EWCE 333
Wastewater Engineering and Sanitation

Lecture 9

Instructor

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Lecture Outline

Topics	Reference
• **Preliminary treatment methods –** ✓ **Screening** ✓ **Grit chambers** ✓ **Cutting screen or comminutors** ✓ **Skimming tank** ✓ **Pre-aeration** ✓ **Flow equalization**	**Water Supply and Sanitation** - **Feroz Ahmed and Mujibur Rahman** ITN -BUET

Purpose of Preliminary Treatment

- To remove large floating objectives such as rags, pieces of wood, kitchen refuse and heavy materials like sand and clay
- To protect the equipment used in the subsequent stages of treatment
- To prevent formation of scum in settling and aeration tanks and
- To prevent clogging sprinkler-nozzle, or on the surface of trickling filter, pumping machineries and siphons etc.

Preliminary Treatment Methods

(a) Screening

(b) Grit chambers

(c) Cutting screen or comminutors

(d) Skimming tank

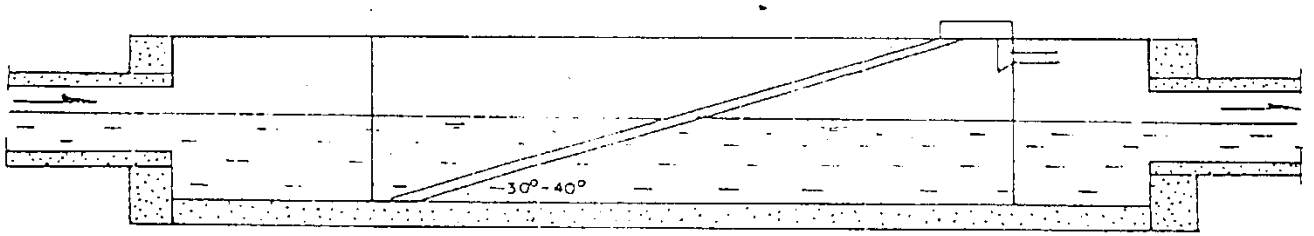
(e) Pre-aeration

(f) Flow equalization

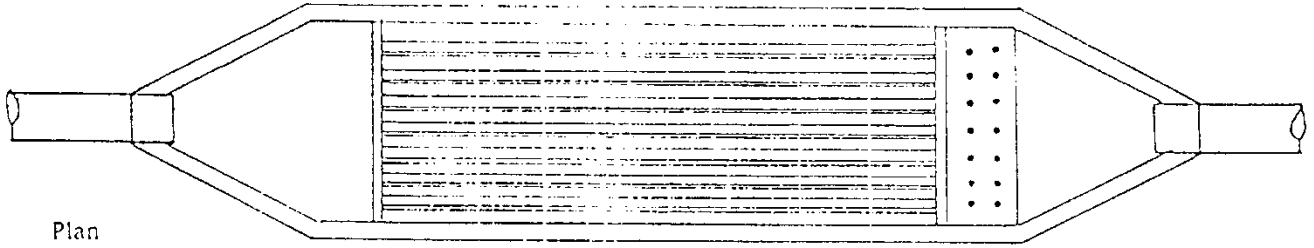
Screening

- Coarse solids are removed by a series of closely spaced mild steel bar placed across the flow.
- The bars are intended to remove only fairly large suspended solids.
- Minimum velocity through the screen - 0.3 m/s, to prevent the deposition of grit
- Maximum velocity - 1 m/s, so that the solids already trapped on the screen are not dislodged.
- The velocity is generally restricted to 0.6 m/s in order to prevent grit deposition and dislodgement of screenings.

Preliminary Treatment - Screening



Sectional Elevation



Plan

Figure:1 Bar Screen





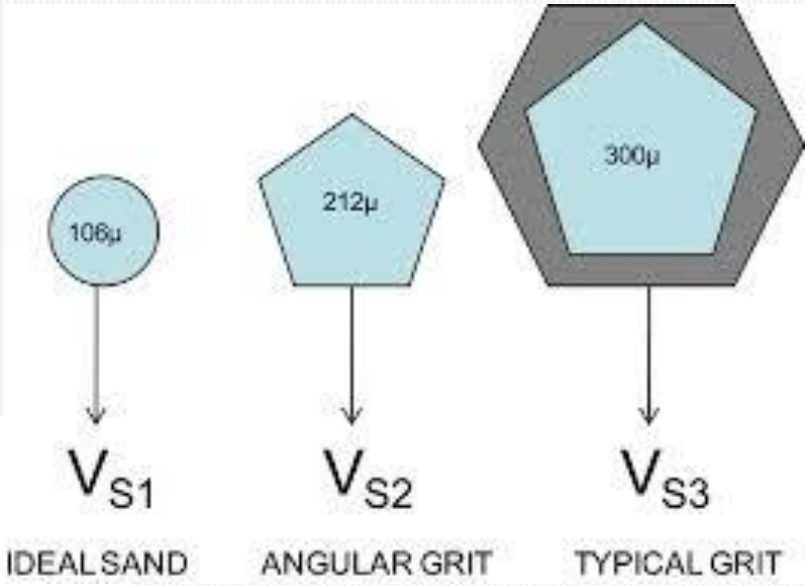
Disposal of Screening

- Screenings are particularly obnoxious in both appearance and content and should be disposed off as soon as possible.
- For small works – Burial in a small piece of land
- At larger works – either dewatered in a hydraulic press and then incinerated, or macerated (softened) in a disintegrator and then returned to sewage flow under the screens.

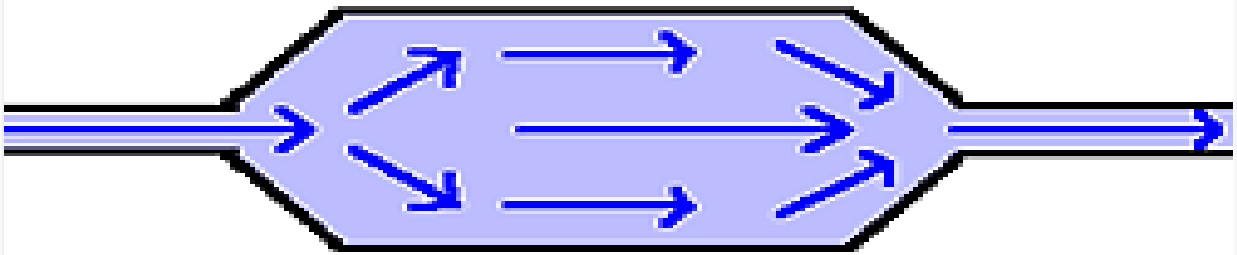
Grit Chambers

- Grit (also called detritus) is the heavy inorganic fraction of sewage solids.
- It includes road grit, sand, eggshells, ashes, charcoal, glass and pieces of metal
- It may also contain some heavy organic matter such as seeds, coffee grounds, etc.
- Grit has an average relative density of about 2-5 and thus has a much higher settling velocity than organic sewage solids (about 30 mm⁄s as against of 3 mm⁄s).

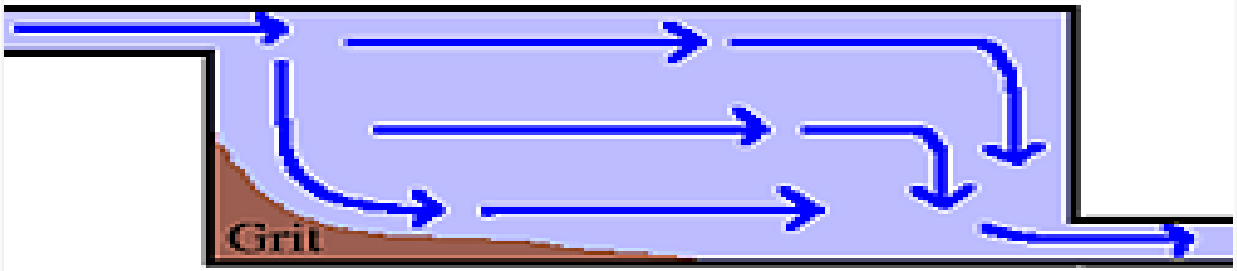
Grit Chamber

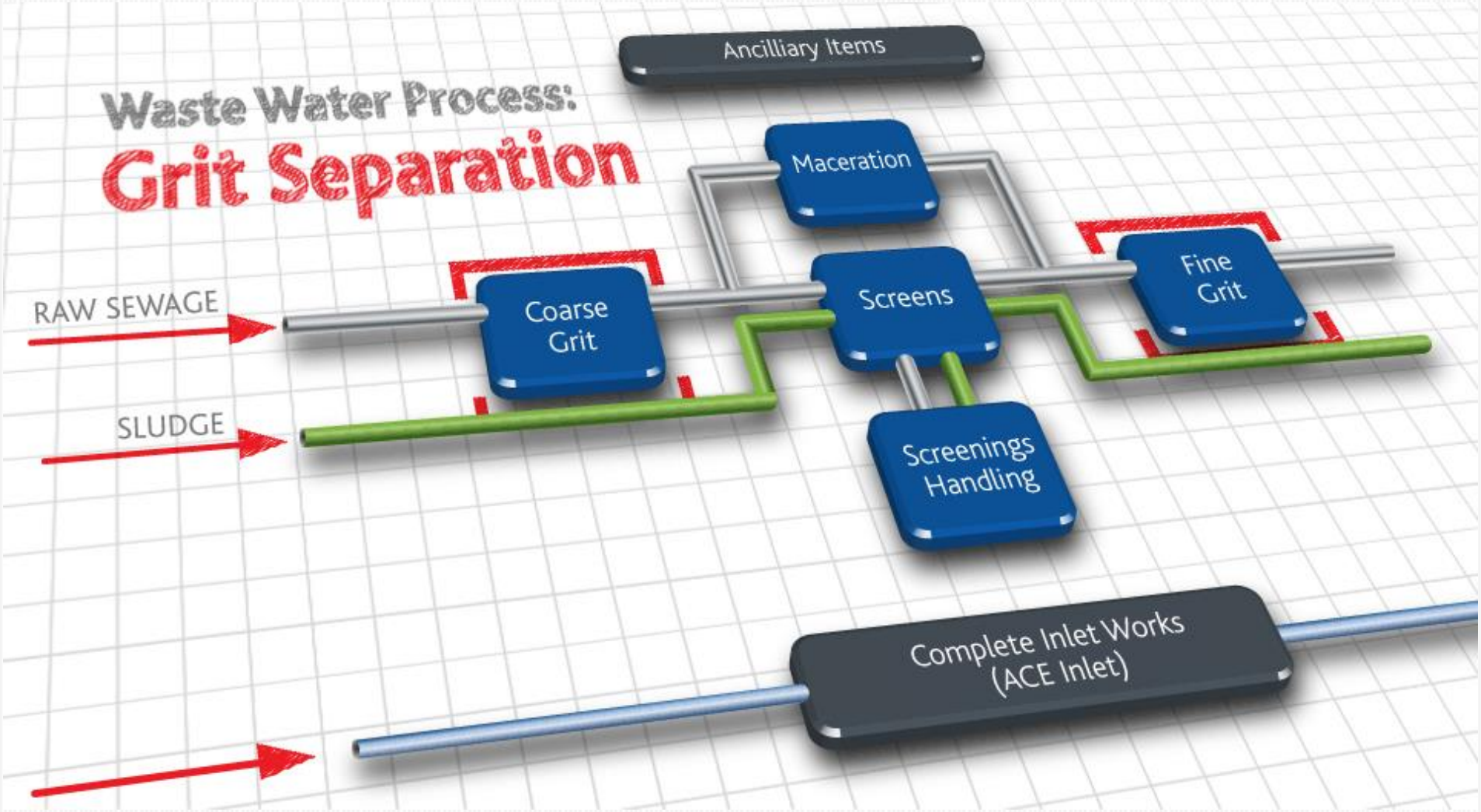


From above:



From the side:




Waste Water Process:
Grit Separation
Ancilliary Items
Maceration
Coarse Grit
Screens
Fine Grit
RAW SEWAGE
SLUDGE
Screenings Handling
Complete Inlet Works (ACE Inlet)

Grit Removal Plants

1. Constant velocity grit channel

- A constant velocity of about 0.3 m⁄s is maintained
- At this velocity, grit particles settle out but organic solids do not
- The geometry of the channel is such that its cross-sectional area is proportional to the flow and hence the velocity of the flow will be constant throughout the channel at all flows.

Constant Velocity Grit Channel



Feed inlet

Recirculation pipe

Inclined grit auger removed for transit

Grit collection box

Grit horizontal auger drive counter flow

Grit Removal Plants

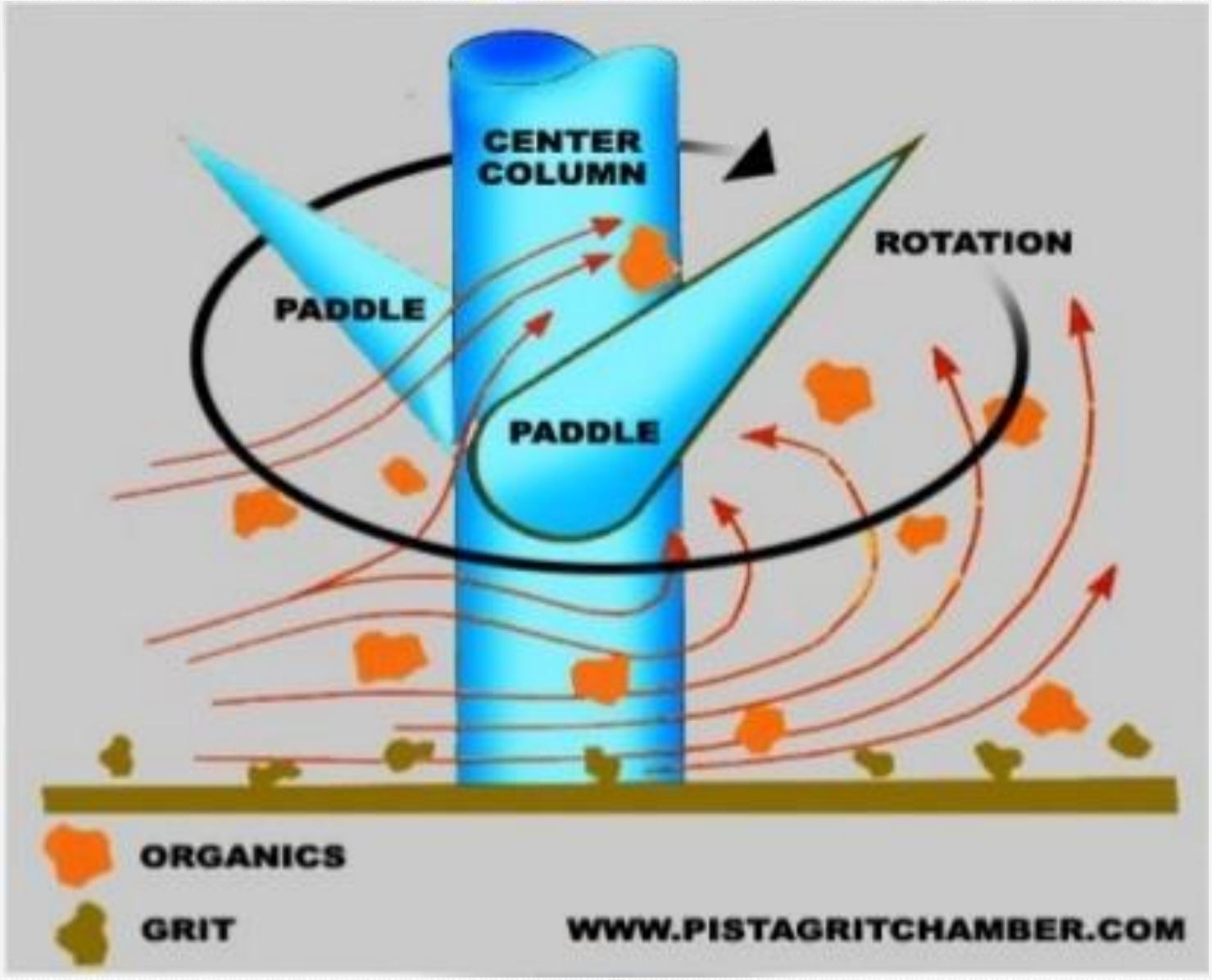
2. Propriety tanks or traps

- For flows > 5000 m^3/d proprietary grit separators are often more economical than several long constant-velocity grit channels.

- The most common type is a settling tank of sufficiently short retention time to allow the grit, but not the organic solids, to settle out.

- One of the simplest grit trap is the Jones & Attwood ‘Pista’ grit trap, where no moving parts come in contact with the grit and that the grit is automatically cleaned before discharge.

Grit Removal Plants - Propriety Trap



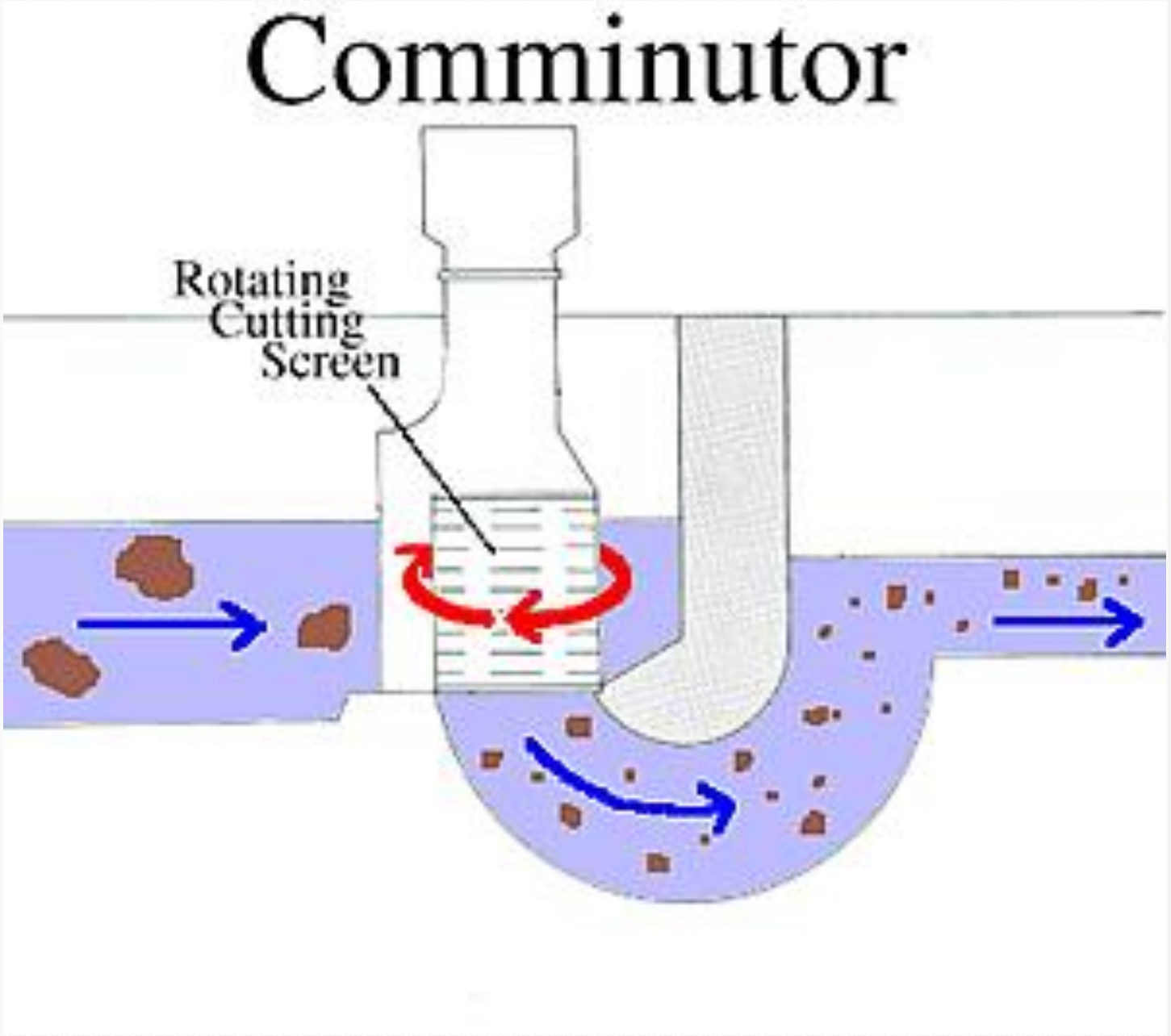
Grit Disposal

- The quantity of grit collected may be as high as 0.17 m^3 / l000 m^3 of sewage, although the average figure is 0.05-0.10 m^3/1000 m^3.
- The grit is either used for landfill or disposed of by burial.

Cutting Screen/ Comminutors

- A comminutor is a self-cleansing shredding machine.
- Instead of removing large suspended solids, comminutors reduce them in such size so that they will not interfere with other treatment processes.
- The comminutor consist of a hollow cast-iron drum, which is a screen with 6-8 mm horizontal slots on which cutter bars and a large number of projecting cutting teeth are fixed. The bars and teeth engage with stationary steel combs.

Comminutor



Cutting Screen/ Comminutors

- Comminutors avoid the problems associated with the handling and disposal of screenings and for this reason they are popular with plant operators.

- Grit can damage the cutting teeth and to avoid this occurring comminutors should be located downstream of grit channels or traps.

Skimming Tank

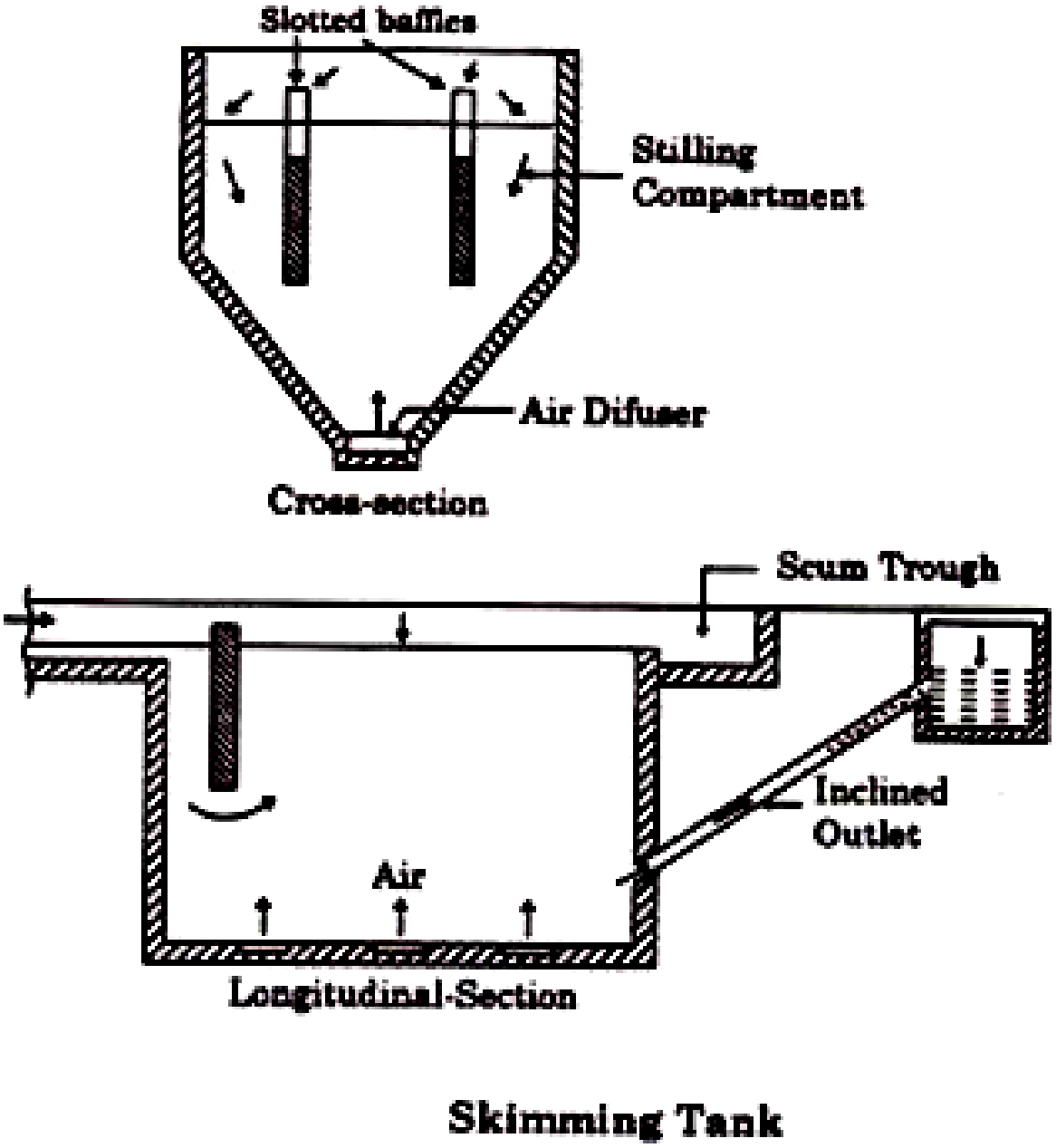
Principle:

- Floating efficiency can be promoted by introducing finely divided air bubbles at the bottom of the tank through skimming device.

- A skimming tank generally includes an aerating device which blows air through the sewage at a rate about 0.1 cft of air per length of sewage.

- The raising air tends to coagulate the grease and oils and cause them to rise to the surface where they can be removed easily either by hand or mechanically.

Aerated Skimming Tank



Skimming Tank

Skimming Tank

Design Criteria:

- Plain skimming tanks are commonly designed on the basis of overflow rate **(Q/A)** with the surface area as the desire factor.

- To avoid turbulence and bottom scour, these tanks are designed as long narrow trough shaped structure with a high velocity of horizontal flow.

- The depth is commonly between 1- 2 m.

Skimming Tank

Design Criteria:

- Short detention period of 300 to 500 sec and high velocity of horizontal flow are commonly preferred to avoid solid deposition at tank bottom and flocculation (when necessary) is promoted by the addition of chemicals such as iron and aluminum salts.

- In case settling cannot be prevented entirely, removal of detritus must be incorporated in the flotation process by equipping the unit with sludge removal facilities.

Skimming Tank

Design Criteria:

- An aerated skimming tank is shown in the above figure, where vertical baffles separate the tank into a central aerated channel and two lateral stilling chambers in which oil and greases gather at the surface.

- Settleable matter slides back into the central channel where it is re-suspended and moved forward till it ultimately reaches the inclined outlet from the tank.

Pre-aeration

- Aeration will strip volatile compounds
- Increase dissolved oxygen content

Preaeration of sewage prior to primary treatment may often provide a number of advantages as follows:

✓ Grease removal may be modestly improved

✓ A degree of flocculation may occur.

✓ Solids will remain in uniform suspension.

✓ BOD will be reduced.

✓ Odor from septic sewage will be reduced.

Flow Equalization

- Reduce the fluctuations in wastewater flow.
- Delivering the flow to treatment processes at a constant rate, which would make the system more efficient

Applications of Preliminary Treatment Methods

- All treatment processes, with the exception of septic tanks and household systems, require some sort of preliminary or screening process to remove large and floatable objects.
- For mechanically intensive wastewater treatment systems, screening and grit removal are strongly recommended.

Applications of Preliminary Treatment Methods

- Grit removal is not necessary in most natural systems, but should be considered in highly mechanized wastewater treatment systems to prolong equipment life.
- The presence of a significant amount of grit in wastewater quickly wears down pumps and other mechanical equipment.