


Conventional Wastewater Treatment : **Grit removal**

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Dictionary Google search

Search for a word

 **grit**
/grɪt/

See definitions in:

noun

1. small loose particles of stone or sand.
"she had a bit of grit in her eye"

Similar:

2. courage and resolve; strength of character.
"I've known few men who could match Maude's grit"

Similar:

verb

1. spread grit and often salt on (an icy road).
"the main roads in Plymouth will be gritted from 6.30 p.m. tonight"

2. grate.
"fine red dust that gritted between the teeth"

Small loose particles of
stone or sand



- **What is grit?**

Inert dense material, such as sand, broken glass, metal fragments, silt, and pebbles, is called grit.

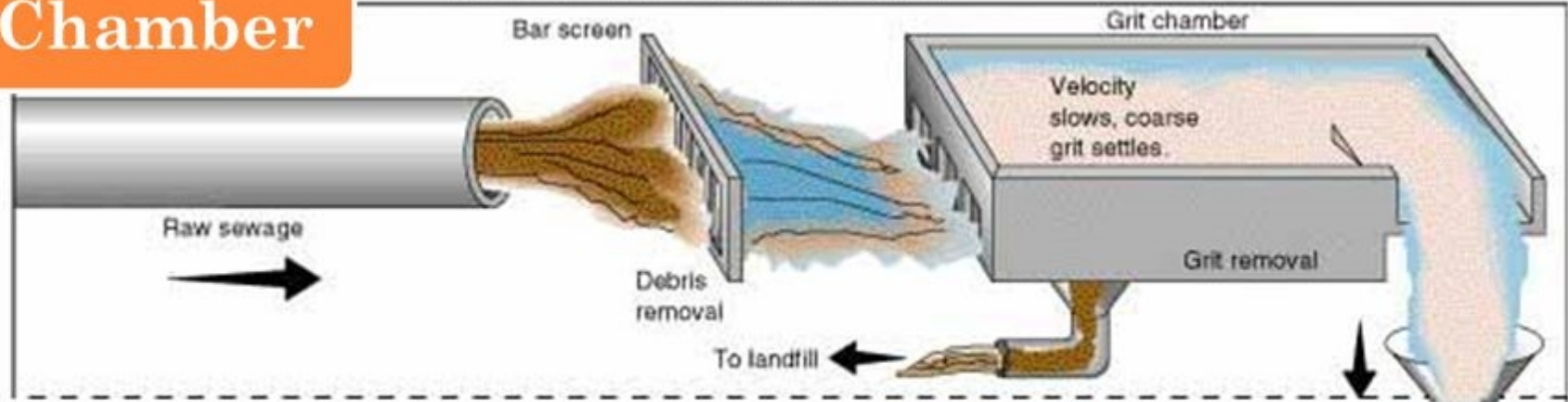
- **What is the problem with grit?**

If these materials are not removed from the wastewater, they abrade pumps and other mechanical devices, causing undue wear.

In addition, they have a tendency to settle in corners and bends, reducing flow capacity and, ultimately, clogging pipes and channels.

Grit Chamber

<http://apesnature.homestead.com/chapter17.html>



The objective of the Grit Chamber is to remove inorganics, and some larger organics e.g. pebbles, sand, silt, egg shells, glass, metal fragments, bone chips, seeds, coffee and tea grounds.

Why we remove Grits?

- Grits are abrasive in nature and will cause wear on pumps
- Grit deposits in pipes, sumps and clarifiers can absorb grease and solidify.
- They are non-biodegradable and occupy valuable space in the digester

What are the sources of Grits-

- The major contributor is infiltration and depends on the type, age and condition of sewerage systems
- Industrial waste
- Domestic garbage grinders



Position in wastewater treatment

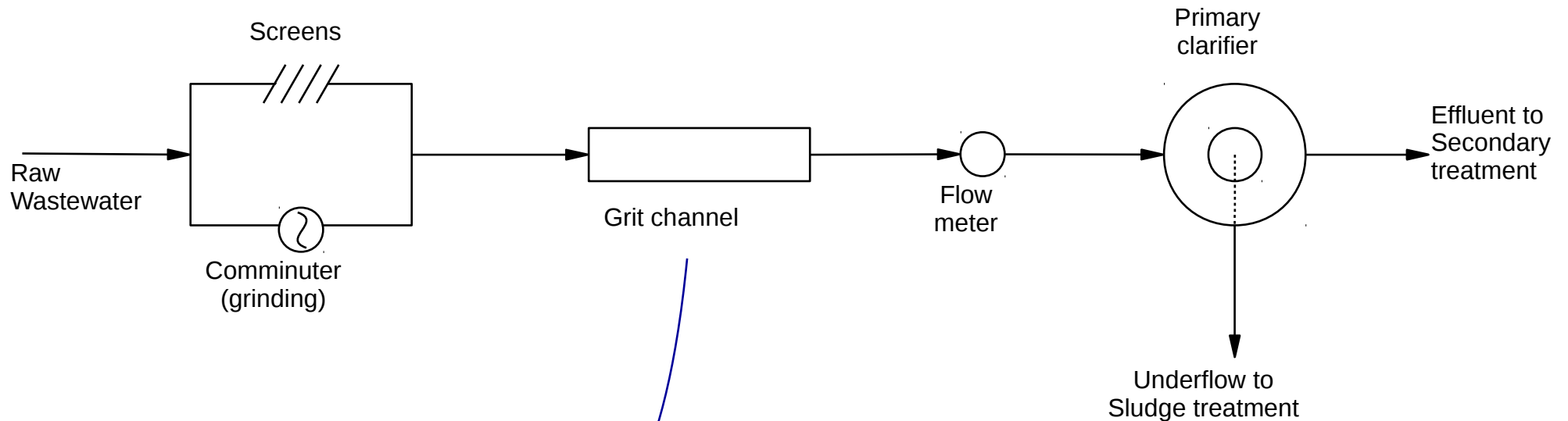
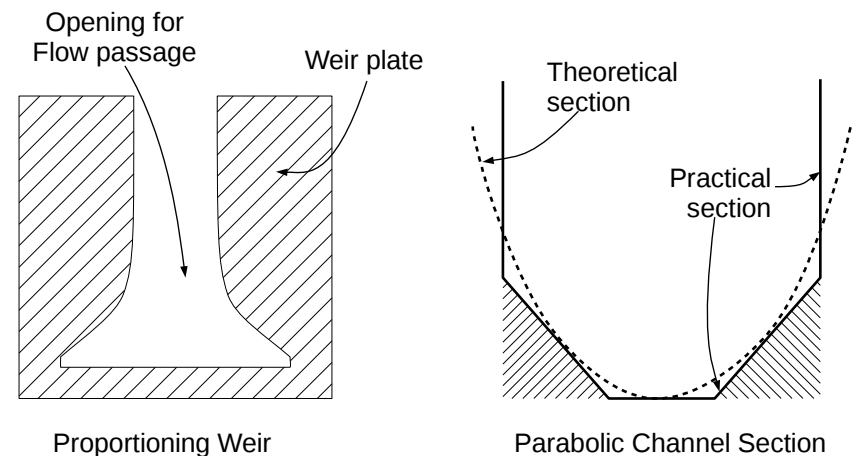


Figure: Typical Primary Treatment system (Peavy)

- **Typical design criteria**

- Type I settling (discrete particles)
- Particle diameter = 0.2 mm
- Particle specific gravity = 2.65
- Horizontal flow velocity = 0.3 m/s

Velocity Control Section of Grit Channel



Types of Grit Removal basins

- Aerated grit chambers
- Vortex-type (paddle or jet-induced vortex) grit removal systems
- Detritus tanks (short-term sedimentation basins)
- Horizontal flow grit chambers (velocity-controlled channel)
- Hydrocyclones (cyclonic inertial separation)

horizontal flow

grease trap

vortex grit

screening

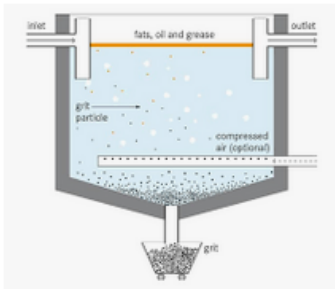
treatment plants

sewage treatment

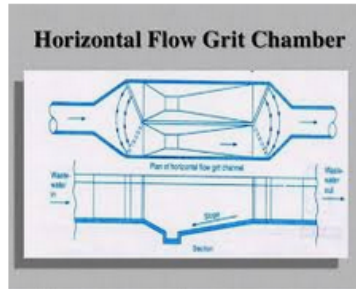
wastewater

sedimentation

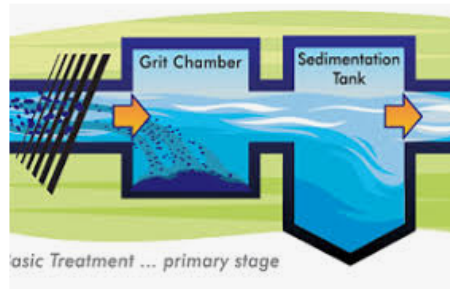
settling velocity



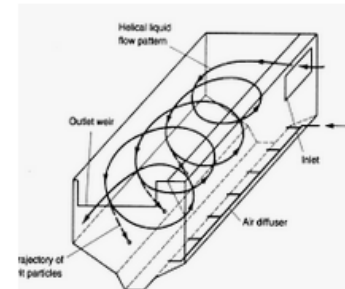
Grit Chamber- Composition, Ty... theconstructor.org



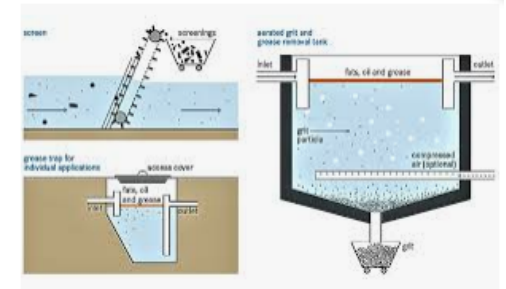
What are Grit chambers | Classi... civildigital.com



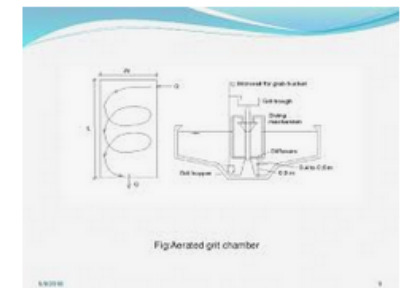
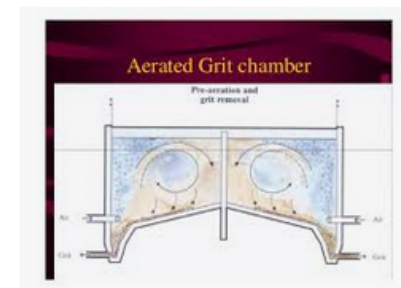
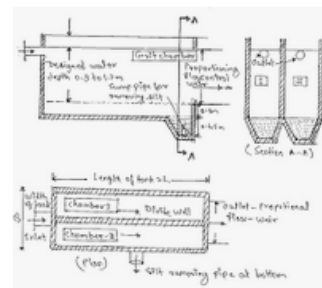
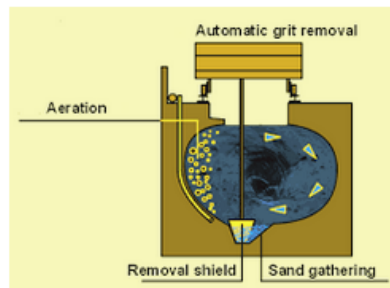
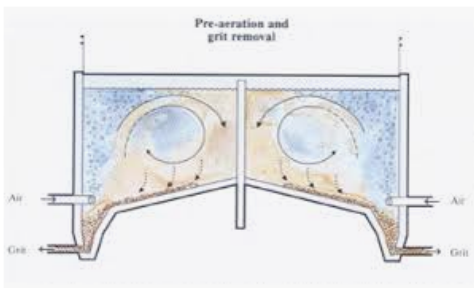
AquaNES DSS - Grit Removal dss.aquanes.eu



ILIAS 3 cgi.tu-harburg.de



Pre-Treatment Technologies | SSWM ... sswm.info



chamber

headcell

aerated grit chambers

hydro international

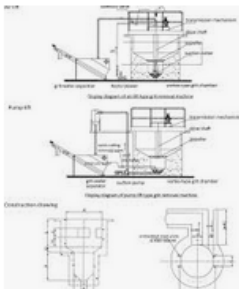
pista

sewage treatment plant

sgs ce

wastewater treatment

classifier



XLC Vortex-type Grit... en.benenv.com



Vortex Grit Removal Syste... jsboeep.en.made-in-china.co...



China Wastewater Vortex G... jsboeep.en.made-in-china.com



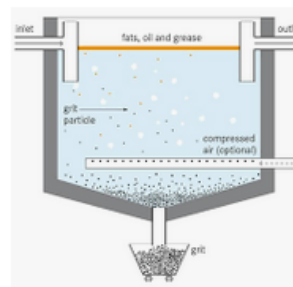
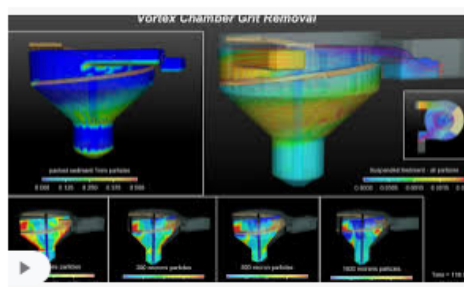
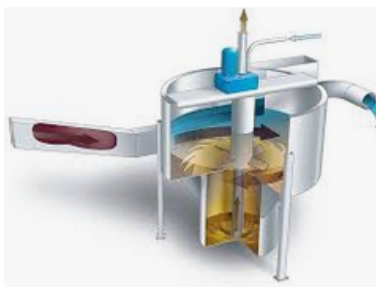
XLC Vortex-type Grit Removal | Prod... en.benenv.com



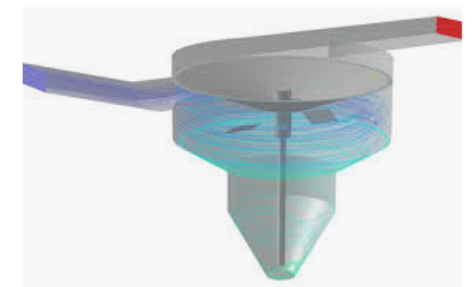
Vortex Grit Removal System | Aguas... indiamart.com



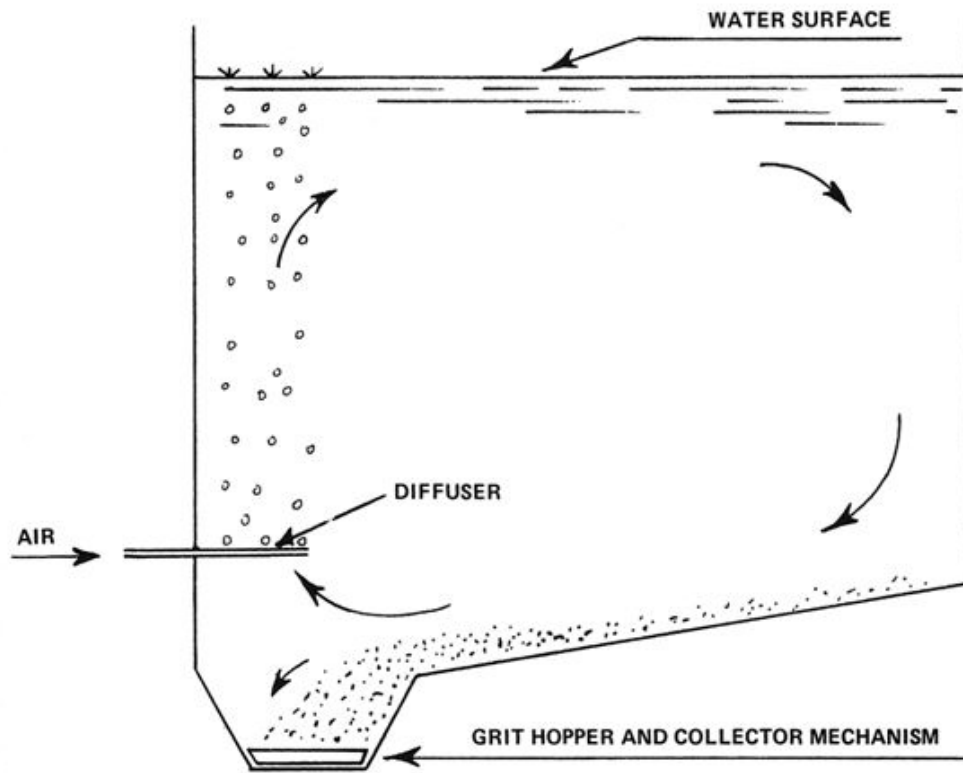
China Industrial Wastewat... jsboeep.en.made-in-china.com



Fluidyne Aircirc™ circulating jet
Recent studies and data from operating plants indicate as much as 50% or more of the inorganic material contained in domestic sewage is fine material (particle size less than 250 microns) and not removed by conventional grit removal systems. The removal of this fine material through the use of the Fluidyne Hydro-Grit™ has numerous advantages in modern treatment plants.
The high-efficiency Hydro-Grit™ takes maximum advantage of the principle of subcyclic separation through a combination of forced and free vortex along with gravity. The Hydro-Grit™ consists of the free-standing grit vortex chamber with support legs, Aircirc™ cleaning system, air-liquid separation unit, circulating jet motive nozzle, grit pump, blower station and automatic control panel.



Aerated grit chambers



NOTE:

Aerated grit chambers often have agitation air systems in the grit hopper to prevent compaction of grit when grit removal is intermittent.

Image source:

https://images.slideplayer.com/19/5731767/slides/slide_5.jpg

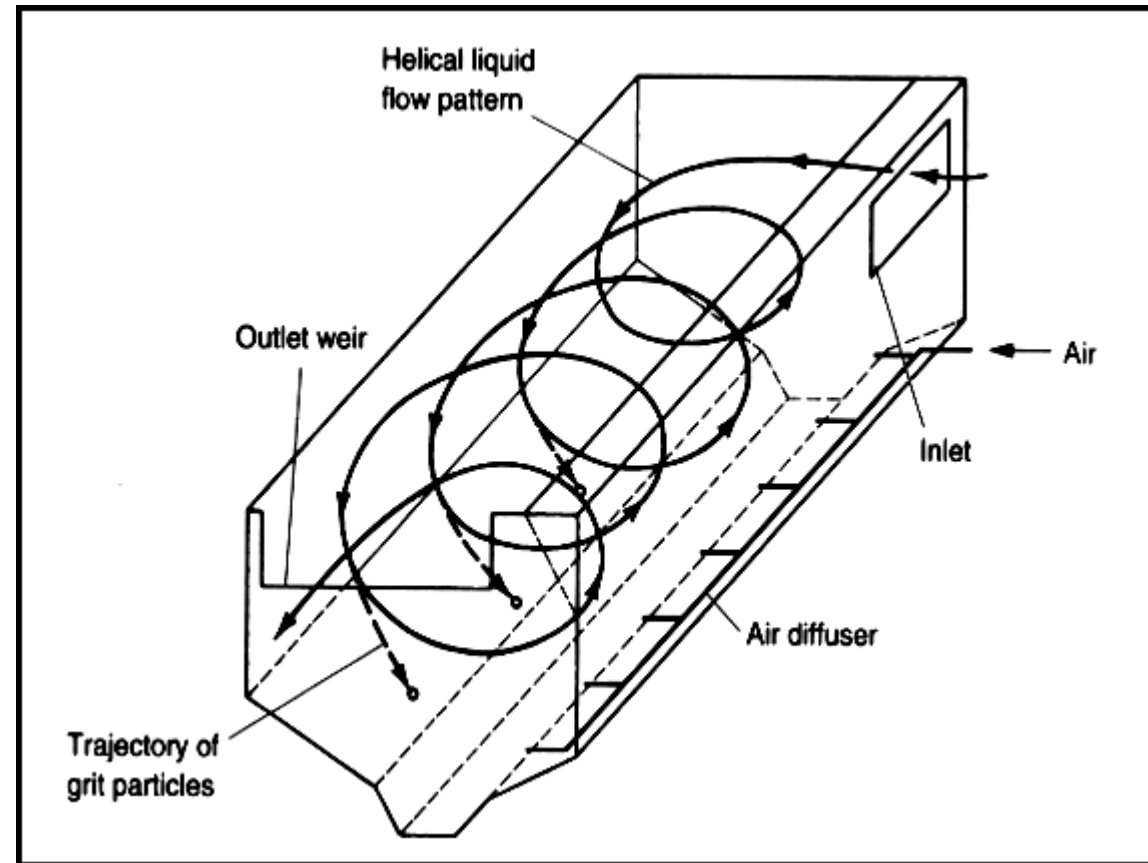


Image source: Crites and Tchobanoglous, 1998

Adapted from

EPA: Wastewater Technology Fact Sheet - Screening and Grit Removal

Vortex type grit chambers

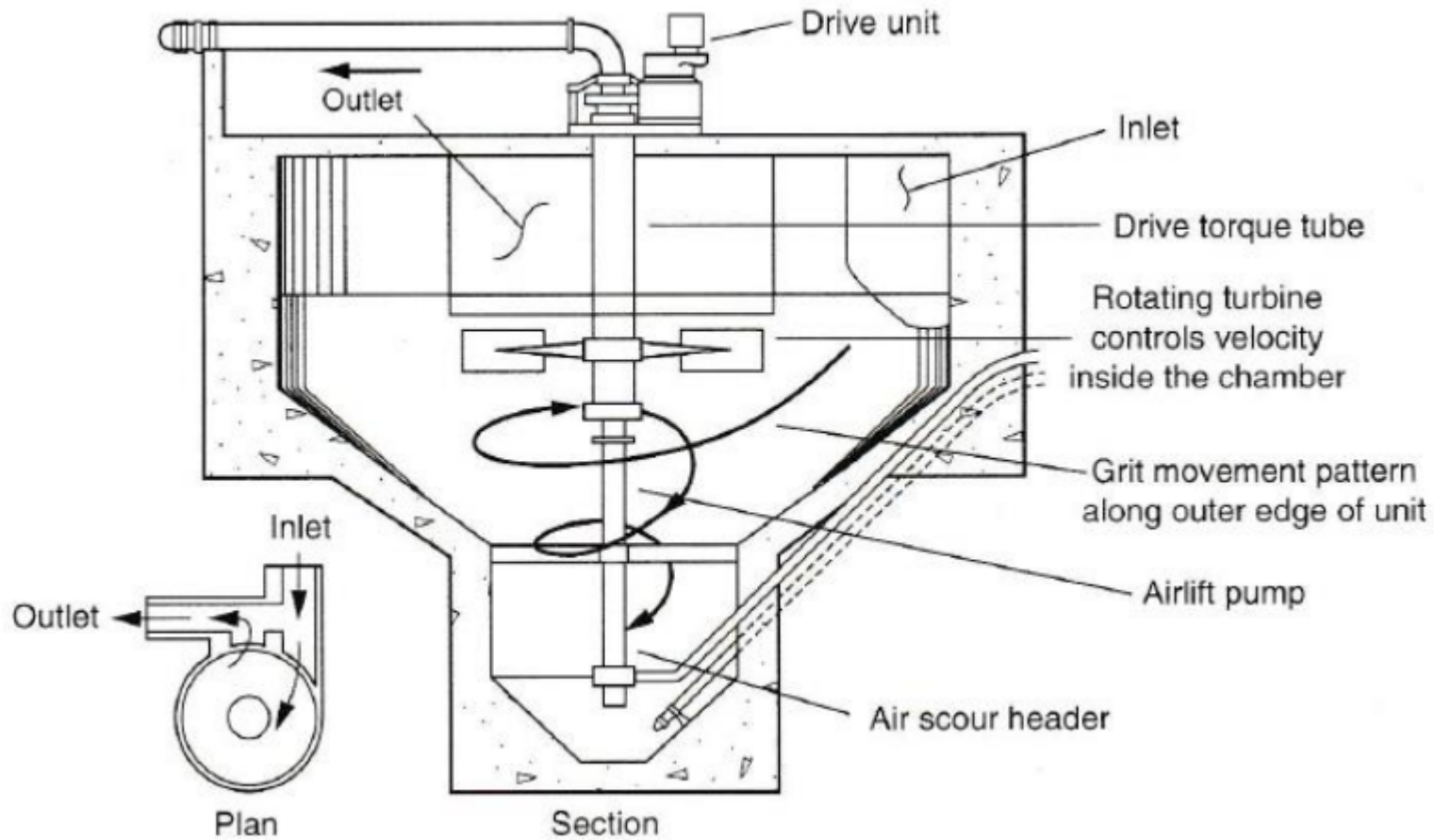


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Vortex type grit chambers

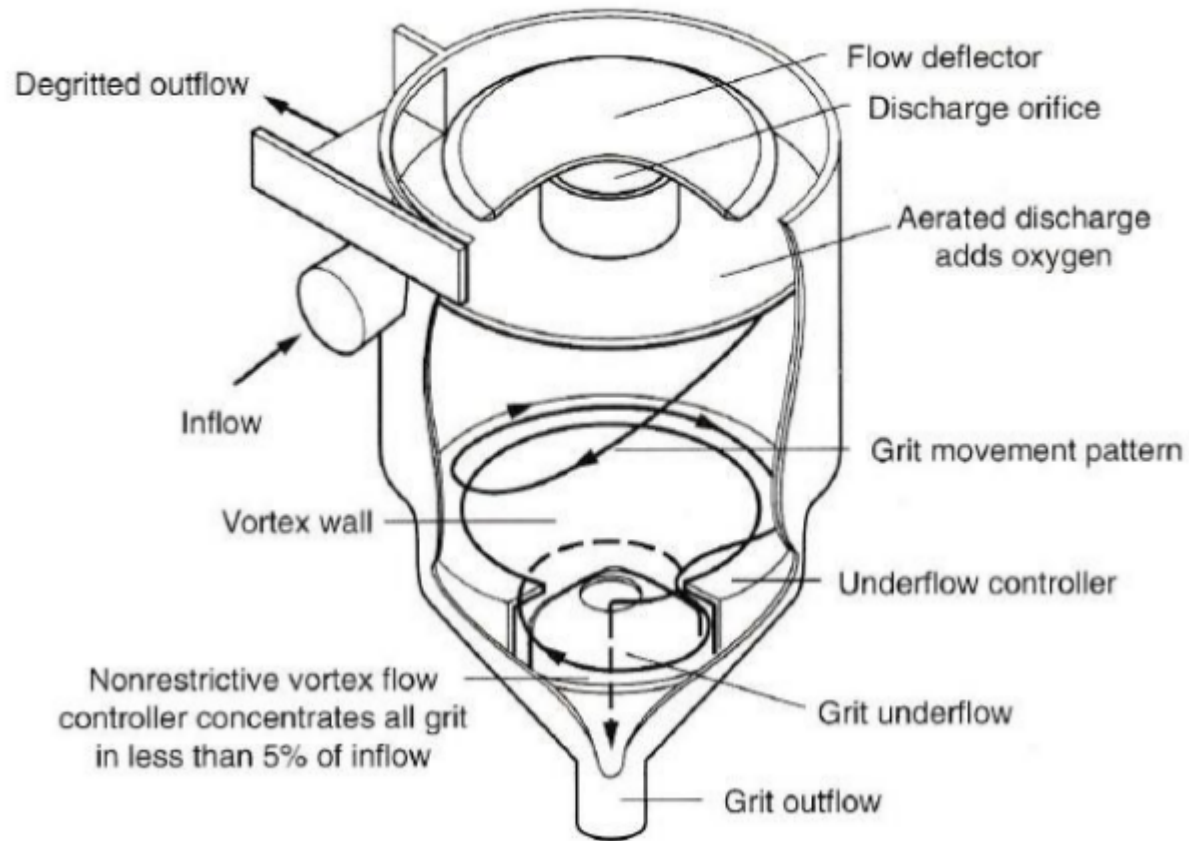


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Detritus tanks

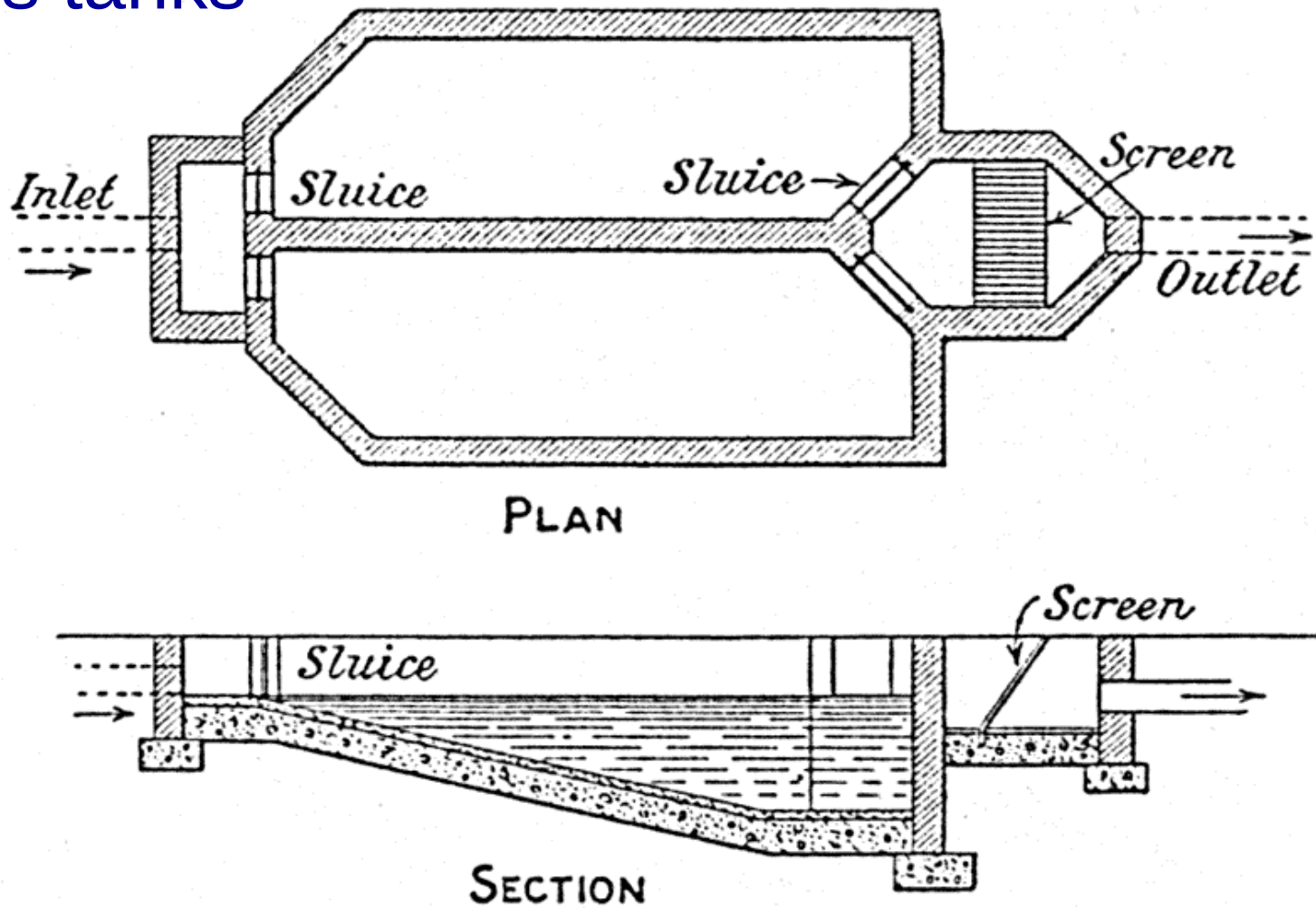


FIG. 1.—Detritus Tank.

Design for detritus (grit) tank, circa 1910. J. T. Brown, W. H. Maxwell, editors, "Sewage Disposal," The Encyclopaedia of Municipal and Sanitary Engineering (New York: D. Van Nostrand Company, 1910), p. 399.

Image Source: <http://www.sewerhistory.org/photosgraphics/sewage-treatment/>

Horizontal flow grit chambers

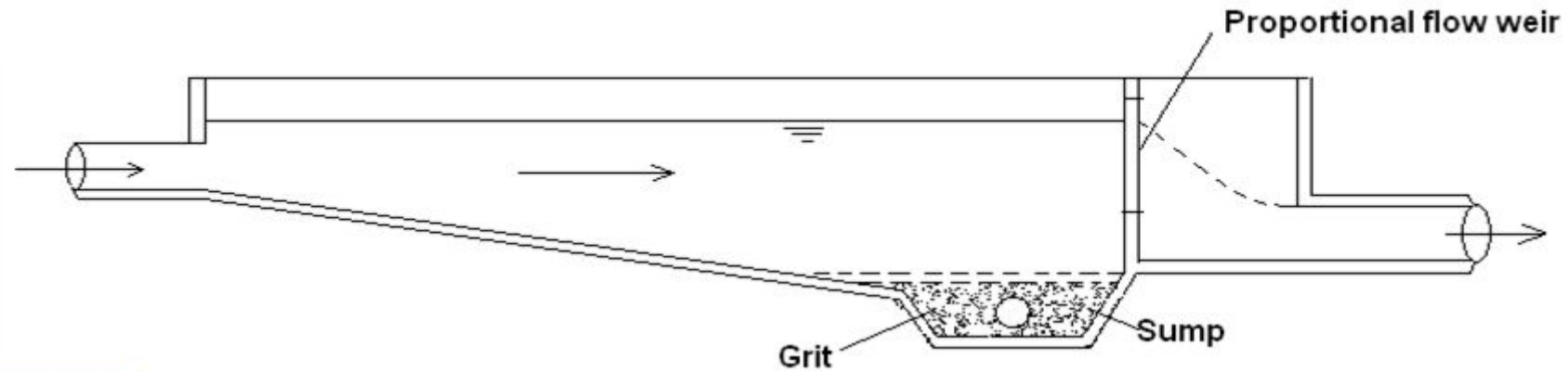
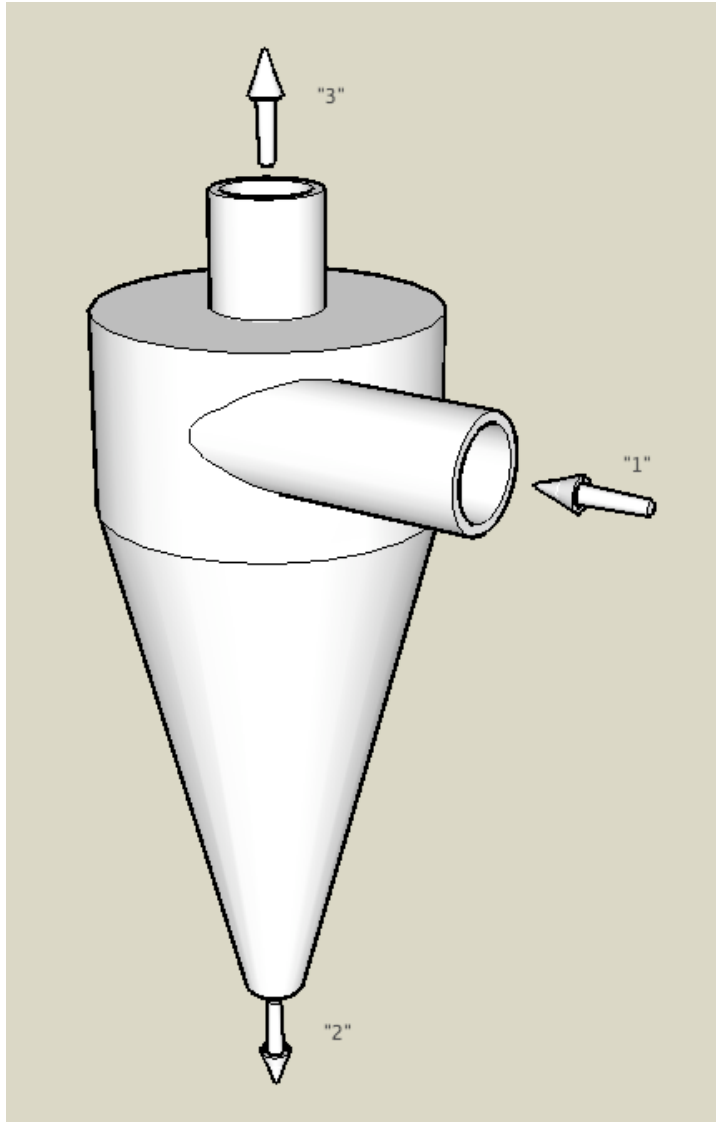
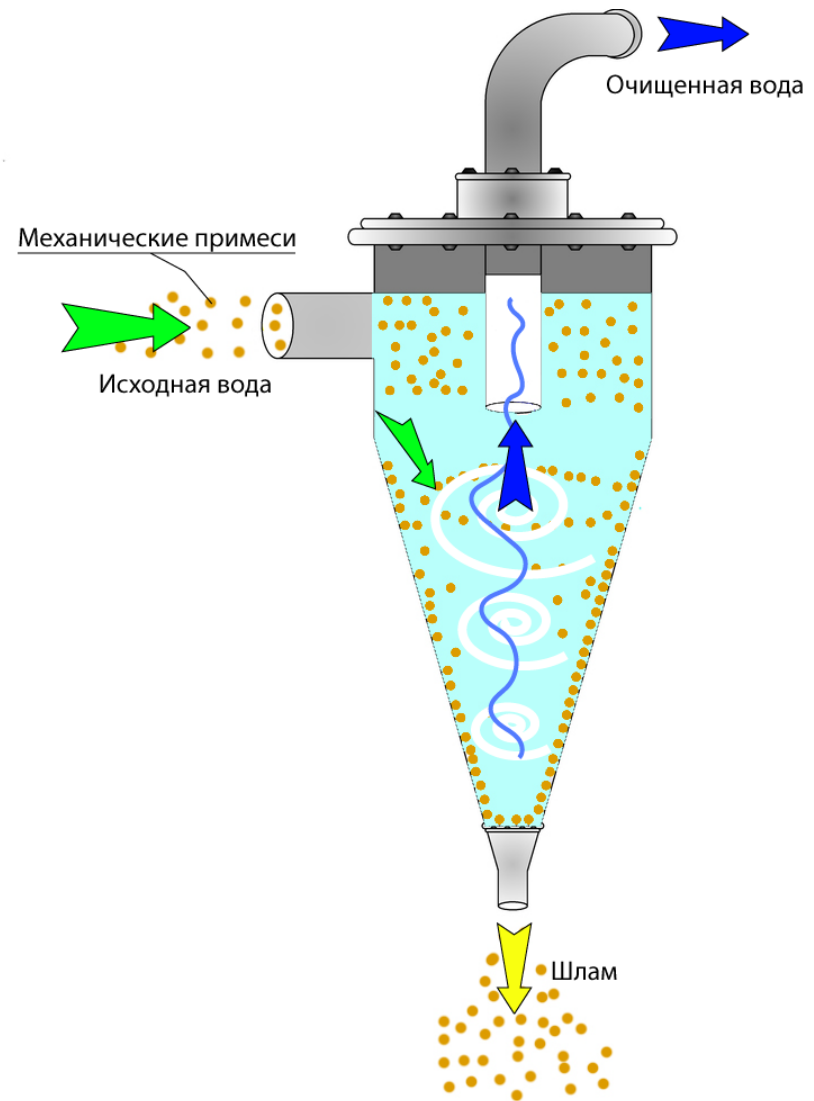


Image source: <https://slideplayer.com/slide/3819742>

Hydrocyclones



<https://en.wikipedia.org/wiki/Hydrocyclone>



https://prom-water.ru/en/catalog/industrial_water_treatment_systems/water_treatment_hydrocyclones/

Mathematical Problems:

Example 5-1 (Peavy p 222-223)

A grit chamber is designed to remove particles with a diameter of 0.2 mm, specific gravity 2.65. Settling velocity for these particles has been found to range from 0.016 to 0.022 m/s, depending on their shape factor. A flow-through velocity of 0.3 m/s will be maintained by a proportioning weir. Determine the channel dimensions for a maximum wastewater flow of 10,000 m³/d.

Solution:

Formulae we have:

$$Q = A V$$

$$v_s = \frac{g (\rho_s - \rho_w) d^2}{18 \mu}$$

$$v_s = \frac{g (S - 1) d^2}{18 \nu}$$

Data given:

$$d = 0.2 \text{ mm}$$

$$S = 2.65$$

$$v_s = 0.016 \sim 0.022 \text{ m/s}$$

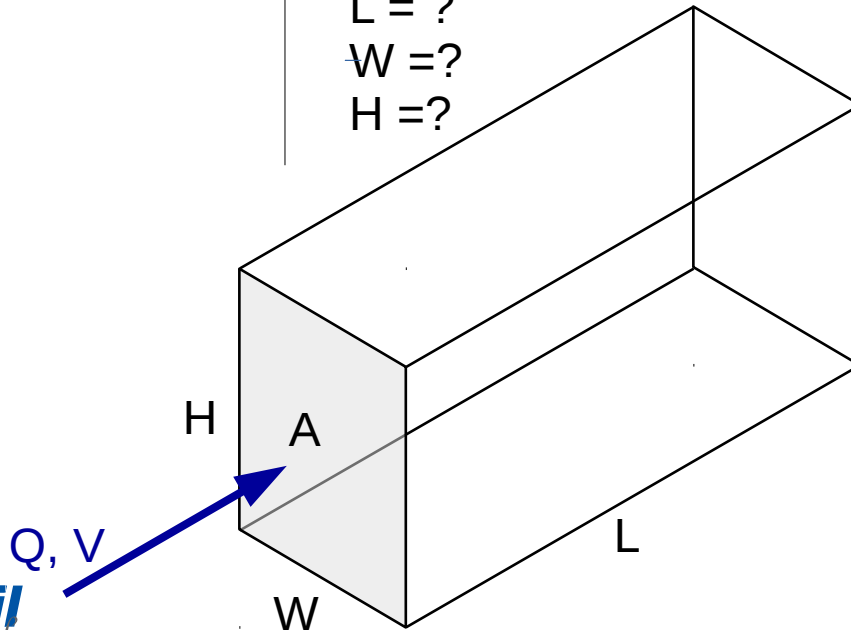
$$V = 0.3 \text{ m/s}$$

$$Q = 10000 \text{ m}^3/\text{d}$$

$$L = ?$$

$$W = ?$$

$$H = ?$$



Solution:

$$1. \text{ Let, } H = 1.5 W$$

$$A = WH = 1.5 W^2$$

$$Q = A V$$

$$A = \frac{Q}{V} = \frac{10000 \text{ m}^3/\text{d}}{0.3 \text{ m/s}} = \frac{10000 \text{ m}^3/\text{d} \times \frac{1}{86400 \text{ s/d}}}{0.3 \text{ m/s}}$$

$$= \frac{10000}{86400 \times 0.3} \frac{\text{m}^3}{\text{d}} \frac{\text{d}}{\text{s}} \frac{\text{s}}{\text{m}} = 0.386 \text{ m}^2$$

$$W = \sqrt{\frac{A}{1.5}} = \sqrt{\frac{0.386}{1.5}} = 0.507 \text{ m}$$

$$H = 1.5 \times 0.507 = 0.761 \text{ m}$$

$$2. \text{ Assume, } V_s = 0.02 \text{ m/s}$$

$$t_H = \frac{H}{V_s} = \frac{0.761 \text{ m}}{0.02 \text{ m/s}} = 38 \text{ s}$$

$$3. \text{ Length, } L = V t_H = 0.3 \text{ m/s} \times 38 \text{ s} = 11.4 \text{ m}$$

Ans. L = 11.4 m, W = 0.507 m, H = 0.761 m

Mathematical Problems:

Example 5-2 (Davis p 366-367)

Will a grit particle with a radius of 0.10 mm and a specific gravity of 2.65 be collected in a horizontal grit chamber that is 13.5 m in length if the average grit-chamber flow is 0.15 m³/s, the width of the chamber is 0.56 m, and the horizontal velocity is 0.25 m/s? The wastewater temperature is 22°C.

Solution:

Formulae we have:

$$Q = A V$$

$$v_s = \frac{g (\rho_s - \rho_w) d^2}{18 \mu}$$

$$v_s = \frac{g (S - 1) d^2}{18 \nu}$$

Data given:

$$d = 0.20 \text{ mm}$$

$$S = 2.65$$

$$L = 13.5 \text{ m}$$

$$W = 0.56 \text{ m}$$

$$H = ?$$

$$Q = 0.15 \text{ m}^3/\text{s}$$

$$V = 0.25 \text{ m/s}$$

$$V_s = ?$$

$$T = 22^\circ\text{C}$$

Solution:

$$1. \text{ For, } T = 22^\circ\text{C, } \nu = 0.959 \times 10^{-6} \text{ m}^2/\text{s} \Rightarrow y = y_1 + (y_1 - y_2) \frac{x - x_1}{x_1 - x_2}$$

[from water property table]

$$\Rightarrow v_{22} = 1.003 + (1.003 - 0.893) \frac{22 - 20}{20 - 25}$$

$$= 0.959$$

$$v_s = \frac{g (S - 1) d^2}{18 \nu}$$

$$= \frac{9.81 (2.65 - 1) \left(\frac{0.2}{1000} \right)^2}{18 \times 0.959 \times 10^{-6}} = 0.0375 \text{ m/s}$$

$$2. A = \frac{Q}{V} = \frac{0.15 \text{ m}^3/\text{s}}{0.25 \text{ m/s}} = 0.60 \text{ m}^2$$

$$A = W \times H \Rightarrow H = \frac{A}{W} = \frac{0.60}{0.56} = 1.07 \text{ m}$$

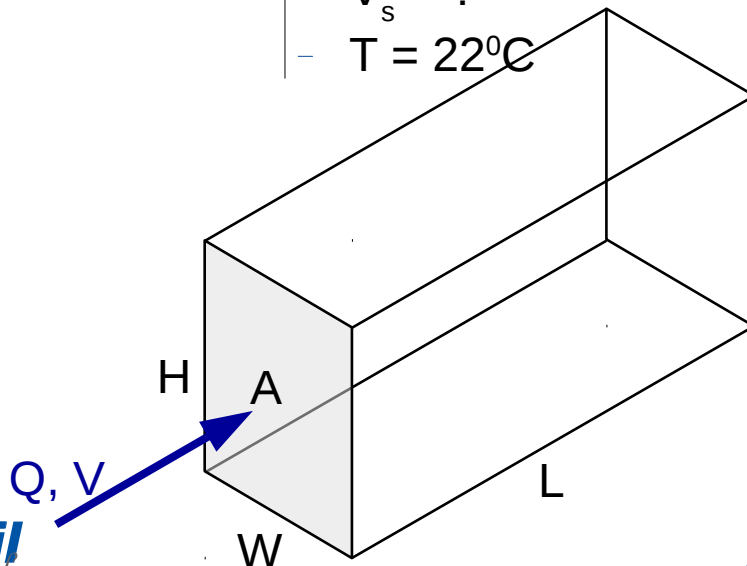
3. Maximum time needed to settle (from surface to bottom)

$$t = \frac{1.07 \text{ m}}{0.0375 \text{ m/s}} = 28.5 \text{ s}$$

4. Time required to travel the whole length (L = 13.5 m)

$$t' = \frac{13.5 \text{ m}}{0.25 \text{ m/s}} = 54 \text{ s} > 28.5 \text{ s, the particle settles}$$

Ans. Yes, the particles will be collected in grit chamber.



Necessary Data / Table

Physical properties of Water (SI units)							
Temperature t °C	Specific weight γ kN/m ³	Density ρ kg/m ³	Modulus of elasticity $E/10^6$ kN/m ²	Dynamic Viscosity $\mu \times 10^{-3}$ N-s/m ²	Kinematic Viscosity $\nu \times 10^{-6}$ m ² /s	Surface tension σ N/m	Vapor pressure p_v kN/m ²
0	9.805	999.8	1.98	1.781	1.785	0.0765	0.61
5	9.807	1000.0	2.05	1.518	1.519	0.0749	0.87
10	9.804	999.7	2.1	1.307	1.306	0.0742	1.23
15	9.798	999.1	2.15	1.139	1.139	0.0735	1.70
20	9.789	998.2	2.17	1.002	1.003	0.0728	2.34
25	9.777	997.0	2.22	0.890	0.893	0.072	3.17
30	9.764	995.7	2.25	0.798	0.800	0.0712	4.24
40	9.730	992.2	2.28	0.653	0.658	0.0696	7.38
50	9.689	988.0	2.29	0.547	0.553	0.0679	12.33
60	9.642	983.2	2.28	0.466	0.474	0.0662	19.92
70	9.589	977.8	2.25	0.404	0.413	0.0644	31.16
80	9.530	971.8	2.2	0.354	0.364	0.0626	47.34
90	9.466	965.3	2.14	0.315	0.326	0.0608	70.10
100	9.399	958.4	2.07	0.282	0.294	0.0589	101.33

Some web references for further study

<https://www.aboutcivil.org/grit-chambers-types>

<https://en.wikipedia.org/wiki/Hydrocyclone>

Use search engines like

<https://duckduckgo.com/>

Or

Google

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