Trickling Filters

What they are and how to operate them.

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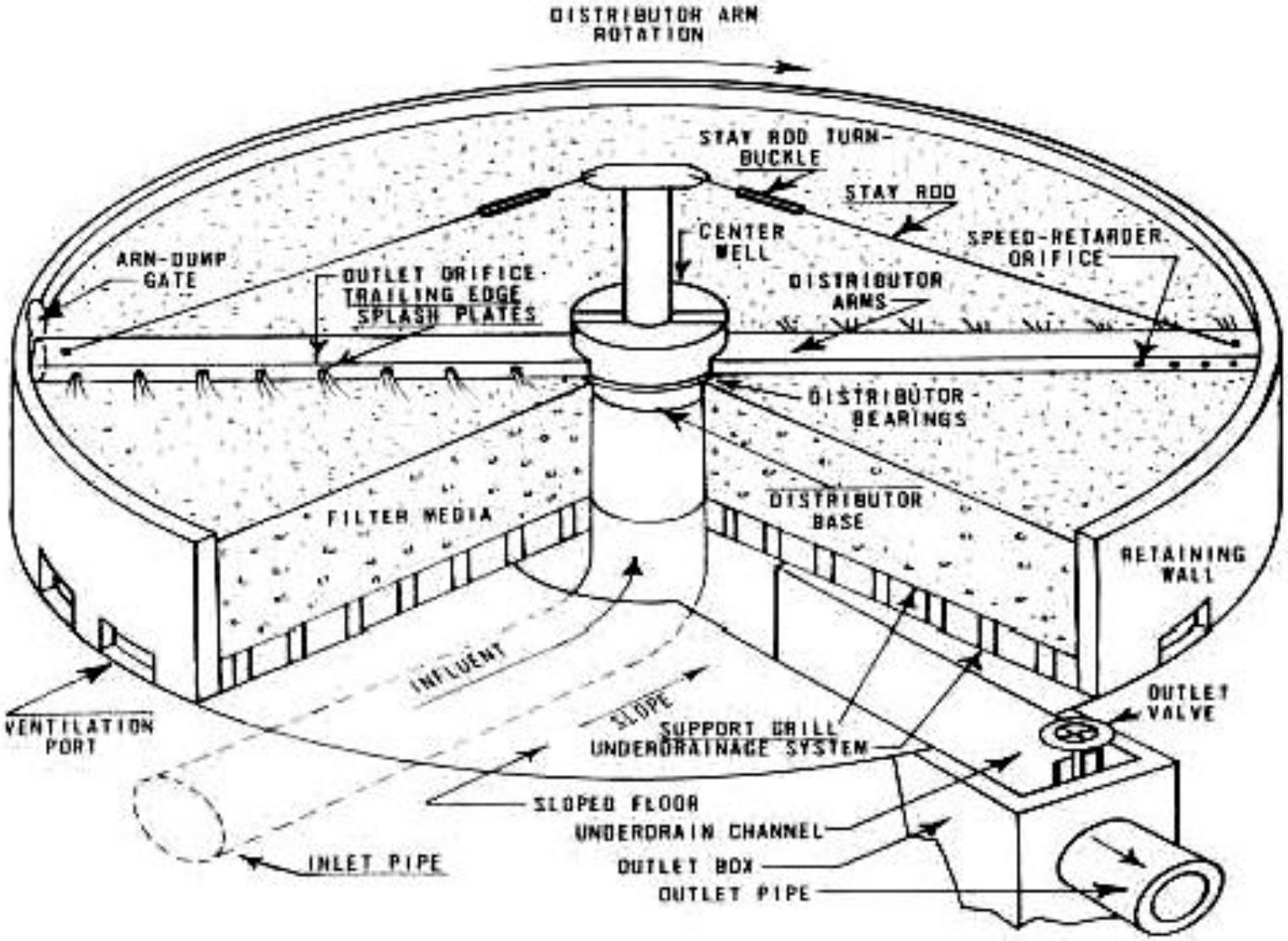
Information on this PowerPoint

- From EPA
- Wastewater
- Technology Fact Sheet
- Trickling filters
- EPA 832-F-00-014
- September 2000
- Various Photos from Internet

Description

- Trickling filters (TFs) are used to remove organic matter from wastewater.
- The TF is an aerobic treatment system that utilizes microorganisms attached to a medium to remove organic matter from wastewater.
- TFs are an attached-growth process.


DISTRIBUTOR ARM ROTATION
STAY ROD TURN-BUCKLE
STAY ROD
CENTER WELL
SPEED-RETARDER ORIFICE
ARM-DUMP GATE
OUTLET ORIFICE TRAILING EDGE SPLASH PLATES
DISTRIBUTOR ARMS
DISTRIBUTOR BEARINGS
FILTER MEDIA
DISTRIBUTOR BASE
RETAINING WALL
INFLUENT
SLOPE
VENTILATION PORT
SUPPORT GRILL
UNDERDRAINAGE SYSTEM
OUTLET VALVE
SLOPED FLOOR
UNDERDRAIN CHANNEL
INLET PIPE
OUTLET BOX
OUTLET PIPE

What Can This Process Do?

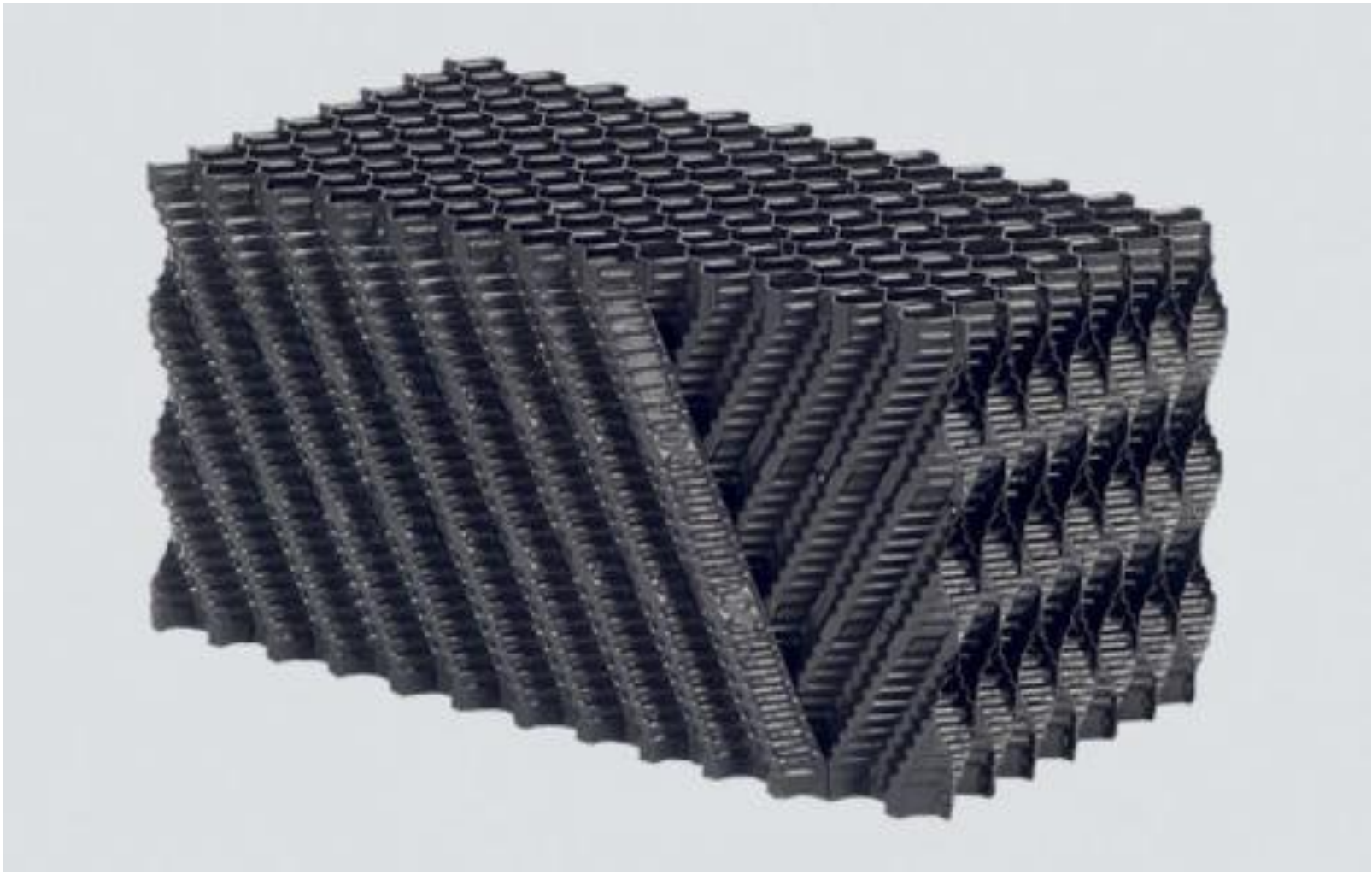
- Remove Nutrient
- Remove Dissolved Organic Solids
- Remove Suspended Organic Solids
- Remove Suspended Solids

Filter Media Types

- Plastic
- Rock
- Slag
- Brick – not used much any more.

Open structured of plastic media; efficient oxygen transfer.

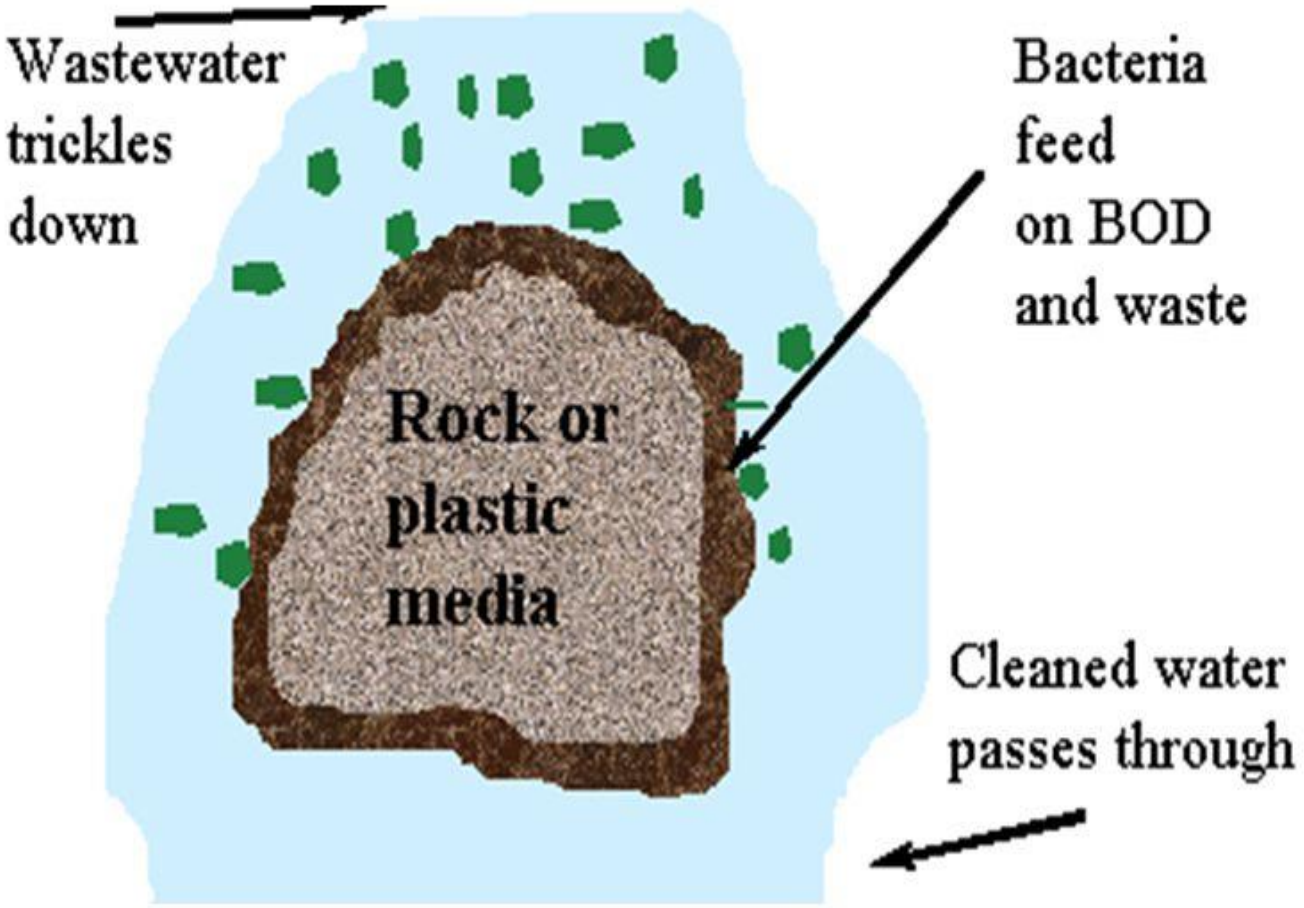
stone media; poorer oxygen transfer.



Applicability

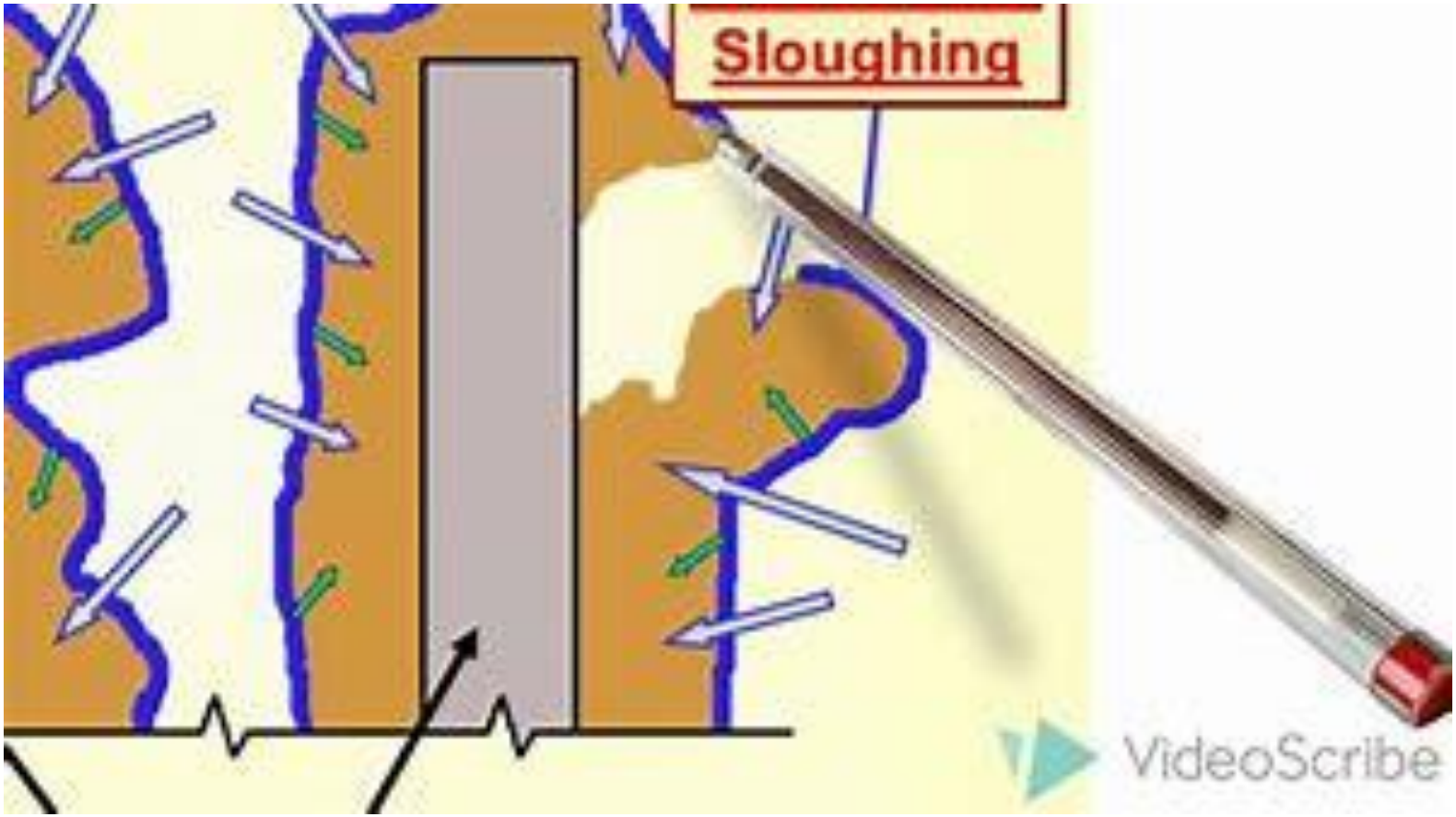
- TFs enable organic material in the wastewater to be absorbed by a population of microorganisms (aerobic, anaerobic, and facultative bacteria; fungi; algae; and protozoa) attached to the medium as a biological film or slime layer (approximately 0.1 to 0.2 mm thick).

Trickling Filter Process



TFs

- As the wastewater flows over the medium, microorganisms already in the water gradually attach themselves to the rock, slag, or plastic surface and form a film.
- The organic material is then degraded by the aerobic microorganisms in the outer part of the slime layer. (Degrading BOD)
- As the layer thickens through microbial growth, the layers will then start to fall off the media, this process is called sloughing.


Sloughing
VideoScribe

Typical Trickling Filter

- Distributor arm allows for hydraulic force turning the arm. Recently, motors have been added to control arm speed.
- Has an underdrain system that collects the filtrate and solids, and also serves as a source of air for the microorganisms on the filter.
- The treated wastewater and solids are piped to a settling tank for separation.

The Underdrain System

- Two Main Objectives
  - Collect treated wastewater
  - Create a plenum that allows for the transfer of air throughout the trickling filter media.

The Underdrain System

AERATION

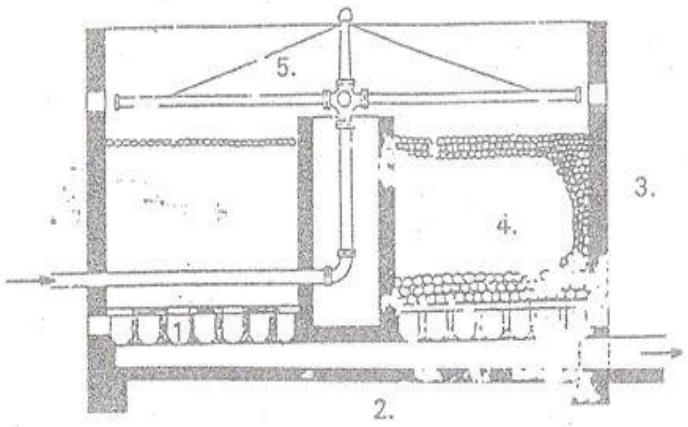
- The vertical flow of air through trickling filter media can be induced by mechanical ventilation or natural air draft.
  - Mechanical ventilation enhances controls airflow with low-pressure fans that continuously circulate air throughout the trickling filter.
  - Adequate underdrain and effluent channel permits free airflow. (vent stacks ventilating manholes or louvers on the sidewall of the tower)
    (Daigger & Boltz,2011)

The Underdrain System

Principal of Trickling Filter

1. Trickling filter is an aerobic attached growth biological system
2. The major components of the trickling filter are:

- The tank
- Rotary distributor
- Filter media (crushed stones, gravel, plastic)
- Under drain system
- Ventilation



3. Biological process

- The bacteria is attached to the filter media forming a biological layer called also bio-film
- Sprinkled wastewater over the filter media forms liquid film including food and dissolved oxygen.
- The bacteria (bio-film) absorbs the organic matter and oxidized it producing CO_2, H_2O, NH_3 and new cell
- The biological layer consists of aerobic and anaerobic partitions.
- When the mass of the bio-film increase the lower layer will be anaerobic with lower food supply which will lead to the decrease of the attaching force between the bio-film and the filter media. In this case the bio-film is sloughed out (disconnected) and flows out with the wastewater to the final sedimentation tank where it settles.

Advantages

- Simple, reliable, biological process.
- Effective in treating high concentrations of organics depending on the type of medium used.
- Appropriate for small to medium sized communities.
- Rapidly reduce soluble BOD_5 in applied wastewater.

Advantages continued

- Efficient nitrification units.
- Durable process elements.
- Low power requirements.
- Moderate level of skill and technical expertise needed to manage and operate the system.

Disadvantages

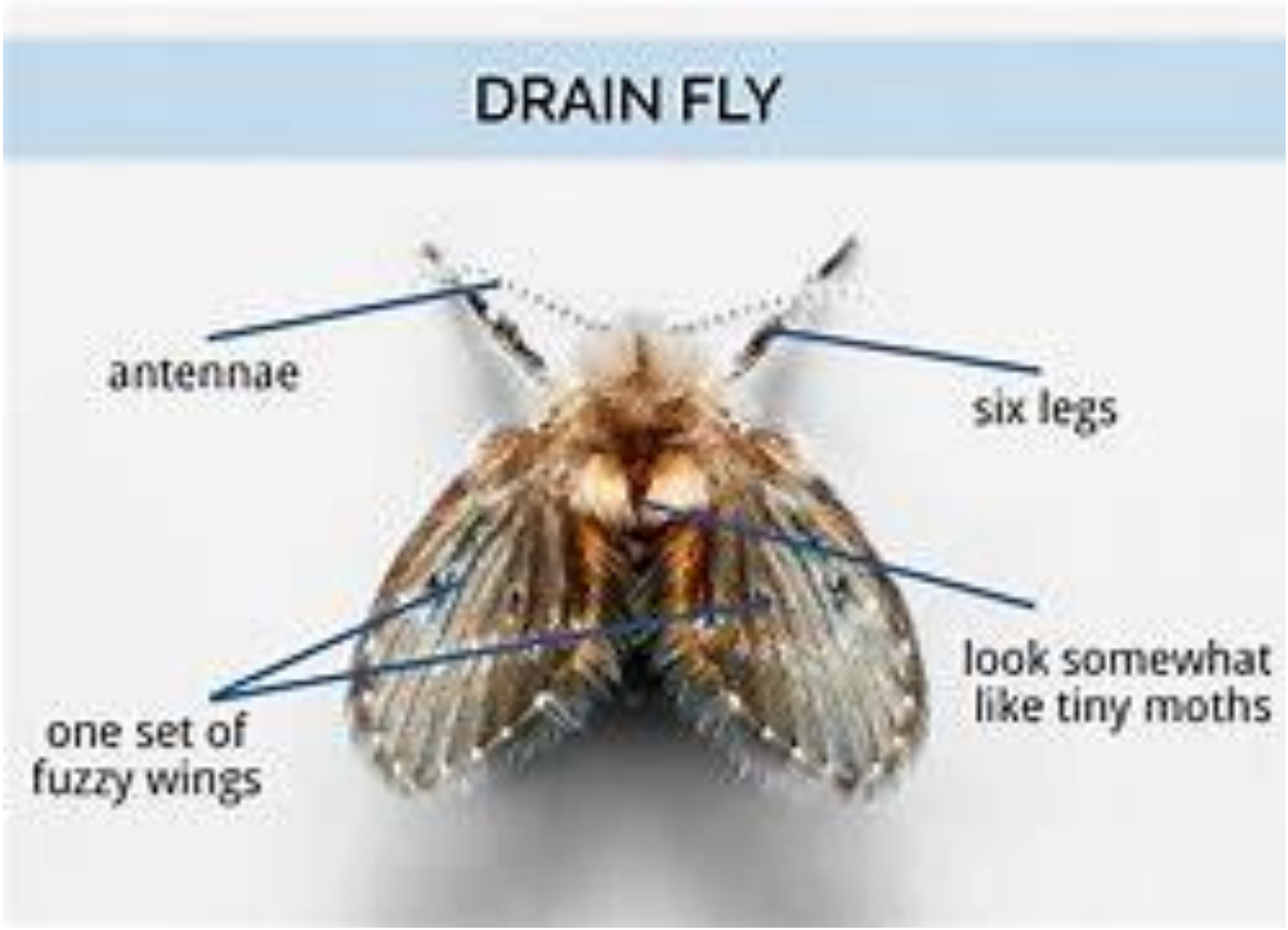
- Additional treatment may be needed to meet more stringent discharge standards.
- Possible accumulation of excess biomass that cannot retain an aerobic condition and can impair TF performance.
- Requires regular operator attention.
- Incidence of clogging is relatively high.

Disadvantages cont.

- Requires low loadings depending on the medium.
- Flexibility and control are limited in comparison with activated-sludge processes.
- Filter Flies (Psychoda Fly)
- Vector and odor problems.
- Snail problems.

3. Filter Flies are a nuisance to plant personnel and nearby neighbors. These tiny, gnat-size flies are called psychoda. They are occasionally found in great numbers, preferring an alternate wet and dry environment for development. Lay their eggs in ponded water.

- The flies are most frequently found in low or standard rate filters with an intermittent dosing system.


DRAIN FLY
antennae
six legs
look somewhat like tiny moths
one set of fuzzy wings

Types of Trickling Filters

- Low-rate filters
- Intermediate-rate filters
- High-rate filters
- Roughing Filters

Low-rate filters

- Low-rate filters are commonly used for loadings of less than 25 lb BOD_5/1000cu ft/day
- The sloughed solids are generally well-digested and as a result these filters yield less solids than higher rate filters.

Intermediate-rate filters

- Can be loaded up to 40 lb BOD_5/1000 cu ft/day.
- In order to ensure good distribution and thorough blending of the filter and secondary effluent, the system should recirculate the trickling filter effluent.
- The biological solids sloughed off are not as well digested as a low-rate filter.

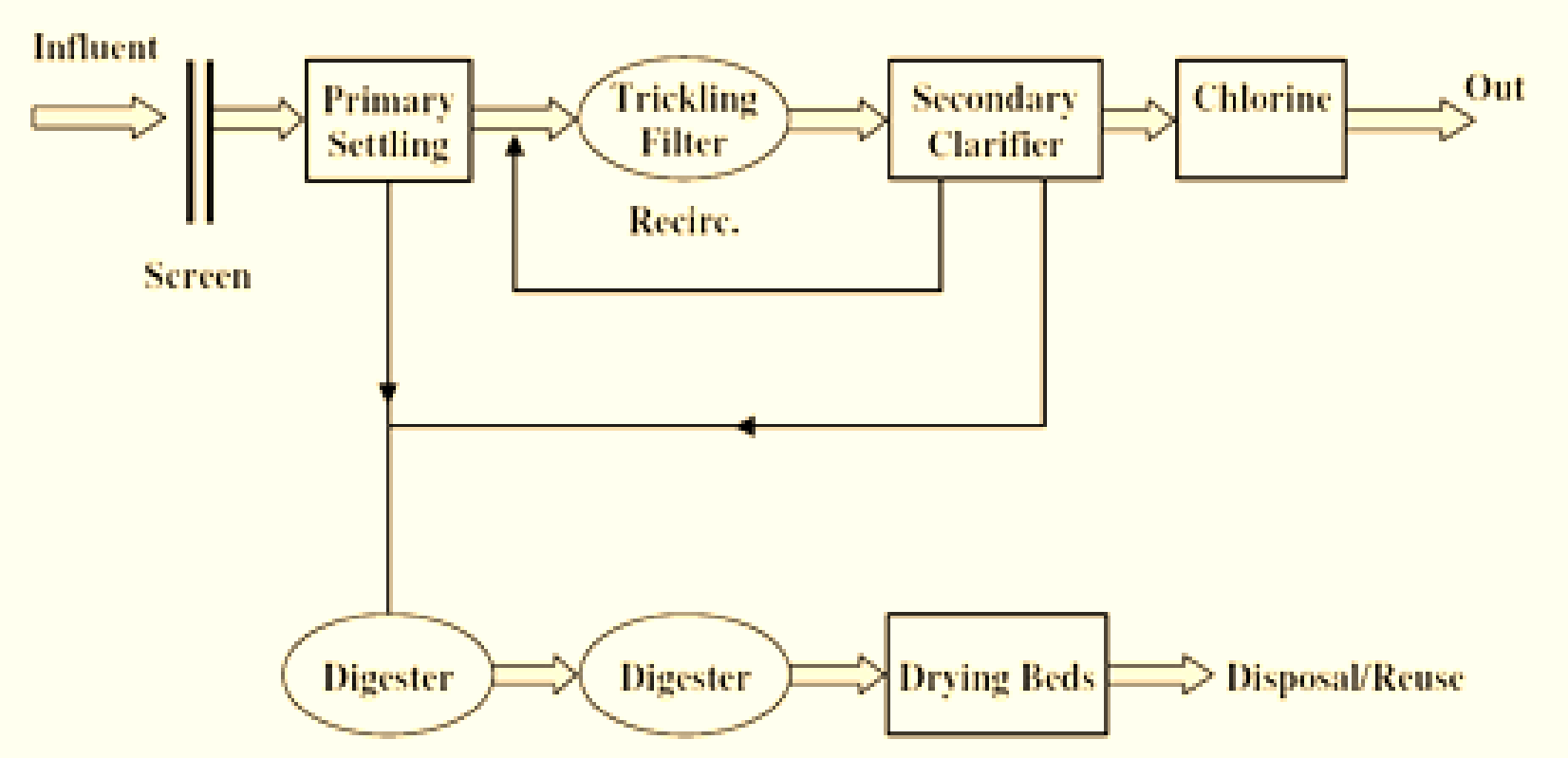
High-rate filters

- Generally loaded at the maximum organic loading capabilities of the filter.
- Loading ranges from 40 to 100 lb BOD_5/1000cu ft/day.
- For good effluent quality, these filters need a second stage process. As a result these filters are often used with combined processes.

Roughing Filters

- Roughing filters are designed to allow a significant amount of soluble BOD to bleed through the trickling filter.
- Loading ranges are 100-300 lb BOD_5/1000cu ft/day.

Typical Flow Path



Operation and Maintenance

- Disagreeable Odors
- Ponding on Filter media
- Filter Flies (Psychoda)
- Icing
- Rotating Distributor slows down or stops

Disagreeable Odors

- Excessive organic loading causing anaerobic decomposition. Reduce loading, increase BOD removal in primary settling.
- Inadequate ventilation – increase hydraulic loading to wash out excess biological growth; remove debris from effluent channel and from the top of the filter.

Ponding on filter media

- Excessive biological growth – reduce organic loading; increase hydraulic loading to increase sloughing; use high pressure stream of water to flush filter surface.
- Use 1 to 2 mg/L residual chlorine on the filter for several hours; flood filter for 24 hours.
- Check for debris, inspect media.

Filter Flies

- Inadequate moisture on filter media.
- Increase hydraulic loading; unplug spray orifices or nozzles; use orifice opening at end of rotating distributing arms to spray filter walls; flood filter for several hours each week during fly season;
- Maintain 1 to 2 mg/L of residual Cl2 for several hours to kill off flies.
- Apply Bacillus thuringiensis
  thank you John T. Mrozek for this tip.

Icing

- Low temperature of wastewater
- Decrease recirculation; use high-pressure stream of water to remove ice from orifices, nozzles, and distributor arms; reduce amount of filters in service as long as effluent limits can be met.
- Look into building wind breaks.

Rotating Distributor slows or stops

- Insufficient flow to turn distributor– increase hydraulic loading; close reversing jets.
- Clogged arms or orifices—Flush out arms by opening end plates; remove solids from influent wastewater; flush out orifices.
- Clogged distributor arm vent pipe—Remove material from vent pipe by rodding or flushing; remove solids from influent wastewater.

Distributor arm issues cont.

- Distributor arm not level—Adjust guy wires at tie rods.
- Distributor arm rods hitting media—Level media; remove some media.


alamy stock photo
CG14A1
www.alamy.com

Questions for you operators.

- What do you do if freezing occurs?
  - Decrease recirculation

  What do you do when you see an increase in Filter Fly population?

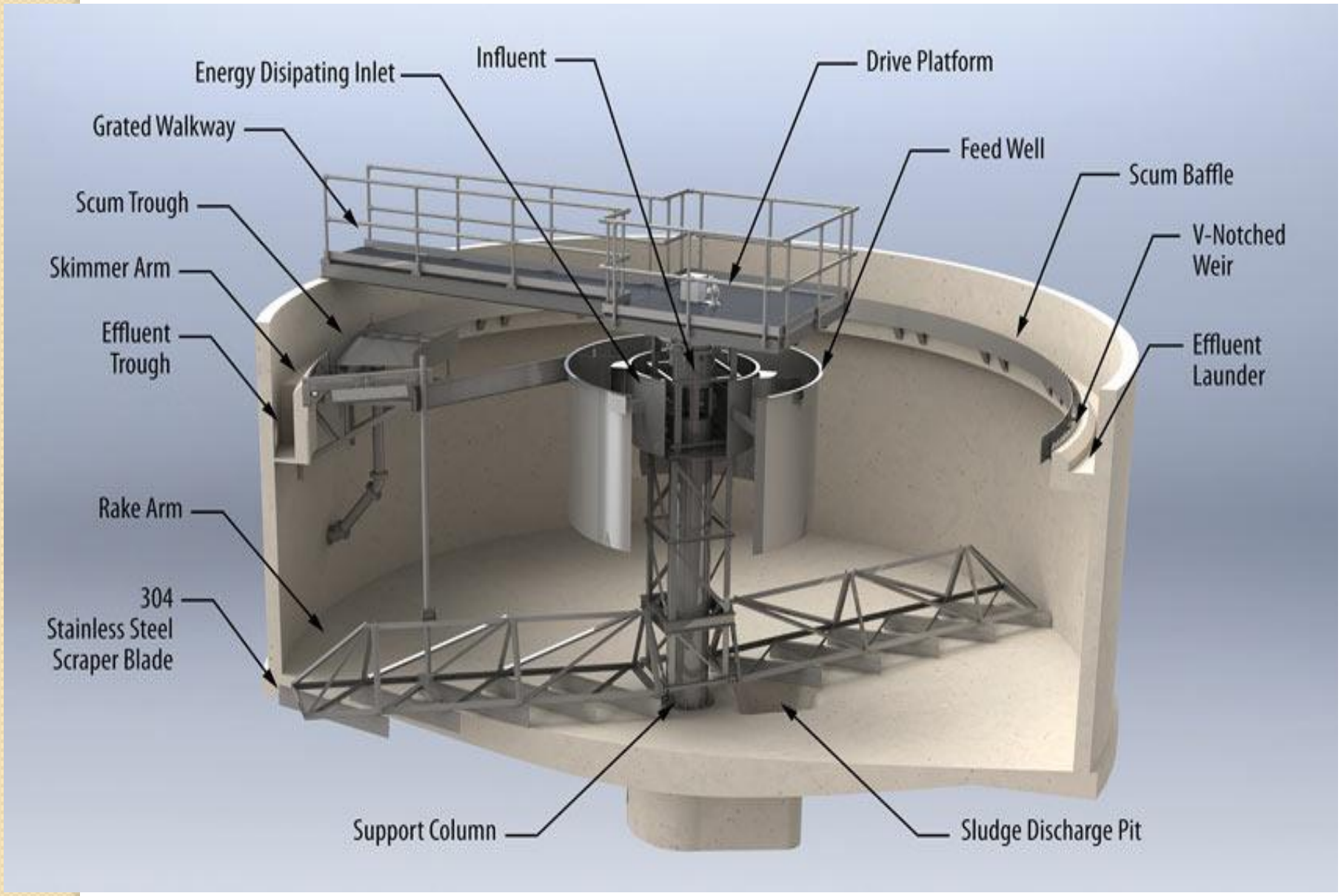
  Increase recirculation

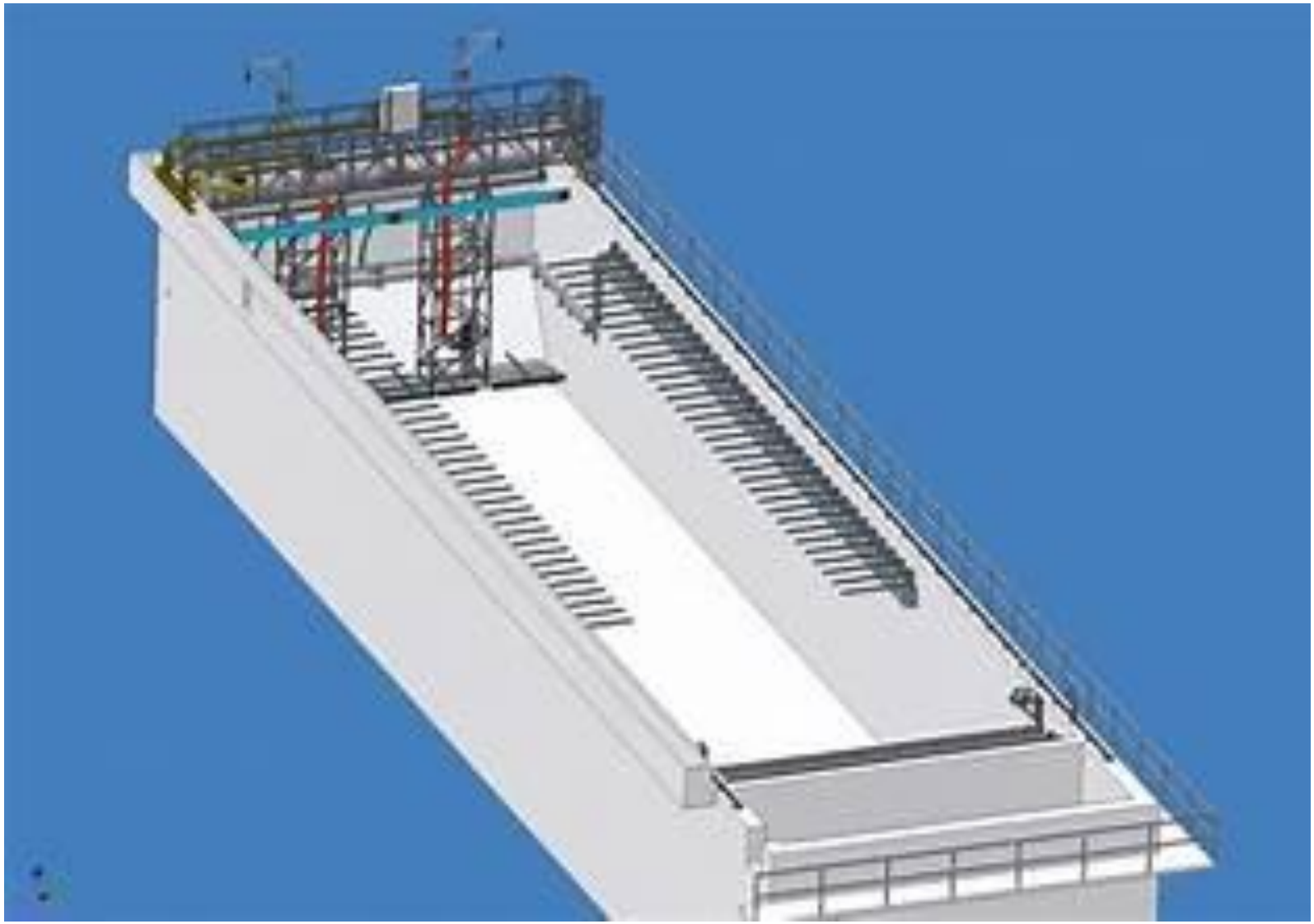
  You see a green strip on the filter media; what has happened?

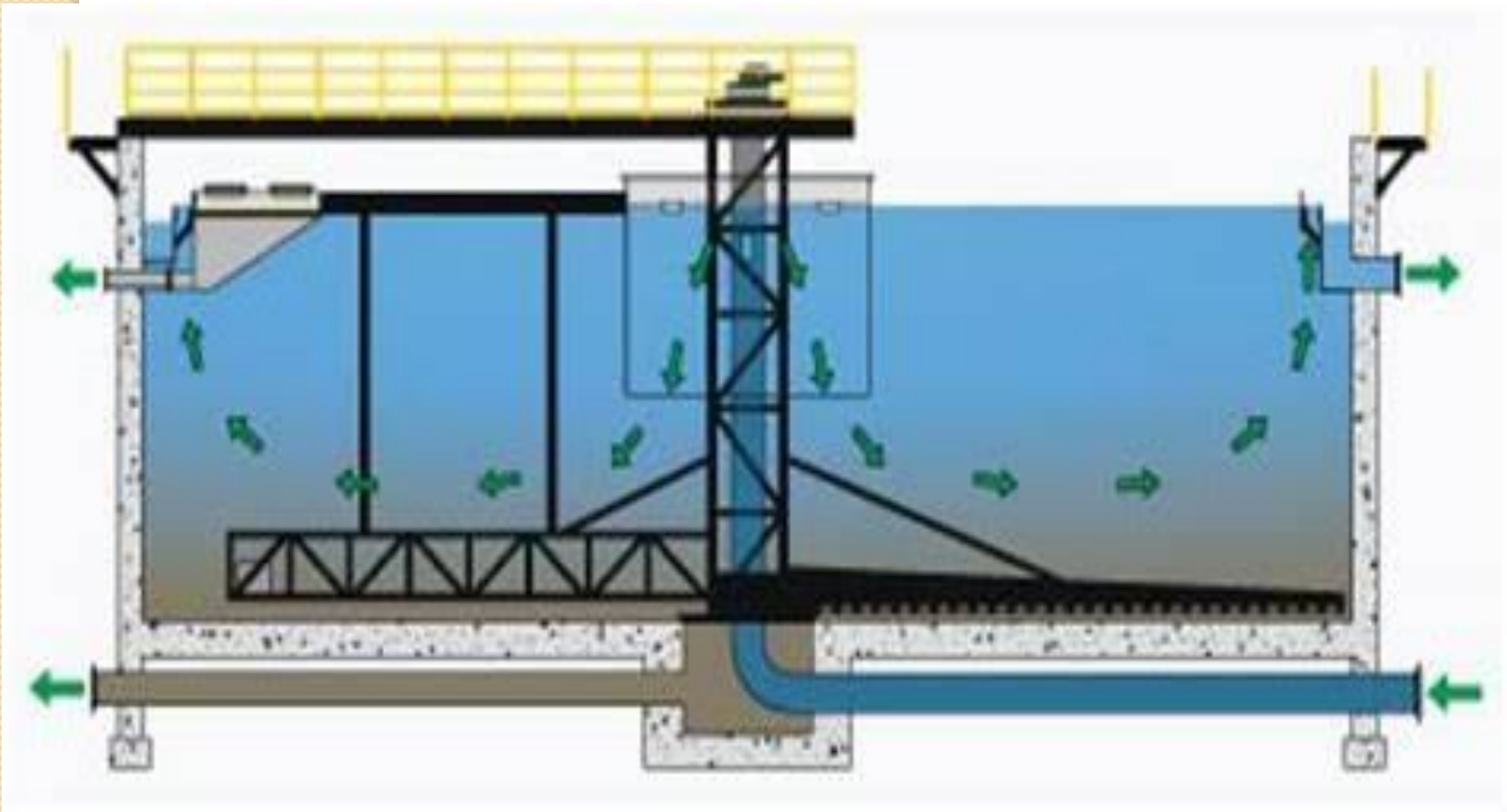
  The distributor arm has stopped.

Secondary Clarifiers

- What are they used for?


Energy Disipating Inlet
Influent
Drive Platform
Grated Walkway
Feed Well
Scum Baffle
Scum Trough
V-Notched Weir
Skimmer Arm
Effluent Trough
Effluent Launder
Rake Arm
304 Stainless Steel Scraper Blade
Support Column
Sludge Discharge Pit





That was it!!!

- Questions?
- Thank you for your time. I hope that you got a chance to learn a little bit.
- Good luck on your test.
- Always match your test question number to your answer sheet number, I made that mistake before.