مهندسی آب و فاضلاب

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جلوتر از دیگران حرکت کنید

اطلاعات آموزشی

اطلاعات فنی و مهندسی

اخبار روز آب و فاضلاب

اخبار استخدامی کارفرمایان

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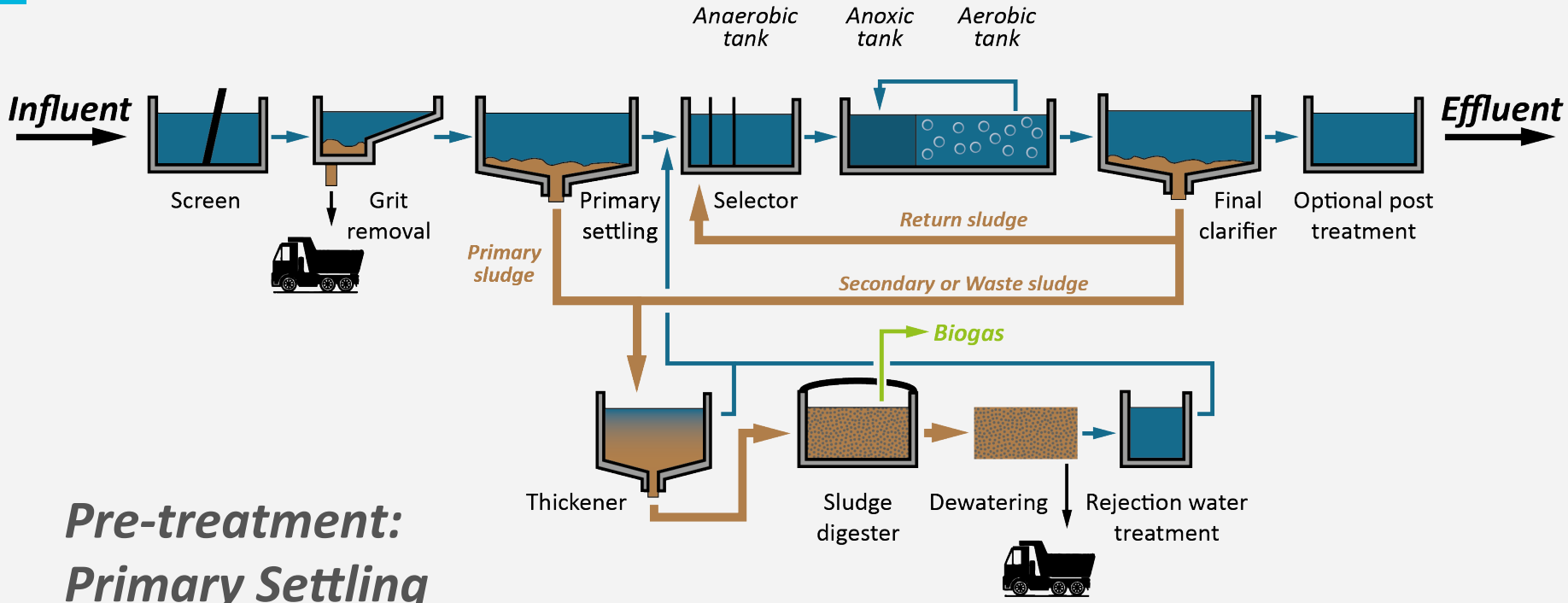
Primary sedimentation

CTB3365x Introduction to water treatment

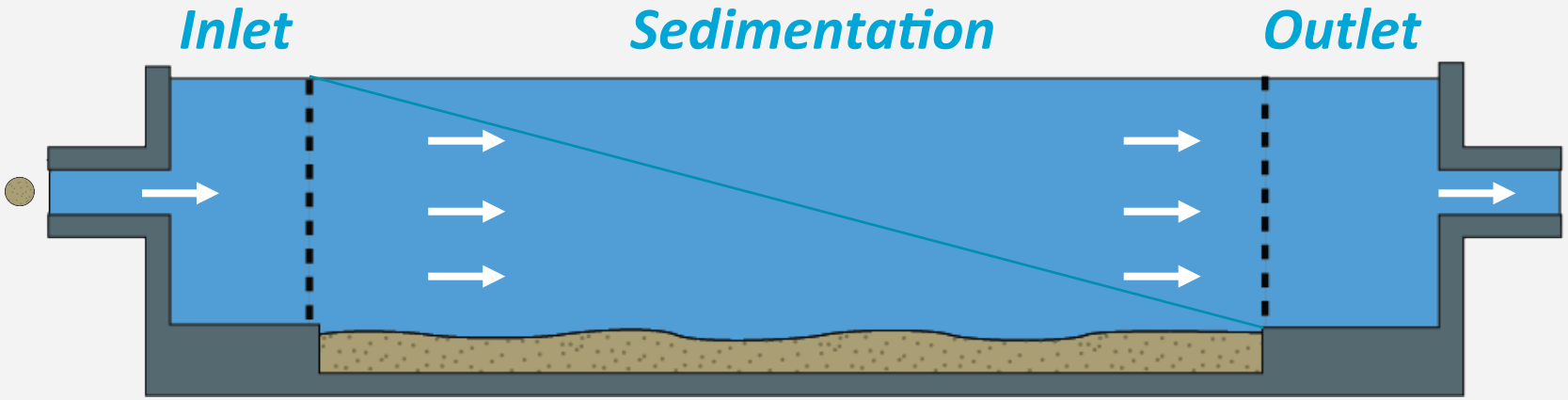
Prof.dr.ir. Jules B. van Lier

Basic WWTP process units



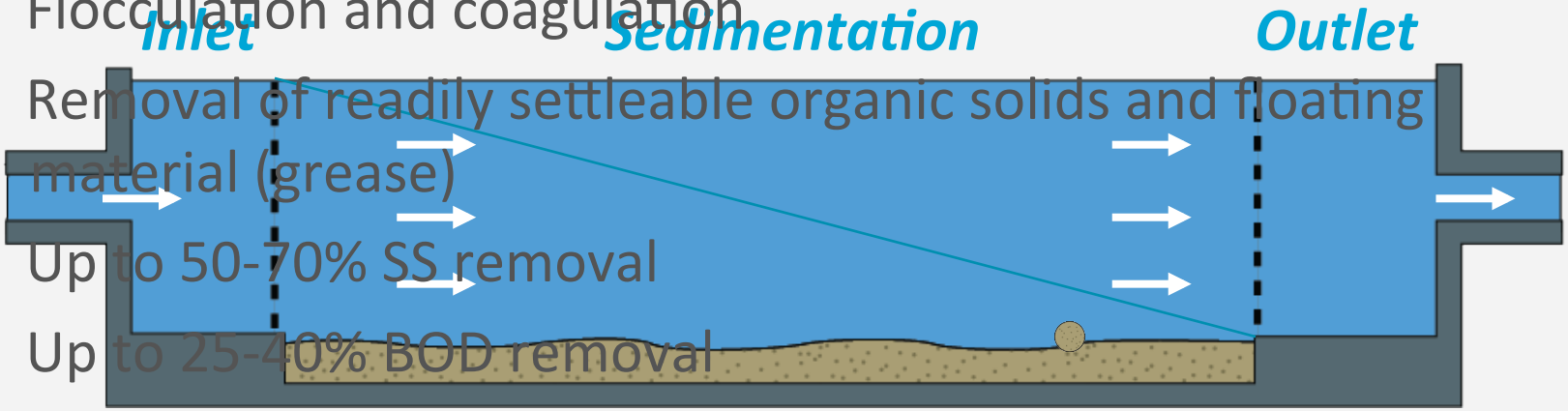
Pre-treatment: Primary Settling

Primary sedimentation

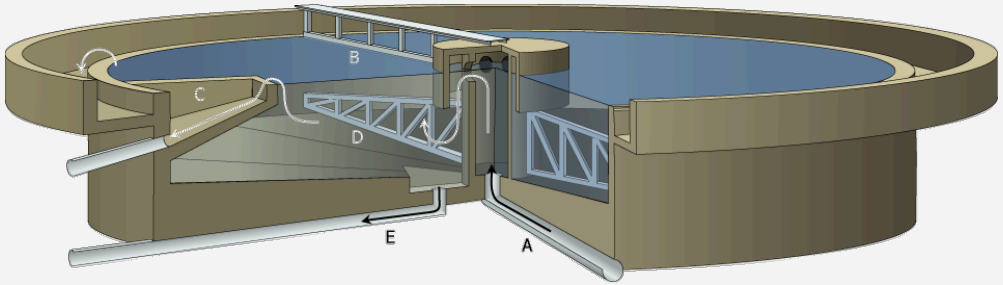


Primary sedimentation

- Flocculent and hindered settling
- Flocculation and coagulation
- Removal of readily settleable organic solids and floating material (grease)
- Up to 50-70% SS removal
- Up to 25-40% BOD removal

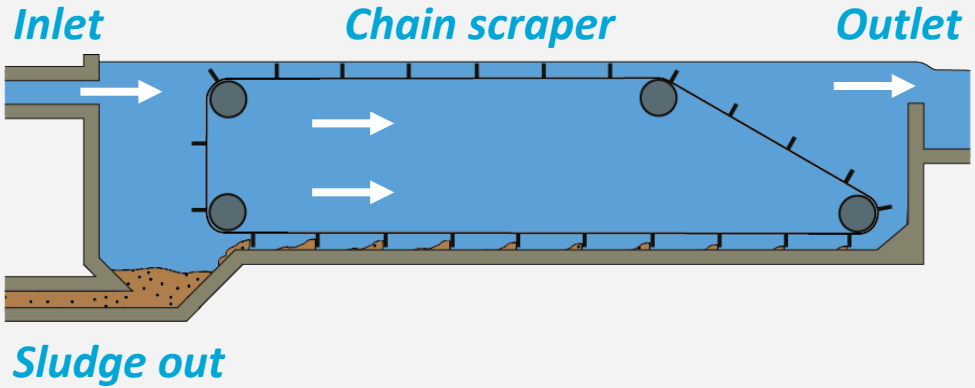


Primary clarifiers



Circular tanks

OR



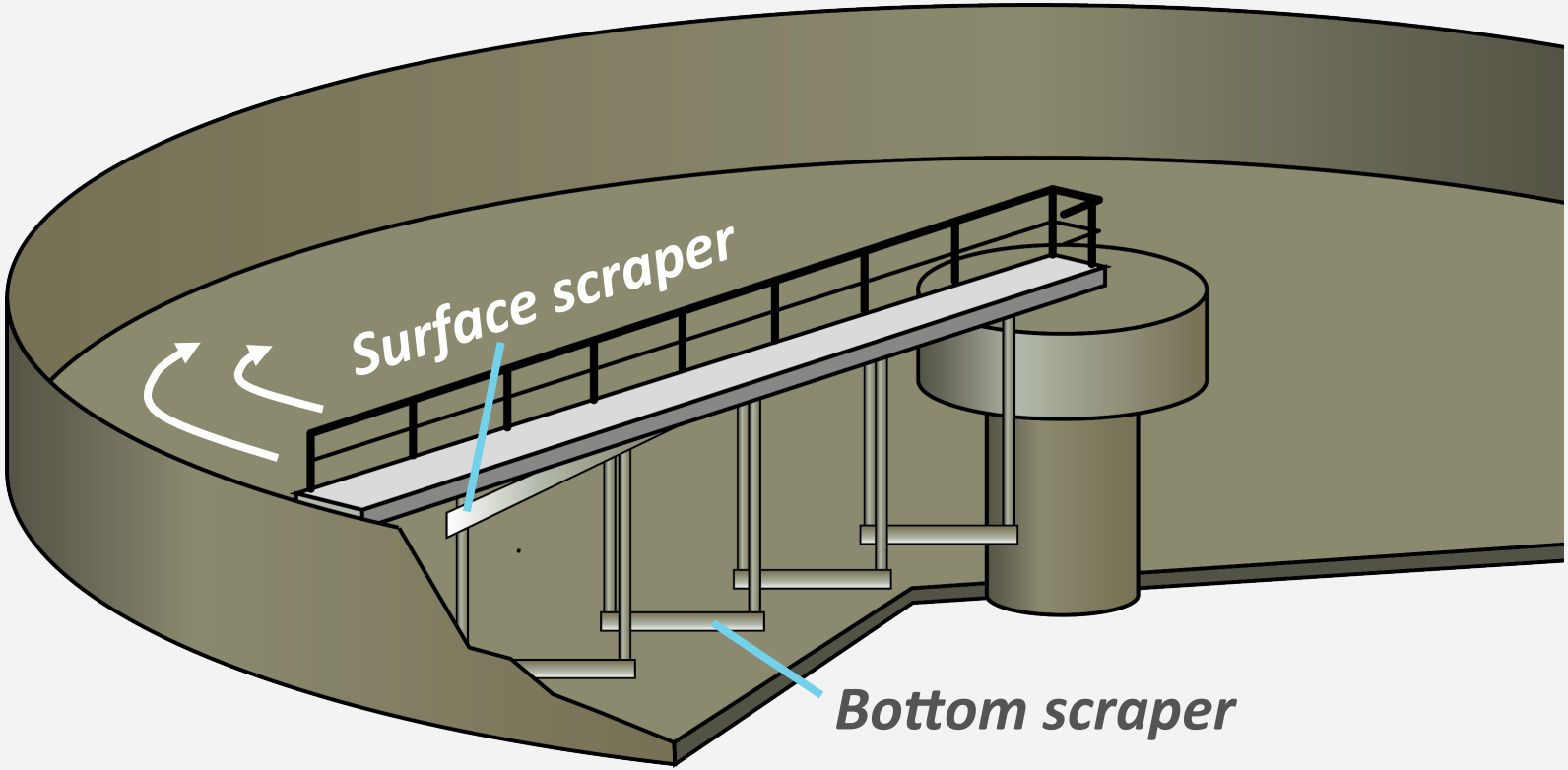
Rectangular tanks

Energy dissipation

Energy dissipation of incoming flow

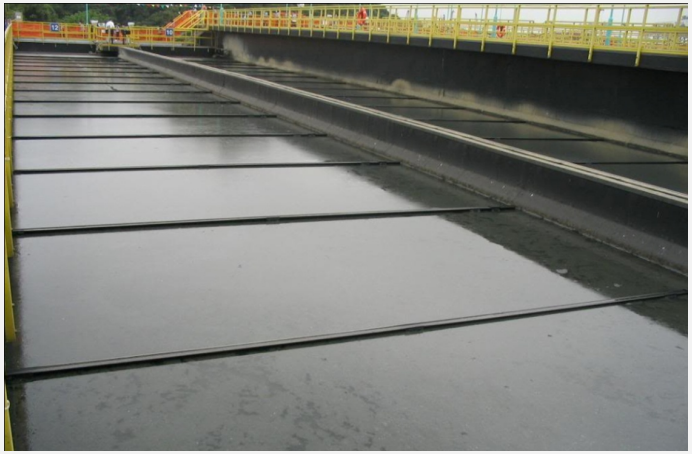
- From 0,3..1 *m/s* to 0,03 *m/s*

Circular clarifier



Rectangular tanks

Rectangular tanks



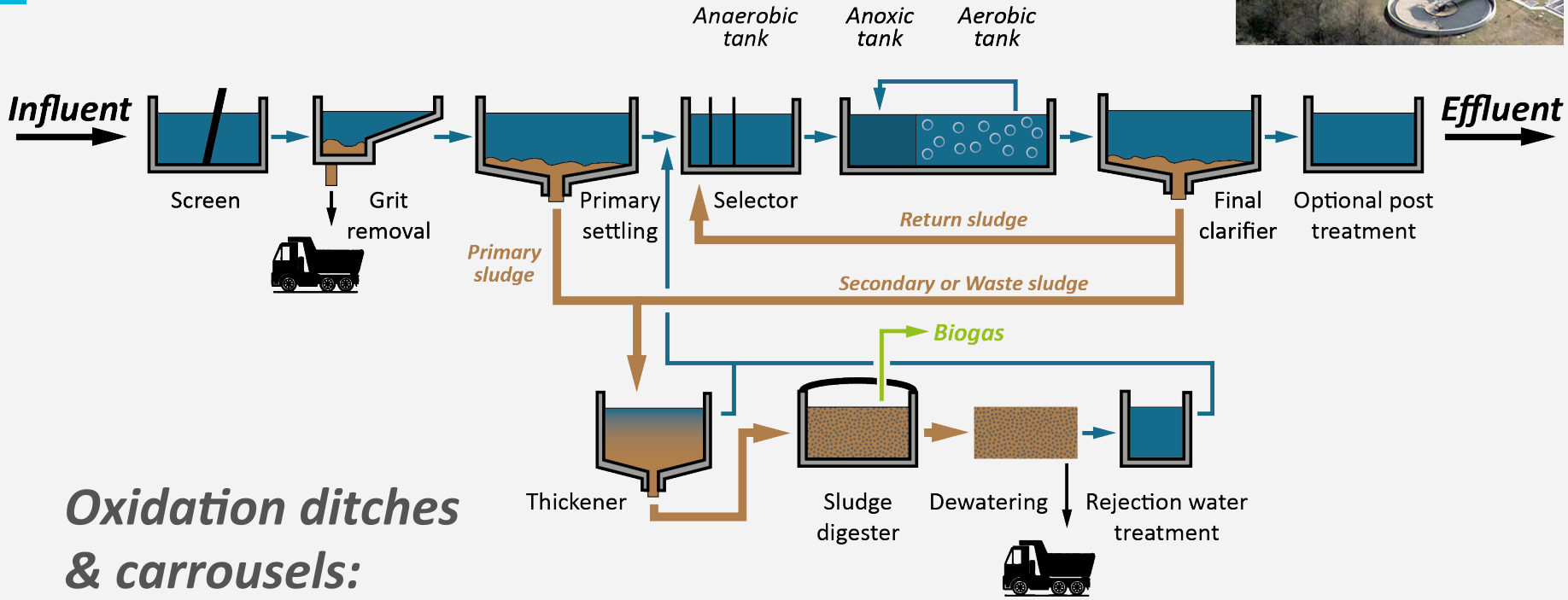
Rectangular tanks

Primary sedimentation

Not allways primary sedimentation!

- Oxidation ditches and carrousels are fed with non-clarified raw sewage!
- Primary sludge is stabilised inside the bio-reactor.

Basic WWTP process units

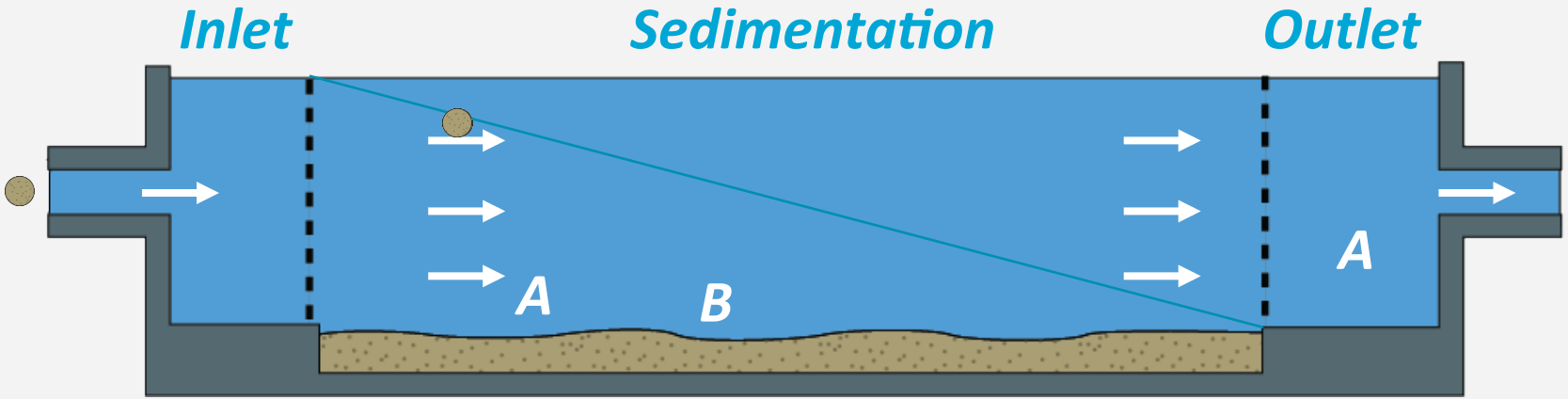


Oxidation ditches & carrousels: NO primary Settling!

Primary sedimentation

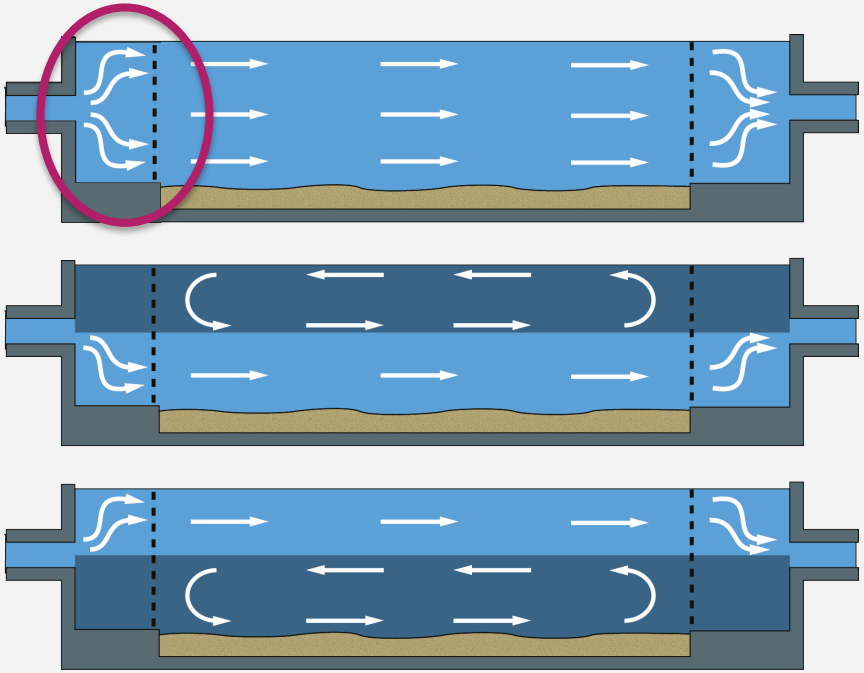
Avoid turbulence:

- $N_R < 1000 – 2000$

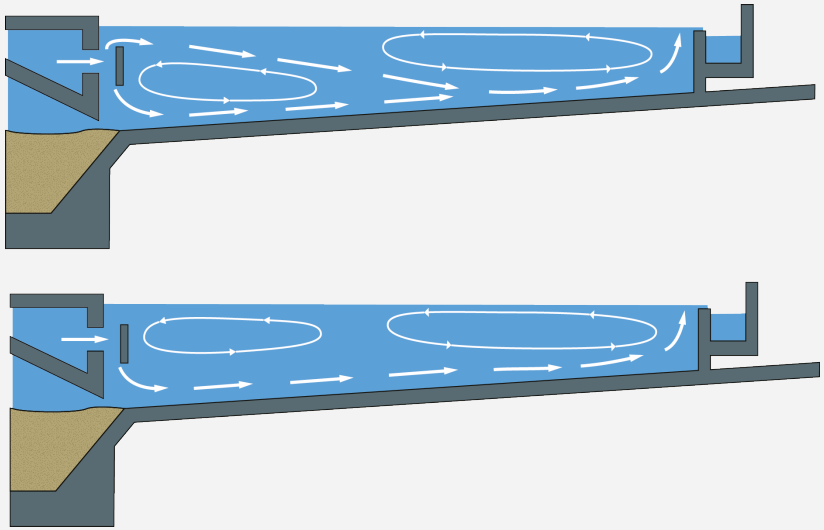


Primary sedimentation, performance

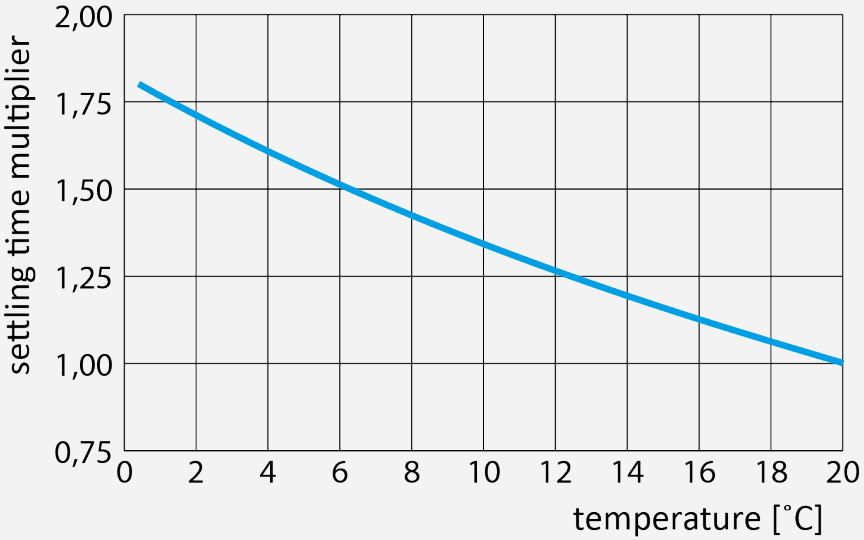
Minimize short-circuiting



Maximize hydraulic stability



Primary sedimentation, temperature

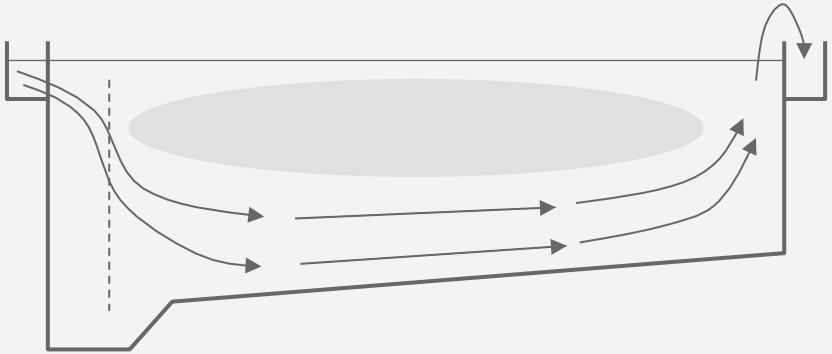


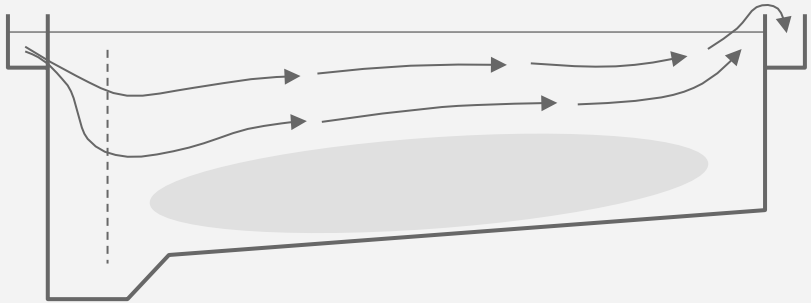
Multiplier: 1.82 · $e^{-0.03t}$

Viscosity:

- Temp ⇧, μ ⇩
- $N_R = \frac{v_O d_p \rho_w}{\mu} = \frac{v_O d_p}{\nu}$ ⇧
- $C_d = \frac{24}{N_R} + \frac{3}{\sqrt{N_R}} + 0.34$ ⇩
- $v_p = v_o = \sqrt{\frac{4g}{3C_d\varphi}\left(\frac{\rho_p - \rho_w}{\rho_w}\right)d_p}$ ⇧

Primary sedimentation, temperature

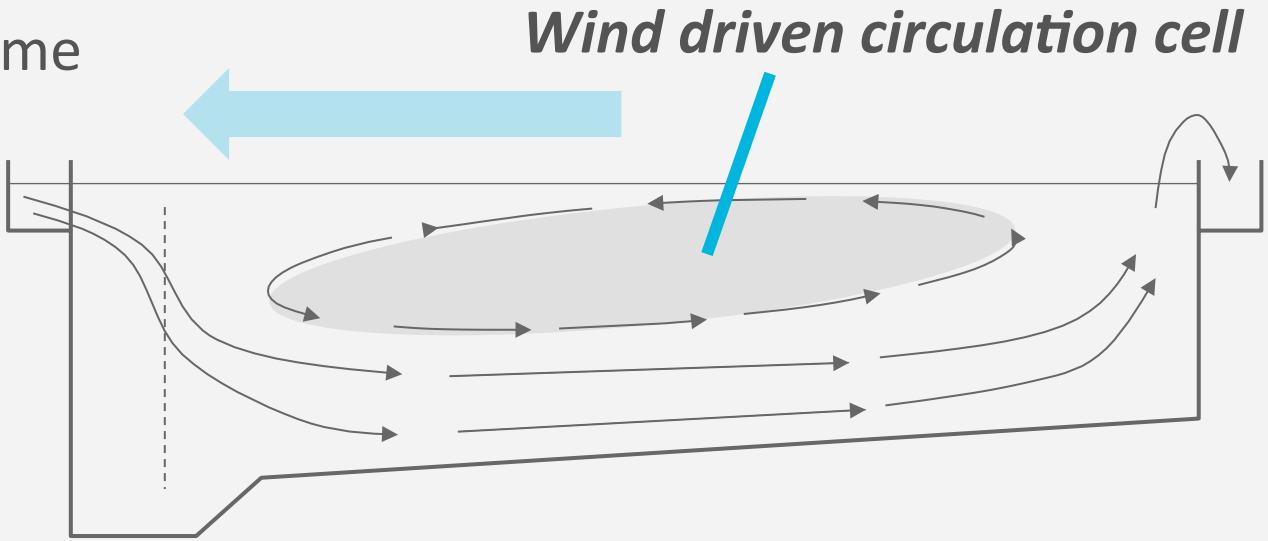




Primary sedimentation, wind energy

Wind effects:

- Circulation cells
- Reduced volume



Short circuiting & hydraulic stability

Froude number:

- $N_{Fr} > 10^{-5}$; defines subcritical / critical flows, resistance to flow disturbances

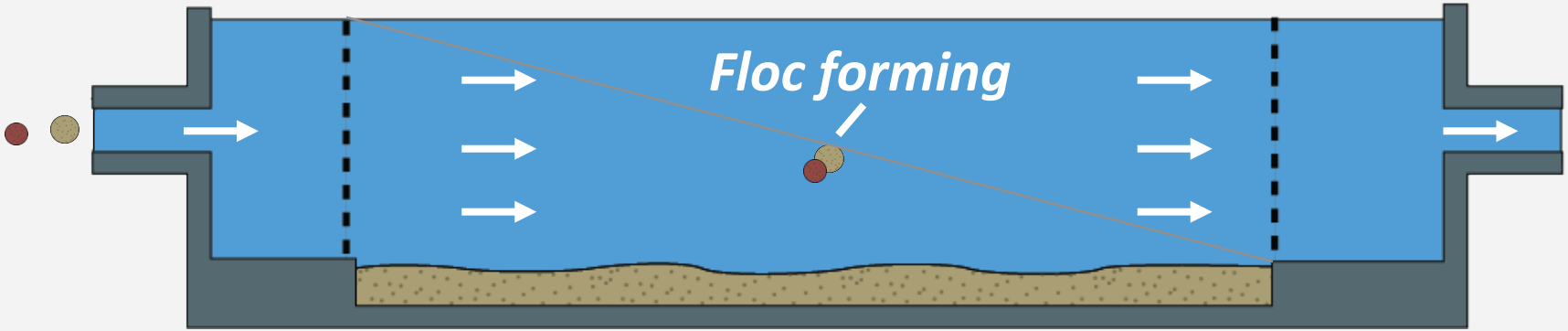
- Rectangular tanks: $$N_{Fr} = \frac{v_O^2}{g} \frac{L^2(W + 2H)}{WH^3}$$ ***narrow and long tanks***

- Circular tanks: $$N_{Fr} = \frac{v_O^2}{g} \frac{D^4}{64x^2H}$$ ***large diameters***

Primary sedimentation performance

Detention time and depth:

- Depth: flocculation (V_p ⇧)
  - *Depth is important! Not only the hydraulic surface load*



Scouring velocity

Depth (H) ⇩ ⟶ **v_h** ⇧ ⟶ **scouring!**

$$v_s = v_h = \frac{Q}{W \cdot H}$$

Scouring velocity:

$$v_s = \left(\frac{8k(s-1)gd}{f} \right)^{1/2}$$

v_s = v_h = critical horizontal velocity (m/s)
= scouring velocity
d = diameter of particles (m)
s = specific gravity of particles (-)
k = material constant (-)
f = Darcy-Weisbach friction factor (-)
g = 9.81 m/s^2

Critical $v_h = v_s$:

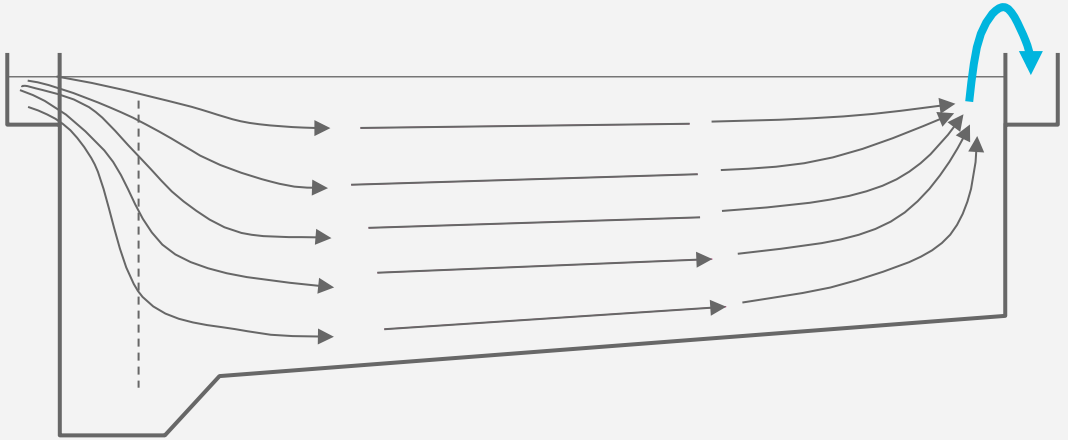
- sand: 0.30 m/s
- primary sludge: 0.03 m/s
- activated sludge: 0.02 m/s

Outlet zone

Primary sedimentation

Outlet zone:

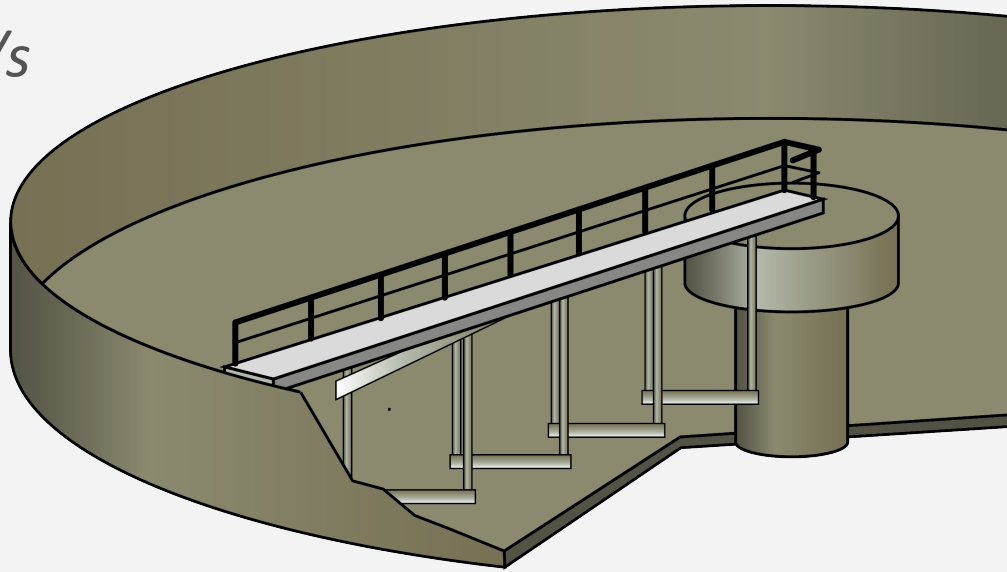
- Acceleration towards discharge
- Primary sedimentation weir loading: $10 - 15 \frac{m^3}{m \cdot h}$



Sludge collection & removal

Sludge collection:

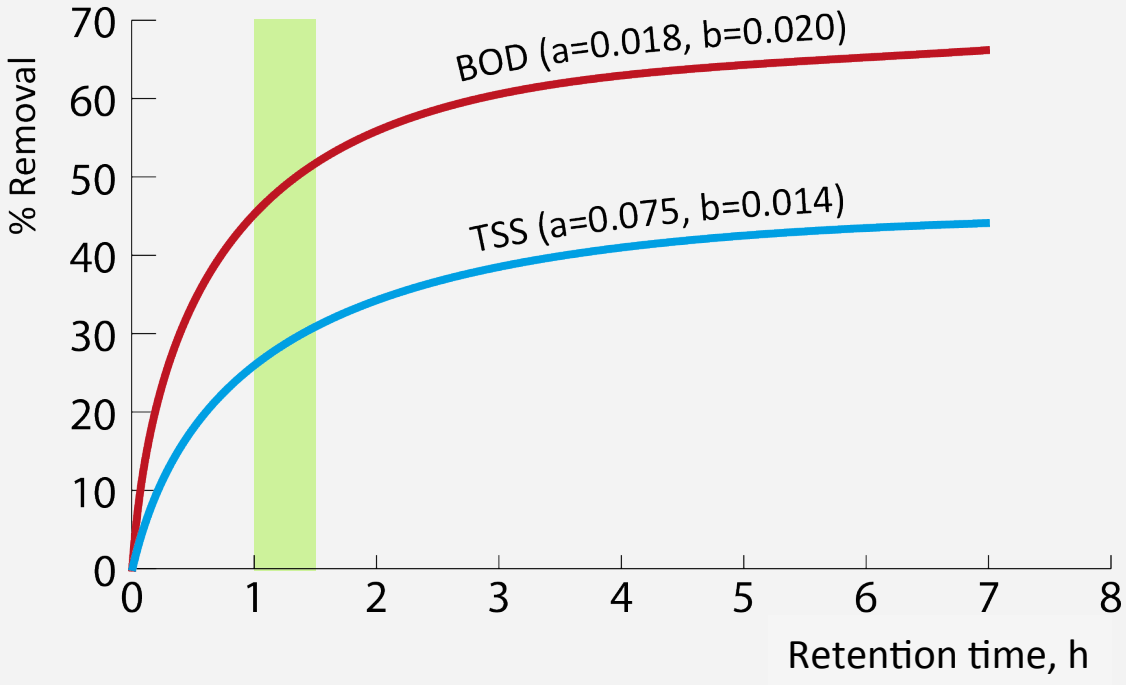
- Bridge speed:
  - *Circular: < 0.06 – 0.07 m/s*
  - *Rectangular: < 0.03 m/s*



Sludge removal:

- (Semi-) Continuous
- Digestion
- Bad odours

BOD and TSS removal efficiency



Expected removal efficiency:

$$R = \frac{t}{a + bt}$$

t = nominal detention time

a,b = empirical constants

Primary sedimentation: Design

General:

- Surface loading rate: $V_O = \frac{Q}{A} = 1.5 - 2.5 \frac{m^3}{m^2 \cdot h}$ (max. flow)
  - $\frac{Q}{A} = \text{up to } 4 \frac{m^3}{m^2 \cdot h}$ (max. flow = avg flow (*constant*))
- Hydraulic Residence Time (HRT):
  - *Average: 5 h*
  - *Minimum: approx. 1 – 1.5 h (during peak flow)*
- Water depth: 1.5 – 2.5 m
- Bottom slope: 1:10 – 1:12

Primary sedimentation: Design

Circular tanks:

- Diameter:
  - *Minimum: 20 m*
  - *Maximum: 60 m*
  - *Optimum: 30 – 40 m*

Rectangular tanks:

- Maximum length: 90m
  - *Optimum: 30 – 50 m*
- Width: 5 – 12 m
  - *Generally: 5 – 6 m*
- Width:Length: 1:5 – 1:6
- Depth:Length: 1:20

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