





### **Applications in food processing**

- 1. Hydrodynamic properties viz., drag coefficient and terminal velocity can be used to evaluate the gravitational and centrifugal separation methods of food materials.
- 2. It is also used to determine the pumping characteristics of various liquid foods.
- 3. Drag coefficient and terminal velocity are also used to determine the trough depth in handling and washing of fruits & vegetables. If the trough depth is optimum, then the food will not damage due to hitting the trough's bottom.



