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GRIT REMOVAL & TREATMENT
for Sustainable Grit Recycling

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Need for Preliminary Treatment?

- Wastewater contains large solids and grit that can interfere with treatment processes or cause undue mechanical wear and increased maintenance on wastewater treatment equipment.

- To minimize potential problems, these materials require separate handling.

- Preliminary treatment removes these constituents from the influent wastewater and protect the operation of the wastewater treatment plant.

- Unwanted constituents are removed from wastewater by using various devices and processes.
Preliminary treatment devices are designed to:

- Remove or to reduce in size the large, entrained, suspended or floating solids. These solids consist of pieces of wood, cloth, paper, plastics, garbage, etc. together with some fecal matter.
  - Various types of screens are used for this.

- Remove heavy inorganic solids such as sand and gravel as well as metal or glass. These objects are called grit.
  - Various types of Grit Removal devices are used for this.

- Remove excessive amounts of oils or greases.
  - Various types of oil/ grease removal devices are used for this.
What Is Grit?

- Sand and silt particles (mostly)
- Cinders
- Fragments of egg shells
- Bone chips
- Coffee grounds
- Shredded garbage
What Is Grit?

Untreated, unwashed grit from a wastewater treatment plant
Why to remove Grit?

• For reasons of operating reliability of wastewater treatment plants it is necessary to separate the grit transported with the wastewater and other mineral materials from the digestable organic material.

• While small in volume, it is desirable to remove grit, because solids cause operational problems such as:

  - they plug, wear out, and break pumps and other mechanical equipment
  - they occupy space needlessly in treatment units, particularly digesters
  - they are difficult to remove from treatment units such as digesters and sedimentation tanks
  - they can clog pipes and solids dewatering equipment
  - they can produce odors
  - interfere with digestion.
Selection of Grit Removal Facilities (Grit Chambers)

• Grit Chambers typically precede primary clarification.

• Grit Chambers should follow screens. This prevents large solids from interfering with grit handling equipment.

• Grit chambers are generally designed to deposit heavy inorganic solids (having specific gravity of 2.65) but to retain organic material in suspension.

• Grit capture rate is usually tested with a grit particle size of 0.2 mm. In combined sewer systems, approximately 60 l of grit can be removed from 1,000 m³ of wastewater.
Selection of Grit Removal Processes

• When selecting a grit removal process, important considerations are -
  ➢ quantity and characteristics of grit and its potential to adversely affect downstream processes
  ➢ headloss requirements,
  ➢ Space requirements,
  ➢ removal efficiency,
  ➢ organic content, and
  ➢ economics.

• The type of grit removal system chosen for a specific facility should be the one that best balances these different considerations.
Types of Grit Chambers

- Horizontal flow Grit chambers
  - Rectangular Grit Chambers
  - Square Grit Chambers
- Aerated Grit Chambers
- Vortex Grit Chambers
- Cyclone Degritter (Hydrocyclones)
Rectangular Horizontal Flow Grit Chambers

- This is the oldest type of grit chamber.

- In the chamber, a constant horizontal velocity is maintained by proper cross-sectional geometry of the chamber.

- Length is governed by depth required by the settling velocity.

- Cross sectional area is governed by rate of flow.
Rectangular Horizontal Flow Grit Chambers

- By providing horizontal velocity and sufficient time, grit particles get settled at bottom.

- Horizontal velocity must be adequate to keep organic matter in suspension and flow with flowing water.

- Velocity is maintained between 0.23 and 0.38 m/s. Typical value is 0.3 m/s.
Rectangular Horizontal Flow Grit Chambers

Rectangular channels of Horizontal Flow Grit Chambers with grit removal mechanisms.
Rectangular Horizontal Flow Grit Chambers

The channel cross-sections are trapezoidal and grit conveyor buckets are mounted on chains driven by sprocket wheels and electric motors. Submerged conveyor buckets rake the settled grit toward the upstream end, where it is raised vertically and deposited into receptacles. The view is toward the upstream end.
Advantages of Rectangular Horizontal Flow Grit Chambers

- Rectangular Horizontal flow grit chambers are flexible because they allow performance to be altered by adjusting the outlet flow control device.

- Uniform flow distribution is possible with more number of channels

- Simple Construction and easy to built.
Disadvantages of Rectangular Horizontal Flow Grit Chambers

- It is difficult to maintain a 0.3 m/s velocity over a wide range of flows.
- The submerged chain, flight equipment, and bearings undergo excessive wear.
- Channels without effective flow control will remove excessive amounts of organic material that require grit washing and classifying.
- Head loss is excessive (typically 30 to 40 percent of flow depth).
- High velocities may be generated at the channel bottom with the use of proportional weirs, leading to bottom scour.
Square Horizontal Flow Grit Chambers – Detritus tank

- This type of grit chamber is in use for more than 60 years.
- A detritus tank (or square tank degritter) is a constant level, short detention settling tank.
- Influent is distributed over the cross section of tank by vanes/gates.
- Waste water flows across tank and overflows a weir in free discharge.
- Overflow rates are dependent on particle size and temperature of liquid.
- Solids are removed by rotating raking mechanism to a sump at the side of tank.
- From there grit is washed cleaned and pumped out.
Square Horizontal Flow Grit Chambers – Detritus tank

Schematic of square horizontal flow grit chamber. Two rakes are used to move settled grit to the periphery for removal.
Advantages of Square Horizontal Flow Grit Chambers

- Square Horizontal flow grit chambers (Detritus tanks) do not require flow control because all bearings and wearable moving mechanical parts are above the water line.

- There is minimal head loss in this type of unit.
Disadvantages of Square Horizontal Flow Grit Chambers

- Detritus tanks have difficulty achieving uniform flow distribution over a wide range of flows.

- This type of removal system removes large quantities of organic material, especially at low flows.

- In shallow installations (less than 0.9 m) the rake arm of scraping mechanism can create agitation of settled grit and again bring it into suspension.
Aerated Grit Chambers

- In aerated grit chambers, grit is removed by causing the wastewater to flow in a spiral pattern perpendicular to the flow through tank.

- Air is introduced in the grit chamber along one side, causing a perpendicular spiral velocity pattern to flow through the tank.

- Heavier particles that have higher settling velocities are accelerated and get settled at the bottom of tank, while lighter organic particles are suspended and eventually carried out of the tank.
Aerated Grit Chambers

Spiral velocity pattern of air
Aerated Grit Chambers

- **Shape of Chambers**
  - Rectangular (for medium to large treatment plants)
  - Square (for small to medium treatment plants)
  - Circular (for small to medium treatment plants)

- **Air flow rate to be adjusted so that 100% grit is removed.**

- **If velocity is too low, organic particles may be removed along with the grit**

- **If velocity is too high grit will be carried out of chamber.**

- **Grit is removed by chain-driven buckets**

- **Detention time ranges between 2 to 5 minutes and is based on the peak flowrate.**
Aerated Grit Chambers
Aerated Grit Chambers

Diagram of a grit removal system with labels for various components:
- Swing diffuser in raised position
- Aluminum pipe railings
- Swing joint
- Air main
- Monorail support
- Maximum water surface
- Upper hanger pipe
- Knee joint
- Lower hanger pipe
- Diffuser tube assembly
- Header stop
Advantages of Aerated Grit Chambers

• Consistent removal efficiency over a wide flow range.

• A relatively low decayable organic content may be removed with a well controlled rate of aeration.

• Performance of downstream units may be improved by using pre-aeration to reduce septic conditions in incoming wastewater.

• Aerated grit chambers are versatile, allowing for chemical addition, mixing, pre-aeration, and flocculation.
Disadvantages of Aerated Grit Chambers

- Potentially harmful volatile organics and odors may be released from the aerated grit chamber.

- Aerated grit chambers require more power than other grit removal processes.

- Maintenance and control of the aeration system requires additional labor.
Vortex Grit Chambers

- The vortex-type grit chamber consists of a cylindrical tank in which the flow enters tangentially, creating a vortex flow pattern.

- A constantly rotating stirrer helps support the wastewater circulation within the grit chamber maintaining a constant velocity of rotation even under dry weather conditions.

- Due to the constant radial rotation solids are very quickly collected within the centre of the grit chamber and then pass into the bottom of the grit collection tank.

- The grit-free wastewater then flows from top to next treatment step.

- Centrifugal or airlift pumps deliver the collected solids from grit collection tank into a grit classifier or grit washer where solids can be subsequently separated and dewatered and organic particles can be removed.
Vortex Grit Chambers
## Vortex Grit Chambers

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<th>270° version</th>
<th>360° version</th>
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- **270° version**: Diagram showing the flow path and design details of the chamber.
- **360° version**: Diagram showing the flow path and design details of the chamber.
Vortex Grit Chambers – 360 degree version

- Bull Gear Box
- Concrete
- Outlet
- Stirrer
- Air lift pump
- Concrete
Vortex Grit Chambers – 270 degree version

Bull Gear Box

INLET

OUTLET

concrete

FLOW

Air lift pump

stirrer
Vortex Grit Chambers

3 pc. VORMAX 270° in Al Ain/UAE; with air lift pumps
Vortex Grit Chambers
Vortex Grit Chambers
Advantages of Vortex Grit Chambers

- Remove a high percentage of fine grit
- Have a consistent removal efficiency over a wide flow range.
- The “footprint” (horizontal dimension) is small
- Headloss through a vortex system is minimal, typically 6 mm.
- Energy efficient and require less power than other systems.
- No submerged bearings or parts that require maintenance.
- Very high thorough put capacities possible.
- For small flows complete stainless steel units are available avoiding concrete constructions.
Disadvantages of Vortex Grit Chambers

• Modifications in the system are difficult at a later stage.

• Propeller blades can collect rags.
Cyclone Degritter (Hydrocyclones)

- Hydrocyclone systems are typically used to separate grit from organics in grit slurries or to remove grit from primary sludge.

- Hydrocyclones are sometimes used to remove grit and suspended solids directly from wastewater flow where grit chambers are not used.

- Heavier grit and suspended solids collect on the sides and bottom of the cyclone due to induced centrifugal forces, while scum and lighter solids are removed from the center through the top of the cyclone.
Advantages of Cyclone Degritter (Hydrocyclones)

• Can remove both grit and suspended solids from wastewater.

• Can potentially remove as many solids as a primary clarifier.

• Avoids cost of building and maintaining grit chambers.
Circular Grit Chamber – complete stainless steel construction
Horizontal grit chamber - Complete Stainless Steel construction
GRIT REMOVAL

Characteristics of Grit

• Generally, a grit is predominantly inert and relatively dry material.
• The characteristics of grit from sewer flushing and from gully and road cleaning can vary widely.
• Grit composition can highly vary with
  - Moisture content from 13 to 65 %
  - Volatile content from 1 to 56%
  - Specific Gravity ranging from 2.7 to 1.3 (typical 2.6)
  - Size of grit particles vary from 10 mm to 0.15 mm or even finer
• Grit often contains high organic material which quickly decay if not properly handled.
• Unwashed grit may contain 50% or more of organic material and has distinctly strong odor and may attract insects and rodents.
Grit Classification and Washing

- Grit classifiers and washers accomplish removal of a major part of the organic material contained in grit.

- Grit washers achieve an outstanding grit product containing less than 10% water and below 3% volatile solids.

- Equally important is that grit washers can achieve a 0.2 mm grit particle capture rate of about 95%.

- There are various types of grit classifiers and grit washers are available in the market.
Grit Classification and Washing

Typical Grit Classifier – Process of classifying and sorting solids from grit

Solids in the flow (grit particles, organic material) are separated due to the flow diversion combined with flow velocity reduction, dependent upon the particle settling velocity, and sink down to the bottom portion of tank.
GRIT TREATMENT

Grit Classification and Washing

Typical Grit Classifier and Washer combined unit

After removal of the organic material in grit washers the clean grit is removed through a classifying screw, statically dewatered and discharged into a container.
GRIT TREATMENT

General advantages of grit treatment / washing

- Organics are returned into the clarification process
- High volume, weight and disposal cost reduction
- Modern washing plants typically give approximately 40% weight reduction, up to 60% volume reduction; loss on ignition of less than 3% and an increase in dry solids (DS) to approximately 90%.

- Significantly increased hygiene:
  - in the screening room
  - during transport

- Optional grit reuse
Disposal of Grit

• The most common method is landfill
• Due to high proportion of sand and gravel-sized inorganic material, sewer grit is being used in several recycling applications.
• Untreated grit has been used as top cover / infill for pipe trenches in WWTP during construction projects.
• Grit can be added to heavy clay soils. This help break-up those soils and improve its compaction properties. It may be used in horticulture and agriculture.
• Grit has also been successfully trialled as an input material for the cement industry as an alternative source of silica rich material.
How should your grit look like in future?

like this

Untreated, unwashed grit from a wastewater treatment plant

or

like this

Treated, washed grit from a wastewater treatment plant