Screens and Grit Removal - An Introduction

Cranfield UNIVERSITY

Peter Jarvis

Screens and Grit Removal - An Introduction

Cranfield UNIVERSITY

Aim: Introduce screens and grit removal

Objective: At the end of the session you should be familiar with

- *Why screens and grit removal are needed*
- *Screen classification and types*
- *Types of grit removal systems*

Wastewater Treatment

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A typical flowsheet might include the following groups of unit operations in order:

- Preliminary Treatment
- Primary Treatment
- Secondary Treatment
- Tertiary Treatment

Wastewater treatment

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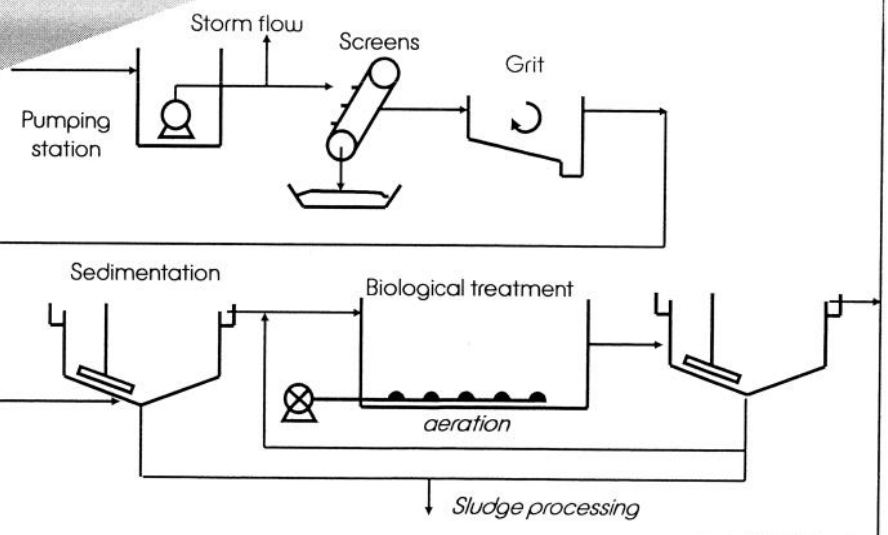

Preliminary Treatment

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Screens + Grit Removal

Removal of "gross solids"

Physical Processes

Preliminary treatment

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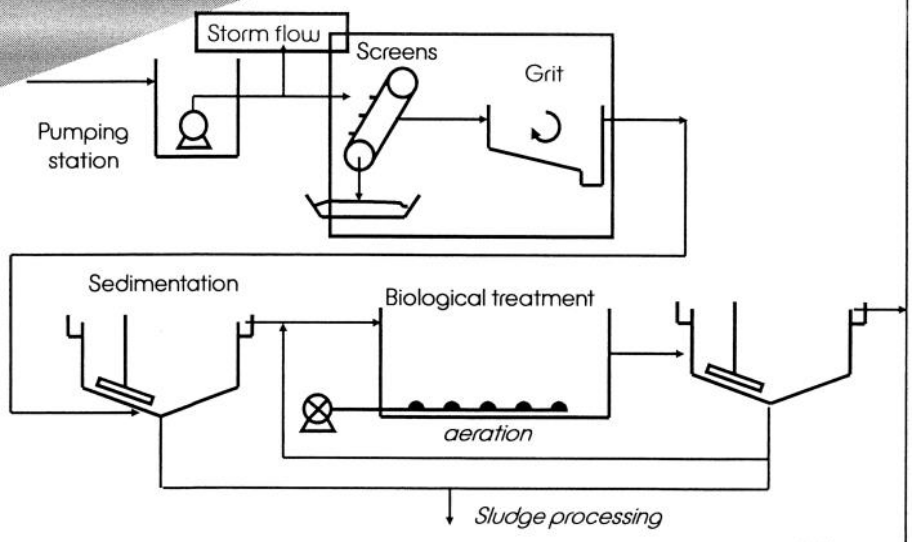

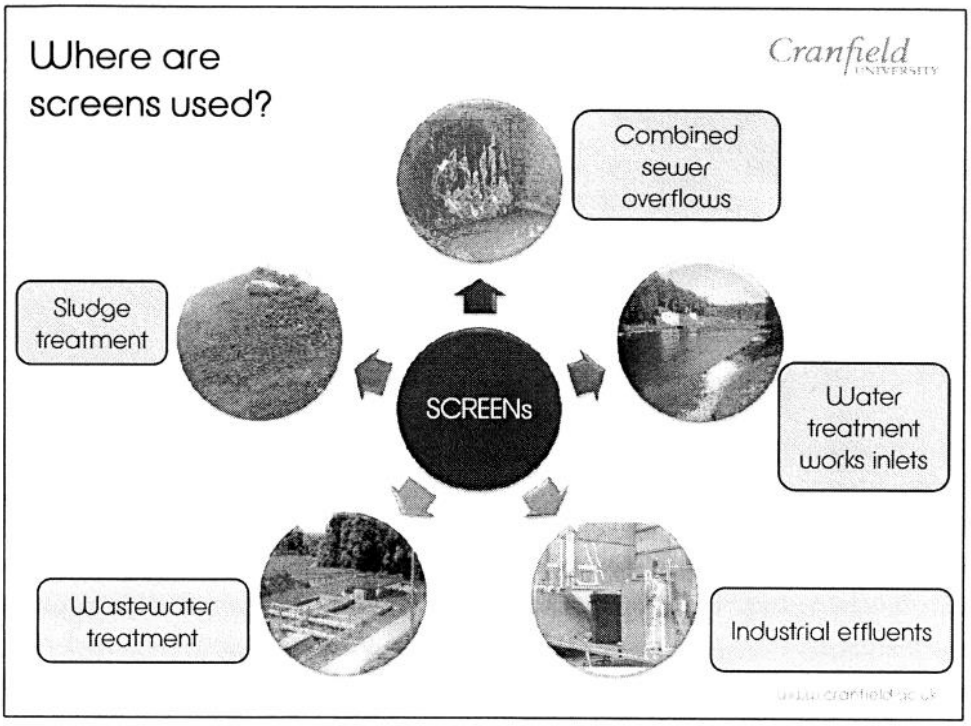
Where are screens used?
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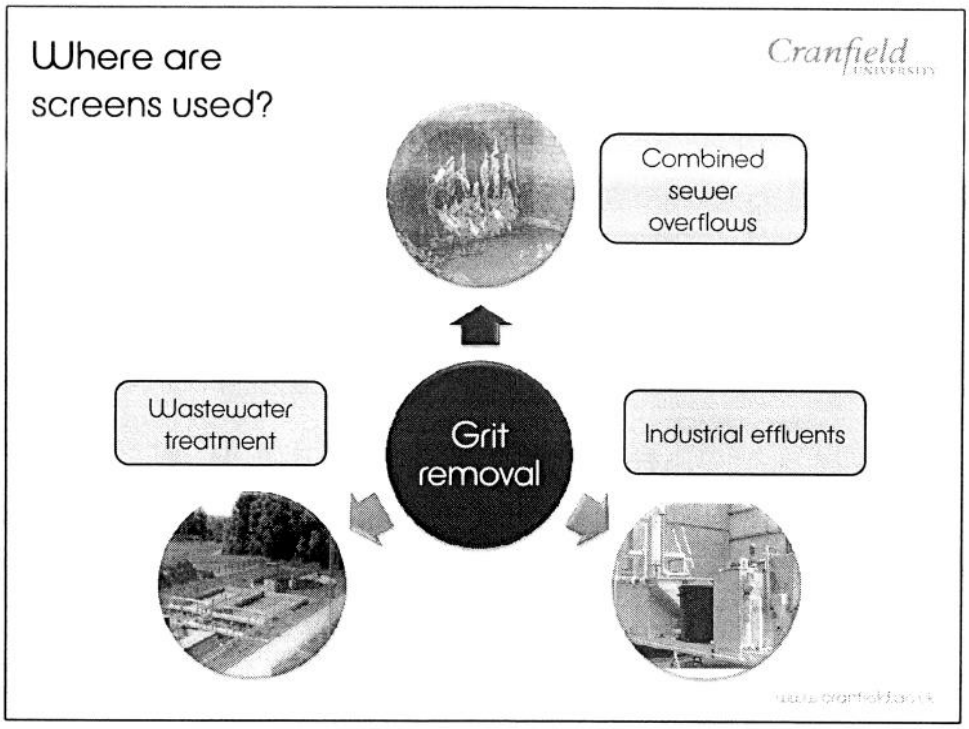
Combined sewer overflows
Sludge treatment
SCREENs
Water treatment works inlets
Wastewater treatment
Industrial effluents


Where are screens used?
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Combined sewer overflows
Wastewater treatment
Grit removal
Industrial effluents

Gross solids

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Screenings – material on screen

Large floating and suspended solids objects

Paper and rags

Wood

Cotton buds

Razor blades

Nappies

Colostomy bags

Incontinence pads

Dental floss

Condoms

Sanitary towels

Tampons

Bandages and plasters

Syringes and needles

Ladies tights

Grit

Sand dense solids glass

Screens

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Purpose

To remove gross solids to protect following treatment processes

&

No more material than is necessary should be removed at this point

Process fundamentals – Screens

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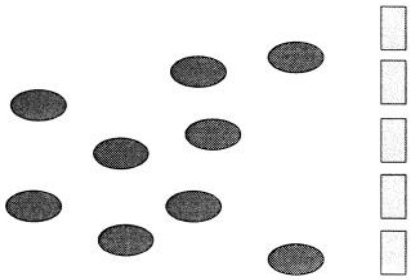

Screen must be cleaned & screenings disposed of

Screenings Handling

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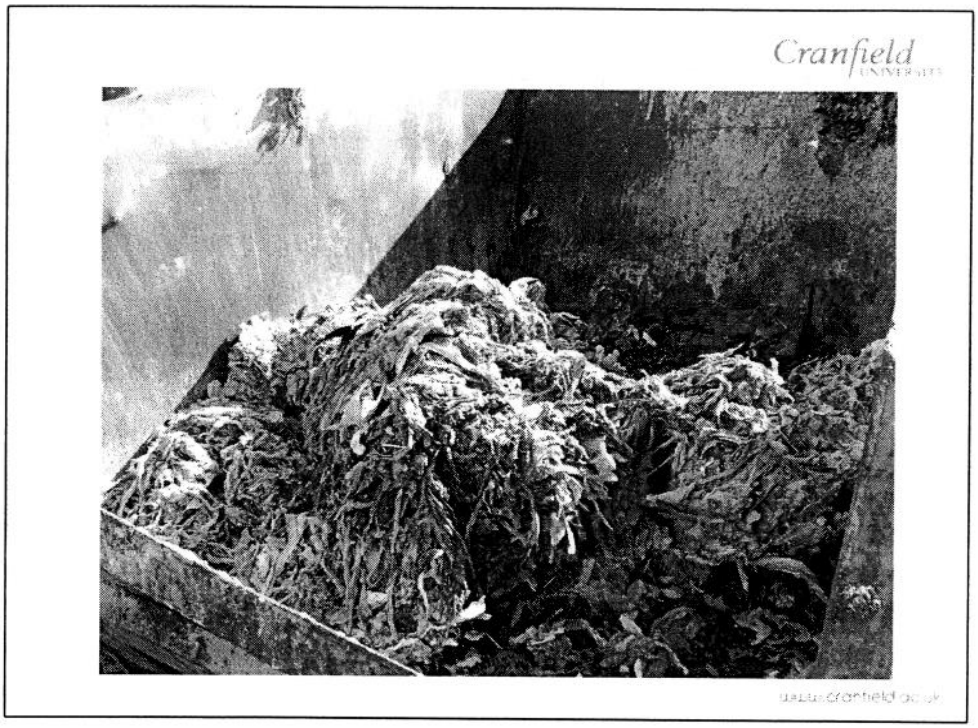
- No treatment, to skip
- Dewatered, to skip
- Washed, to skip
- Disintegrated, back to main flow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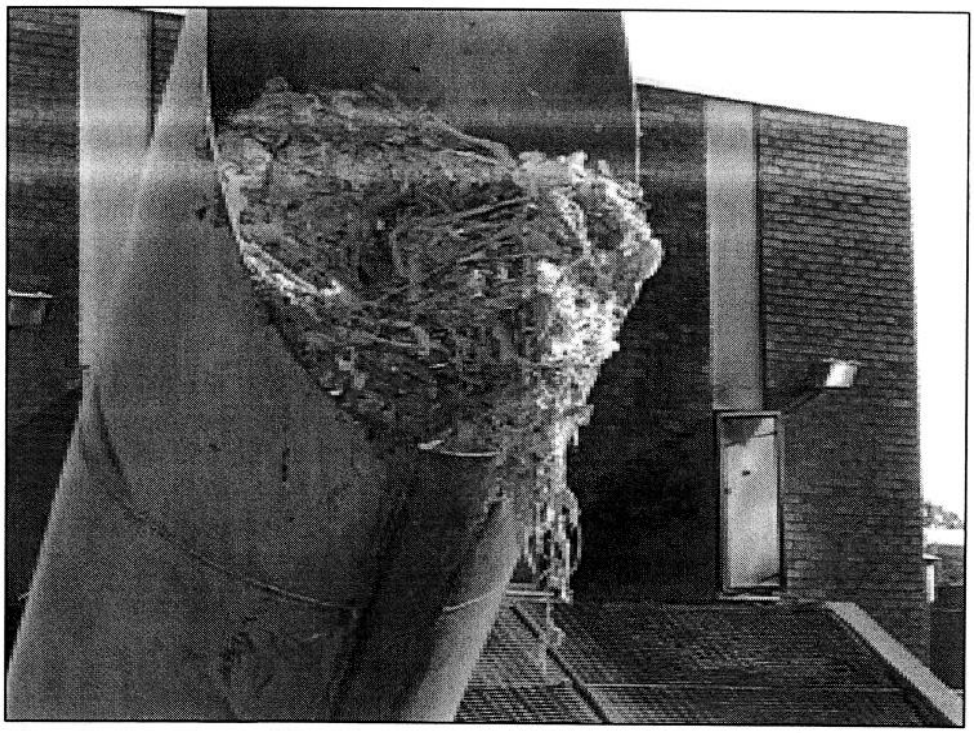

Screen Types - Aperture

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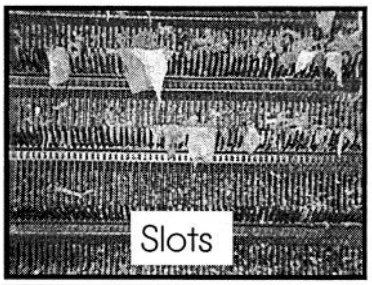
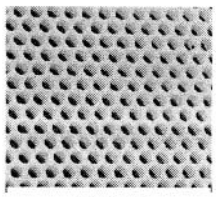
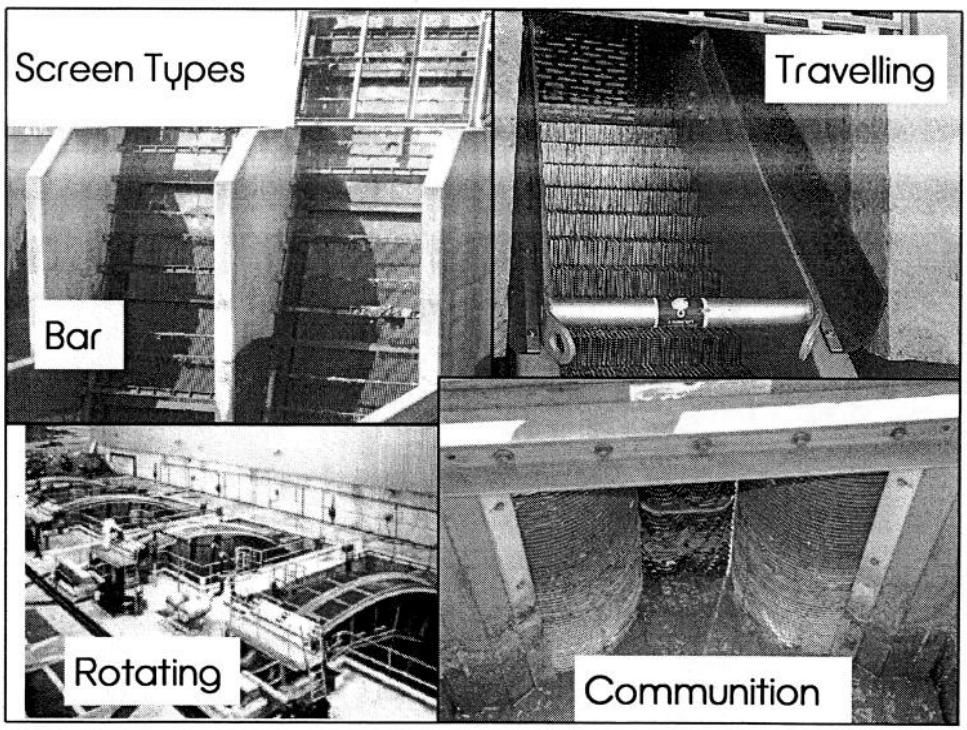
Type	Aperture (mm)
Coarse	>50
Medium	15-50
Fine	3-15
Milli	0.25 - 3





Holes
(perforated
plates or wires)



Bar Screens

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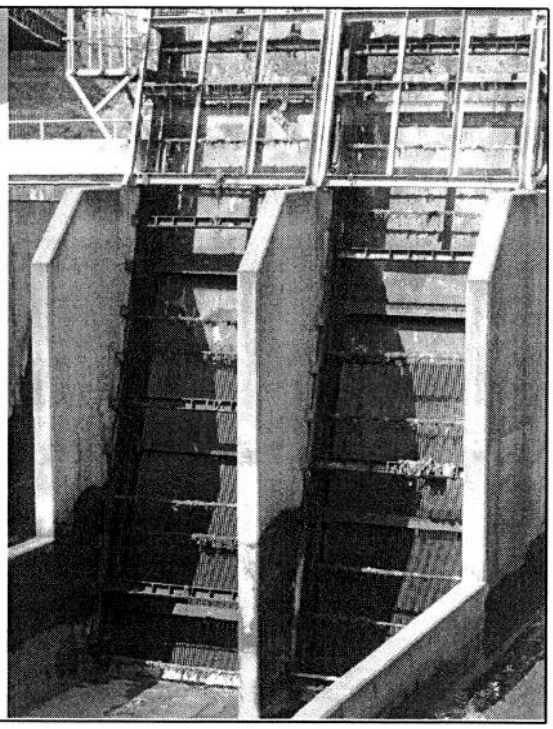
- Parallel fixed bars with spaces
- Manual or mechanically cleaned
- Bars rectangular or tapered
- Empirical formula for design
- Coarse screens usually bars

Bar screens

Static bar

Cleaning mechanism normally defines screen

Automated cleaning (normally)



Bar screens

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- Smaller the space, the more efficient the screen: (mechanically raked bar screen)

Bar spacing	Mean efficiency (%)
25	18
15	33
12	40
6	52

- Most municipal screens use 6 mm as standard Can go down to 1 mm

Bar screens

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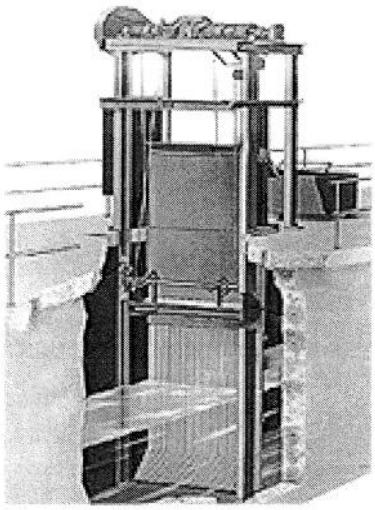
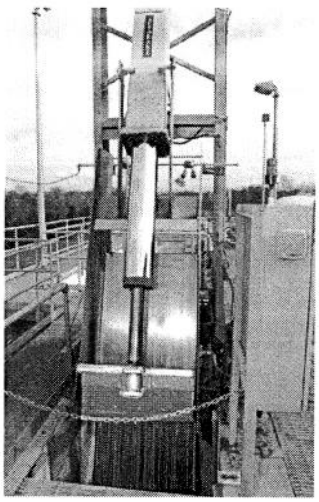
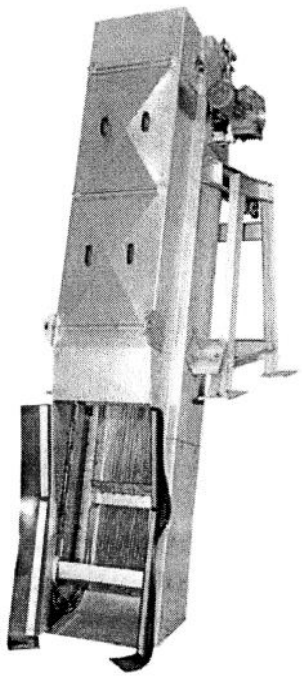


Catenary screen



Reciprocating rake screen

Bar screens



Chain screen

Travelling Screens

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- Moving screen, with static cleaning mechanism
  - Bars or holes
  - Continuously cleaned
  - 'Double pass' – screening twice

Most commonly used for wastewater treatment

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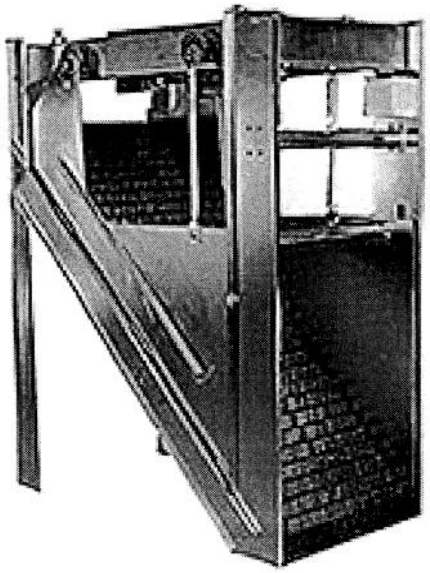
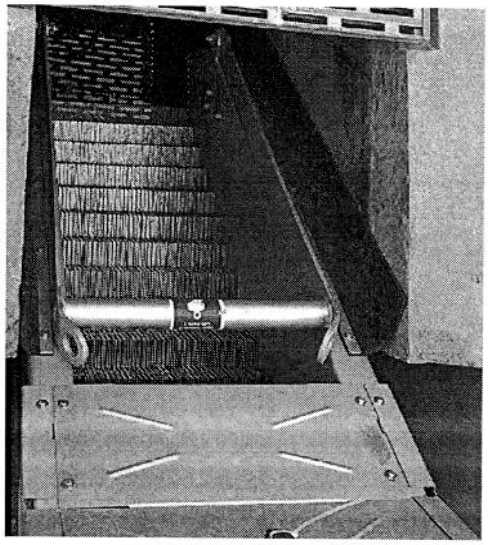


Step Screen®



Rotating Fine Screens

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- Apertures can range from 0.02 – 10 mm depending on the application.

Cup Screen

- Influent from centre, effluent to outside. Debris flushed onto collection hopper by water jets.

Drum Screen

- Influent from outside. Debris washed off by influent, i.e. self cleaning

Drum and cup screens

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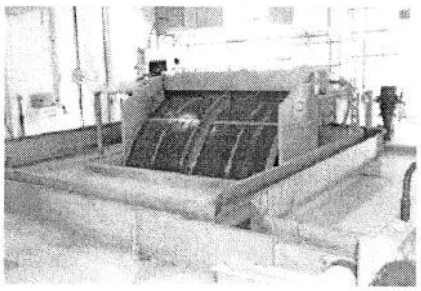

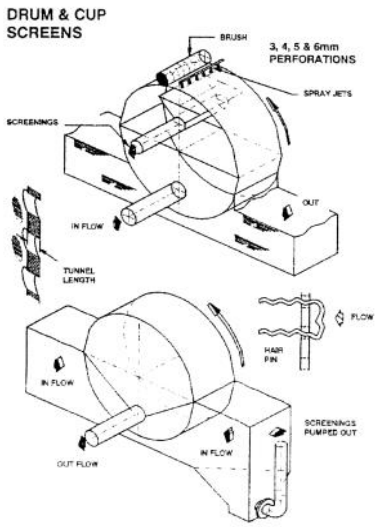

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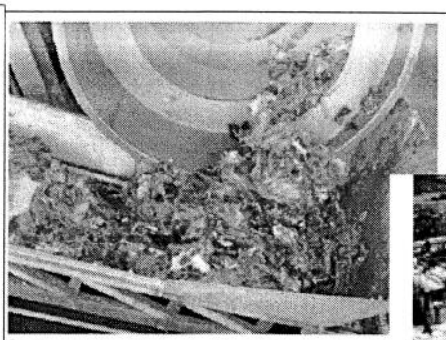
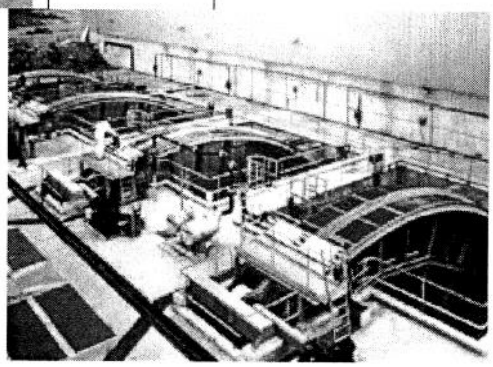


Drum screen



Cup screen

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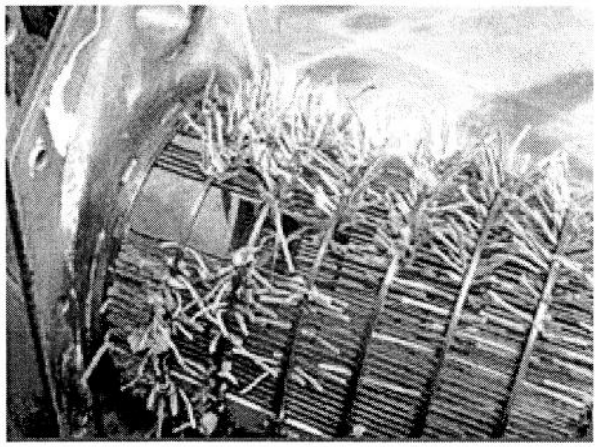

Broken cup screen – Cotton buds!

Comminution

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A chamber which intercepts and macerates material without removing it from the flow

(after grit removal)

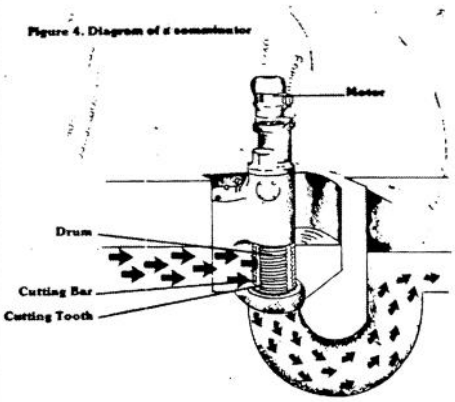
Advantages

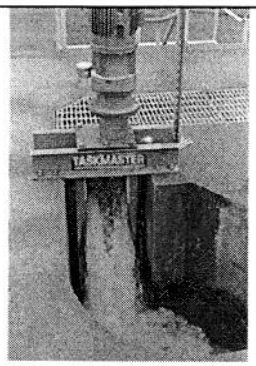
- No screenings disposal
- No detailed design needed
- Protects pumps
- Faecal matter enters plant

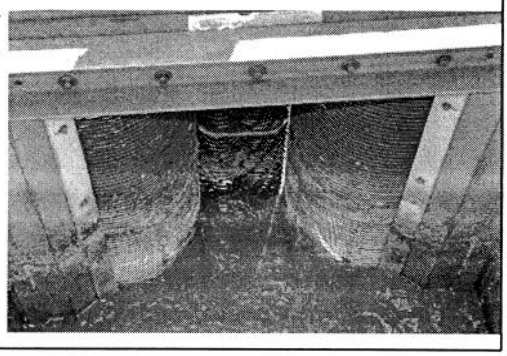
Disadvantages

- Power needed
- Prone to breakdowns
- Damage from large objects
- Rags "ball-up"
- Screenings in sludge

Comminutor







Grit Removal

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Purpose

To protect downstream unit operations

- Protect moving equipment from abrasion
- Reduce deposit build-up in pipelines/channels
- Reduce frequency of cleaning digesters

Process fundamentals –
Grit removal

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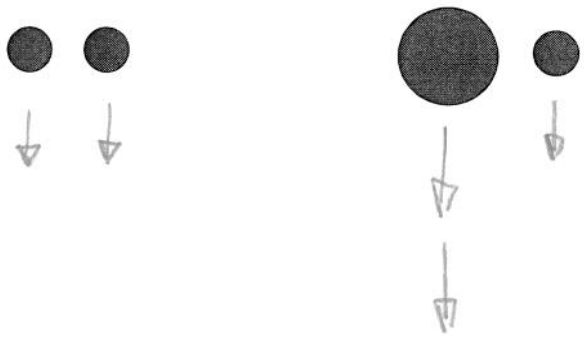

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Process fundamentals –
Grit removal

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Solid density

Particle diameter

Liquid density

Acceleration due to gravity - constant

$$v_s = \frac{gd^2(\rho_s - \rho_l)}{18\mu}$$

Particle settling velocity

Water viscosity

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Grit Removal

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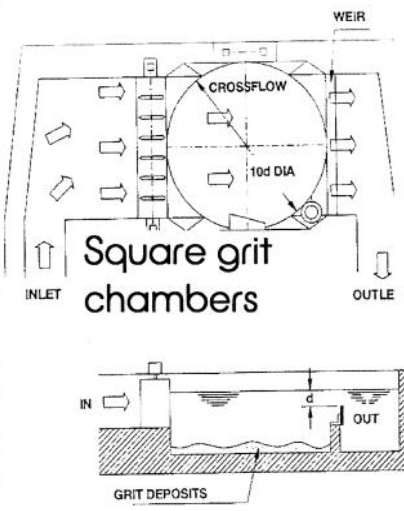
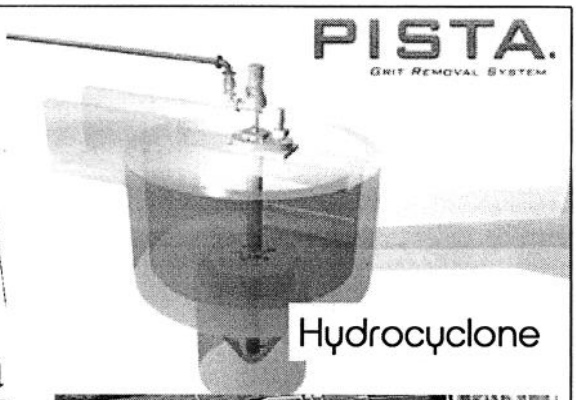
- Content: heavy mineral fraction, i.e. silt, sand, glass, metal
- Assume design particle density = 2,500 – 2,650 kg/m^3
- Therefore unit operations designed to ensure less dense solids remain in suspension

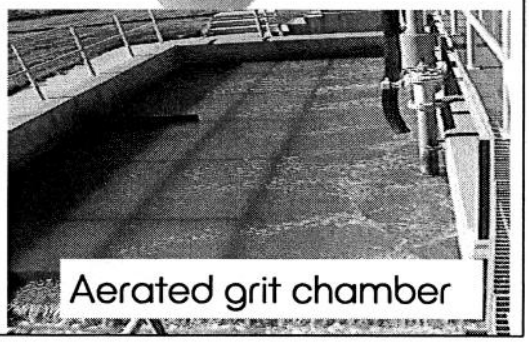
Grit removal



Square grit chambers



Hydrocyclone



Aerated grit chamber

Square Grit Chamber

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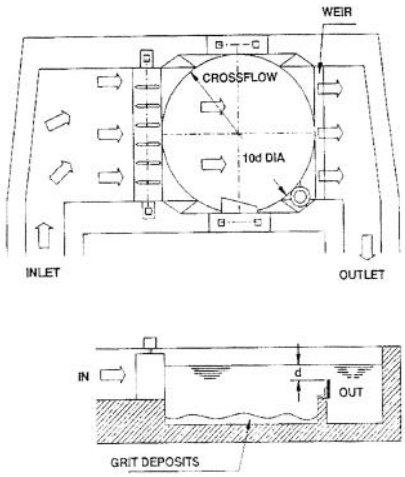
- a.k.a. "detritors"
- Flow enters square tank via baffles for distribution, scraper moves grit into a sump, for periodic removal
- tanks 3 – 12m diameter
- design based on surface loading
- 0.2mm grit – c.2100 $m^3/m^3/d$
- 0.15mm grit – c.1300 $m^3/m^2/d$
- i.e. classic sedimentation theory



Hydrocyclones

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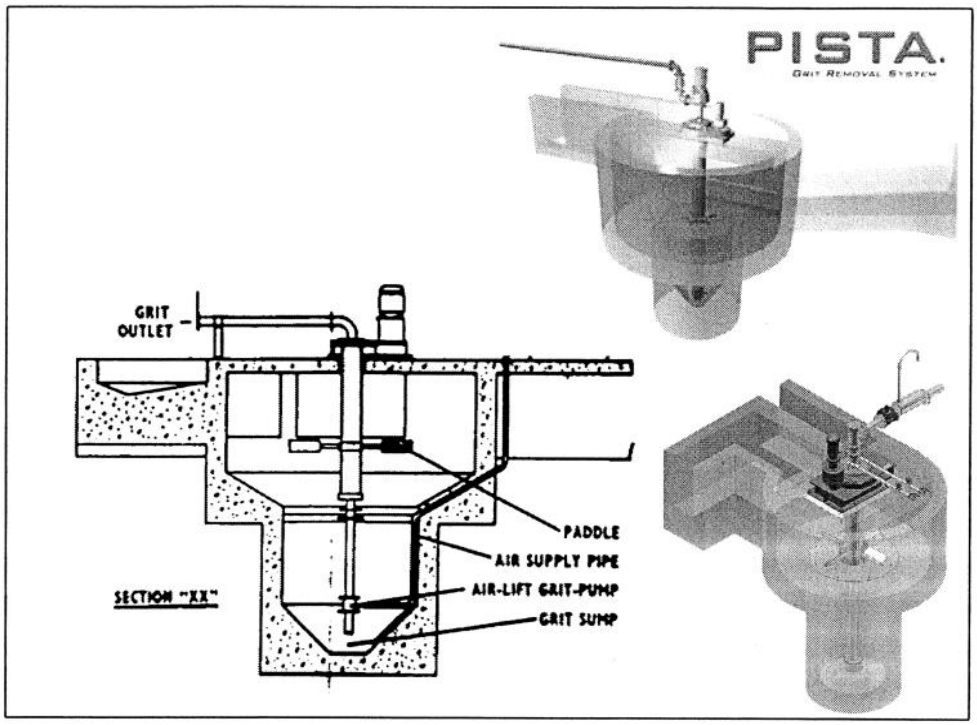
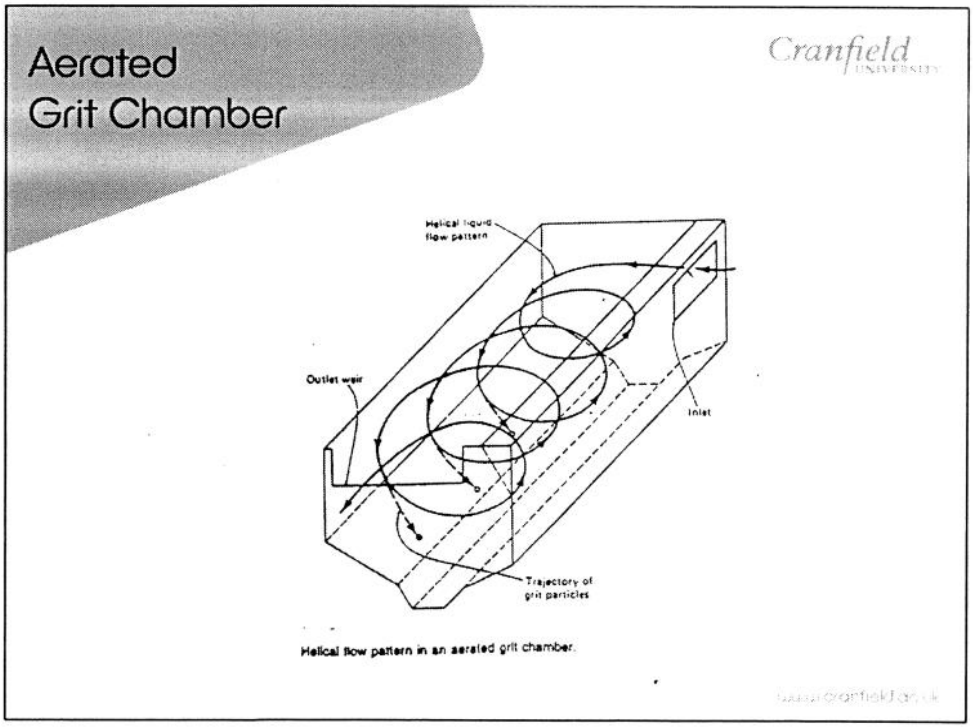
Known in water industry as "vortex separators" and "Pista traps"

- Sewage enters a circular tank tangentially to create a vortex, grit falls to bottom, effluent outlet at centre
- "Pista traps" incorporate power driven paddles plus air lift to removal grit.
- Advantages are "clean" grit and small area


PISTA.
GRIT REMOVAL SYSTEM
GRIT OUTLET
PADDLE
AIR SUPPLY PIPE
AIR-LIFT GRIT-PUMP
GRIT SUMP
SECTION "XX"


Aerated
Grit Chamber
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Helical liquid flow pattern
Outlet weir
Inlet
Trajectory of grit particles
Helical flow pattern in an aerated grit chamber.

Aerated Grit Chamber

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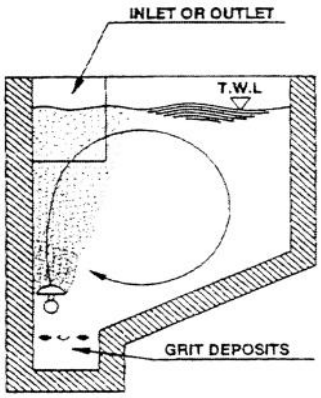
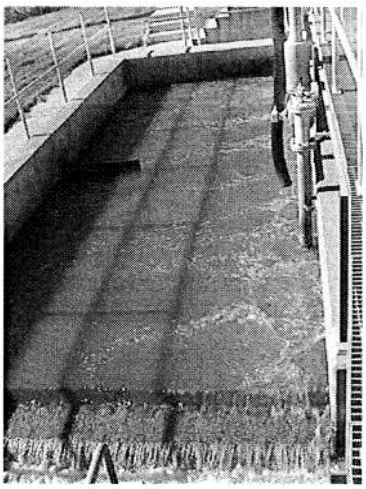
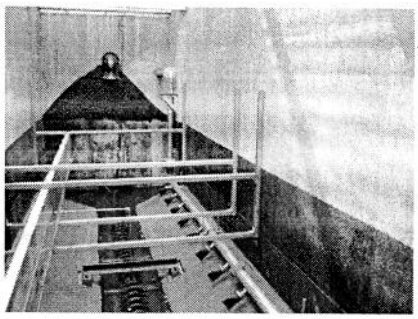
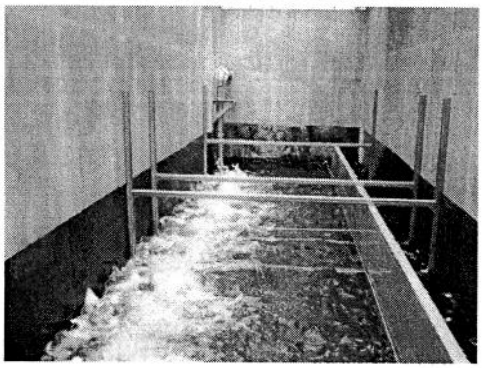


MORE COMPACT







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- Objective: At the end of the session you should be familiar with:

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