Fundamental Concepts: Sedimentation

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Sedimentation

Sedimentation is the gravitational accumulation of solids at the bottom of a fluid (air or water)
Types of Settling

Four types of sedimentation:

- Discrete settling
- Flocculant settling
- Hindered settling
- Compression
Examples of Settling Types

Discrete

Flocculant

Hindered
Types of Sedimentation

- In **discrete settling**, individual particles settle independently.
- It occurs when there is a relatively low solids concentration.
Types of Sedimentation

- In flocculant settling, individual particles stick together into clumps called flocs.
- This occurs when there is a greater solids concentration and chemical or biological reactions alter particle surfaces to enhance attachment.
Types of Sedimentation

- In hindered settling, particle concentration is great enough to inhibit water movement.
- Water must move in spaces between particles.
Types of Sedimentation

- Compression settling occurs when particles settle by compressing the mass below.
Sedimentation Rate

- **Stoke’s Law**
  - Used for spherical particles
  - Assumes no fluid mixing, so usually will not work for gasses

\[ V_p = \frac{(\rho_p - \rho_w)d^2g}{18\mu} \]
Sedimentation Rate

\[ V_p = \frac{(\rho_p - \rho_w)d^2g}{18\mu} \]

- \( V_p \) = particle settling velocity \((m/s\) or \(ft/s\))
- \( \rho_p \) = particle density \((kg/m^3\) or \(lb/ft^3\))
- \( \rho_w \) = fluid density \((kg/m^3\))
- \( d \) = particle diameter \((m\) or \(ft\))
- \( g \) = gravitational acceleration \((9.81 m/s^2\) or \(32.2 ft/s^2\))
- \( \mu \) = dynamic viscosity \((Ns/m^2\) or \(lbs/ft^2\))
Applications

- Stoke’s Law can be used to determine the surface area of a settling tank
  - Set the critical velocity equal to the settling velocity of the smallest particle
  - The overflow rate is equal to the flow rate into the tank divided by the surface area
  - Setting the overflow rate equal to the critical settling velocity allows time to capture smallest particles of interest
Applications

\[ \text{OFR} = v_c = \frac{Q}{A} \]

- **OFR** = over flow rate \((m/s\text{ or } ft/s)\)
- **\(v_c\)** = critical settling velocity \((m/s\text{ or } ft/s)\)
- **\(Q\)** = the flow rate into the basin \((m^3/s\text{ or cfs})\)
- **\(A\)** = the surface area of the basin \((m^2\text{ or ft}^2)\)