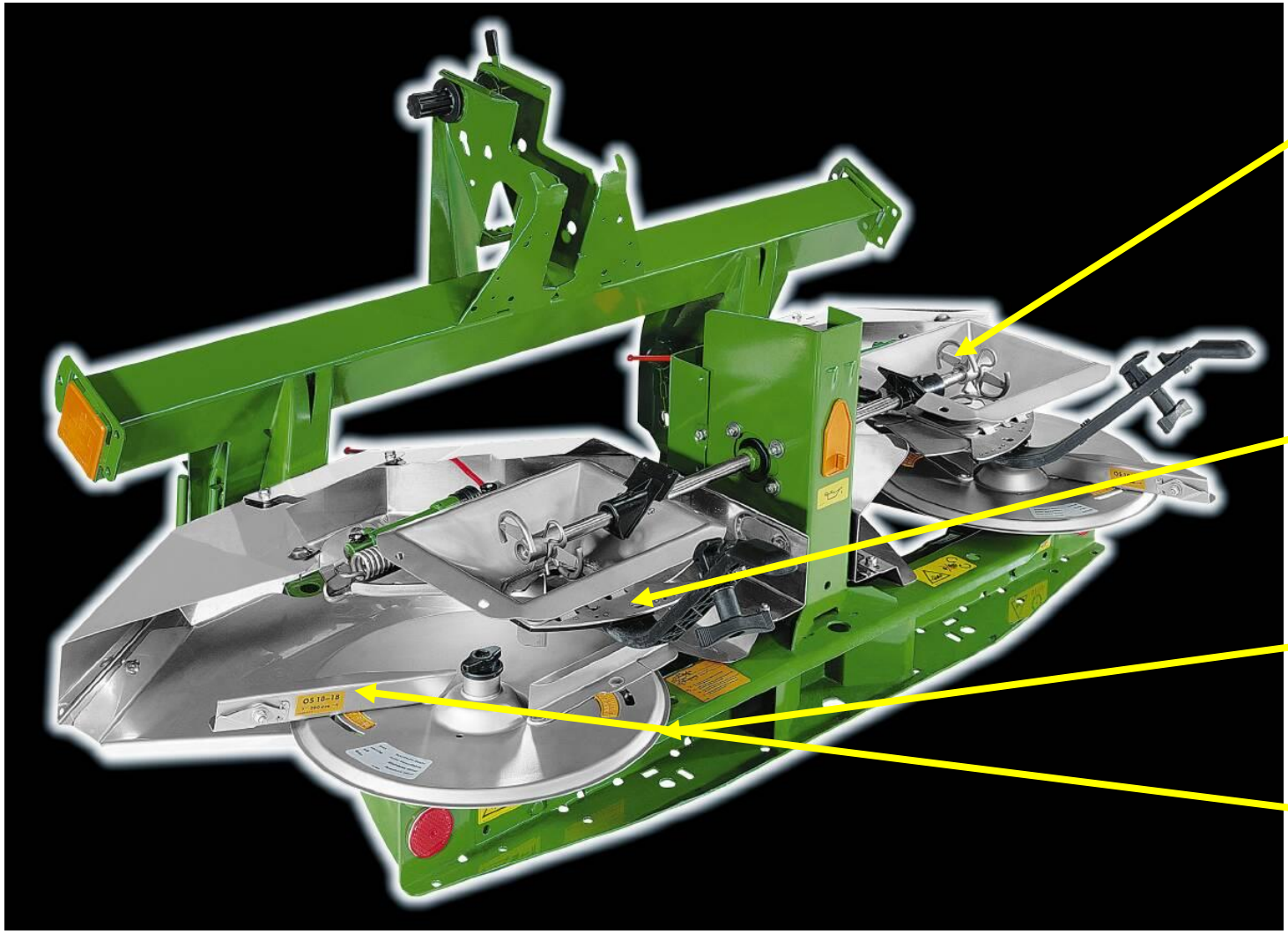
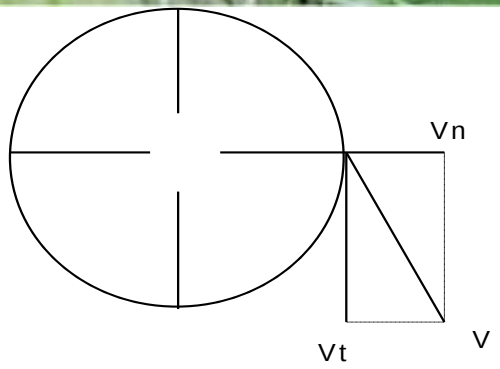
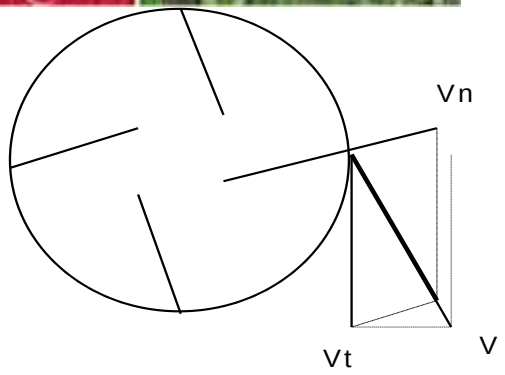
Disk Spreaders

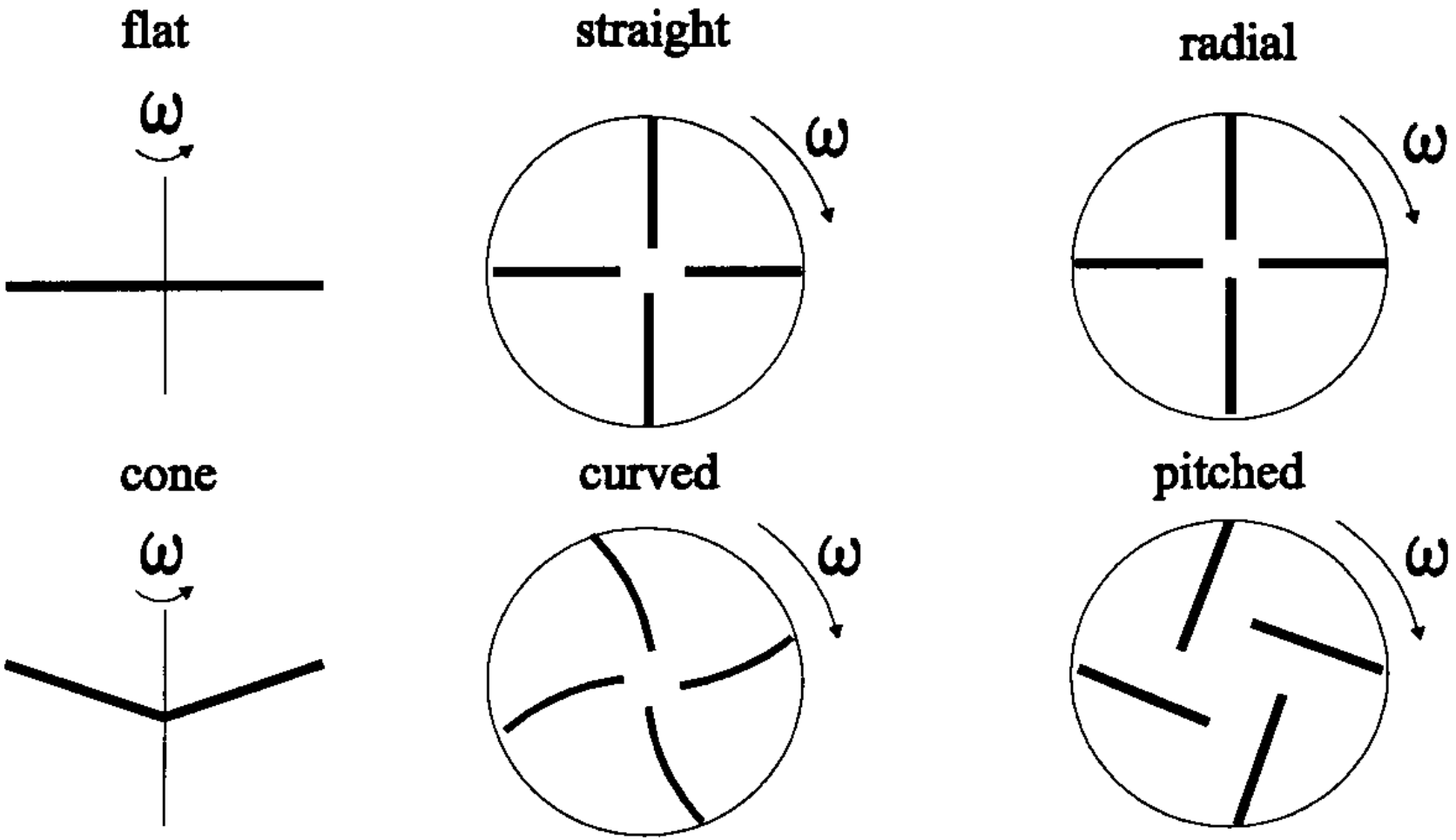


Disk Spreaders



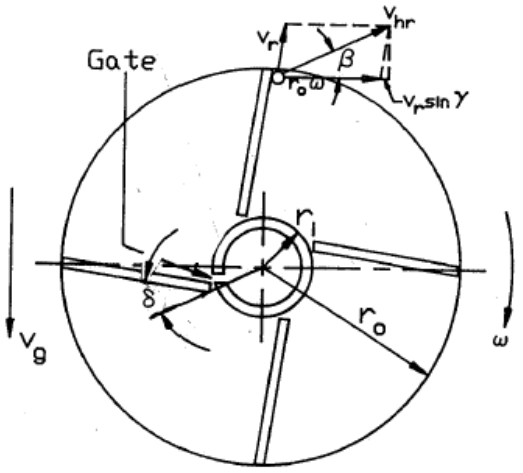


Design Parameters



Design Parameters

- Disk Speed, ω
  - 540-1000 rpm
- Disk radius, r_d
  - 0.3-0.45 m
- Feed Radius, r_o
- Cone Angle, α
  - Slope Up, + ve value
  - Slope Down –ve value
- Shape of Vane
- Coefficent of Friction
  - 0.2-0.6
- Initial pitch Angle of vane, β_o
  - Slope in direction of rotation, + ve direction, incre
  - Slope in opposite of rotation, - ve direction, decre
  - Constant β is logarithmic spiral
  - Instantaneous Pitch Angle



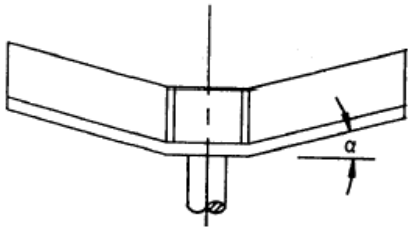


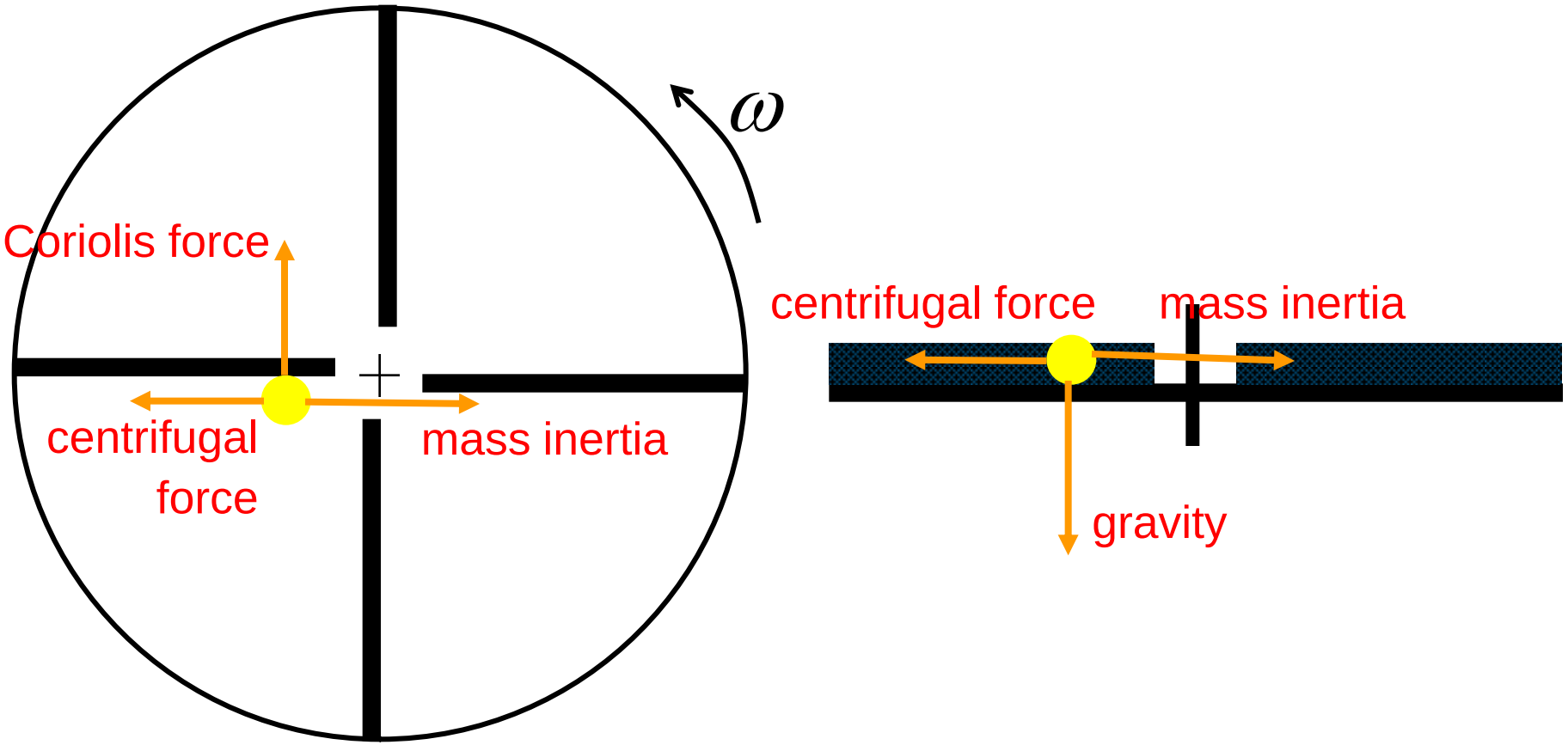
Figure 9.15 – A centrifugal spreader.

Srivastava, A.K., C.E. Goering, R.P. Rohrbach, and D.R. Buckmaster. 2006. Crop planting. In: Engineering Principles of Agricultural Machines, 2nd ed., 231-268.

Particle on a disc

Top view

Side view

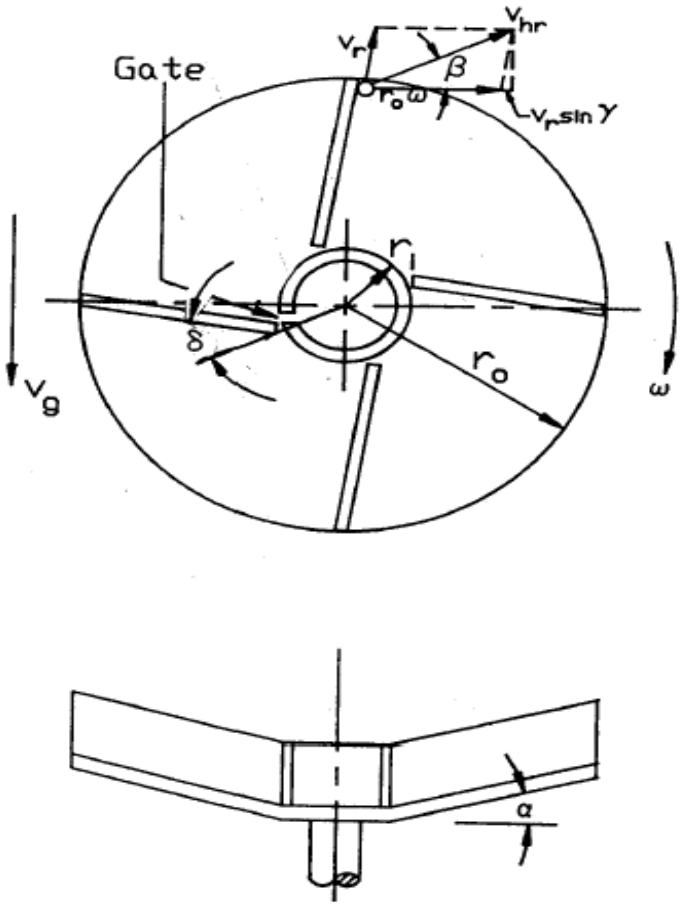


Forces on Partcile

- Gravity : $$F_g = m_p \cdot g$$
- Centrifugal force : $$F_{ce} = m_p \cdot \omega_d^2 \cdot r$$
- Mass inertia : $$F_I = m_p \cdot \frac{d^2 x_v}{dt^2}$$
- Coriolis force : $$F_{Co} = 2 \cdot m_p \cdot \omega_d \frac{dx_v}{dt}$$
- Friction force :

Force components perpendicular to vane or disc

Particle Velocity



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Disk Velocities

- Angle of Rotation, θ

$$\frac{(C_1 + f)e^{C_2(C_1 - f)\theta} + (C_1 - f)e^{-C_2(C_1 + f)\theta}}{2C_1} = \frac{(r_o - [C_3 g]/[C_4 \omega^2])}{(r_i - [C_3 g]/[C_4 \omega^2])}$$

$f = Friction\ cooefficient$ $\qquad$ $g = gravity$

$r_i = Inner\ radius$ $\qquad$ $r_o = Outer\ radius$

$\omega = rotational\ speed\ (rad/s)$

$C_1 = (f^2 + C_4 / C_2)^{0.5}$ $\qquad$ $C_2 = \cos(\alpha)$

$C_3 = \sin(\alpha) + f\cos(\alpha)$ $\qquad$ $C_4 = \cos(\alpha) - f\sin(\alpha)$

Particle Velocity w.r.t Blade

- Velocity of Seed

$$V_r = \frac{C_4\omega}{C_2} * \frac{r_i - [C_3 g]/[C_4\omega^2]}{C_1} * [e^{C_2(C_1 - f)\theta} - e^{-C_2(C_1+f)\theta}]$$

V_r Velocity of the particle w.r.t. the blade

$V_r \cos\alpha \cos\gamma$ is the horizontal component of Velocity radial w.r.t. the disk

$V_r \cos\alpha \sin\gamma$ is the horizontal component of Velocity tangential w.r.t the disk

$r_o w$ is the tangentia l disk veloc ity with respect to the vehicle

$$\tan\gamma = r_i \tan(\delta)/[r_o - r_i]$$

Horizontal Velocity of particle w.r.t the vehicle

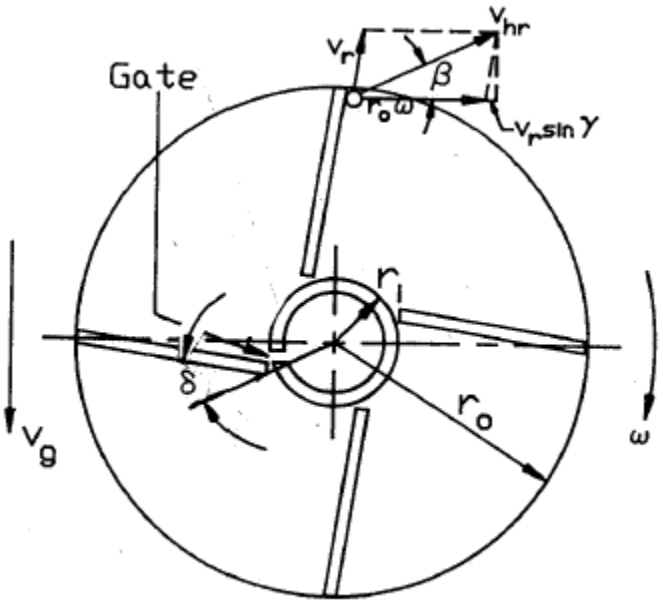
$$V_{hr} = ([V_r \cos\alpha \cos\gamma]^2 + [r_o w + V_r \cos\alpha \sin\gamma]^2)^{0.5}$$

Tangential Angle of particle w.r.t the vehicle

$$\tan\beta = [V_r \cos\alpha \cos\gamma]/[r_o w + V_r \cos\alpha \sin\gamma]$$

Vertical Velocity of particle w.r.t the vehicle

$$V_v = V_r \sin\alpha$$



Particle Trajectory

Drag Forces

$$D_f = \frac{C_d \rho_a A_p V_r^2]}{2}$$

C_d Drag Coefficien t

ρ_a Air Density

A_p Projected area of particle

V_r Velocity of particle w.r.t fluid medium

$$C_d = \frac{24}{N_{re}} \quad N_{re} < 1$$

$$C_d = 26.38 N_{re}^{-0.845} + 0.49 \quad N_{re} > 1$$

$$\rho_a = \frac{29\mathrm{P}}{8.314 T_K}$$ p is pressure in kPa

$$N_{re} = \frac{\rho_a D_p V_p]}{\mu_a}$$

μ_a is Dynamic Viscosity

$$\mu_a = 4.79 * 10^{-6} * e^{0.678 + 0.0022 T_K}$$

Forces

- Gravity
- Drag Forces