QUICK REVIEW

PRELIMINARY TREATMENT

PRIMARY TREATMENT

SECONDARY TREATMENT
SECONDARY TREATMENT

- WASTE TREATMENT PONDS
- TRICKLING FILTERS
- ROTATING BIOLOGICAL CONTACTORS
- ACTIVATED SLUDGE
TRICKLING FILTERS

Rotating Distributor Filter Tower

Rotating Distributor

Filter Tower
FILTER TOWERS
(aka Biotowers)

INFLUENT → VENTILATION

NOZZLES

MEDIA

EFFLUENT
FILTER TOWER MEDIA

PLASTIC MEDIA
ALL TRICKLING FILTERS CONSIST OF 3 PARTS

• MEDIA
• UNDERDRAIN
• DISTRIBUTION SYSTEM
TRICKLING FILTERS COULD BE CALLED…

“ATTACHED GROWTH BIOLOGICAL REACTORS”
MEDIA

FUNCTION

• PROVIDES A PLACE FOR BIOLOGICAL SLIME TO DEVELOP

SLIME: aka ZOOGLEAL FILM
(ZOE-glee - al)
ZOOGLEAL FILM

CONSISTS OF BACTERIA, ALGAE, Protozoa, fungi, worms...?
THE PROCESS IS AEROBIC—EVEN WITH AN ANAEROBIC LAYER NEXT TO THE MEDIA
TRICKLING FILTER

ROCK (OR PLASTIC)

HUMUS

HUMUS (SLOUGHING BIOMASS) GOES TO THE CLARIFIER
SOME ZOOGLEAL CRITTERS AT 1000 X

“STALKED” CILIATES

ROTIFER
DEPTH OF MEDIA

3-8 FT FOR ROCKS
(DEPTH LIMITED BECAUSE OF WEIGHT OF ROCKS)

15-30 FT FOR SYNTHETIC MEDIA
All trickling filters consist of 3 parts...

- Media
- Underdrain
- Distribution system
UNDERDRAIN
UNDERDRAIN

- THESE ARE DESIGNED TO FLOW $\frac{1}{2}$ FULL AT MAXIMUM FLOW RATES

- SLOPED TO DRAIN AT MINIMUM OF 2 fps
DISTRIBUTION SYSTEM
INFLUENT

FILTER MEDIA

EFFLUENT

TRICKLING FILTER
DISTRIBUTOR BEARINGS
UNDERDRAIN SYSTEM

INFLUENT

EFFLUENT
STAY RODS

INFLUENT

EFFLUENT
INFLUENT

EFFLUENT

OUTLET VALVE
INFLUENT

EFFLUENT

SPEED RETARDING ORIFICE
VENTILATION PORTS

INFLUENT

EFFLUENT
PRINCIPLES OF OPERATION

A TRICKLING FILTER IS NOT A FILTER... (NO STRAINING ACTION)

THE “JELLY-LIKE” COATING ON THE MEDIA USES THE ORGANICS IN THE WASTEWATER AS NUTRIENTS
AIR FROM VENTILATORS

DISTRIBUTOR SYSTEM

SUSPENDED, COLLODIAL, & DISSOLVED ORGANICS

O₂ O₂ O₂ O₂

MEDIA

O₂

AIR FROM VENTILATORS
NUTRIENTS + $O_2$ + SLIME $\rightarrow$ NEW SLIME + $CO_2$ + $H_2O$

Wastewater trickles down

Bacteria feed on BOD and waste

Rock or plastic media

Cleaned water passes through
ROCKS PROVIDE ABOUT 35% VOID SPACE

SYNTHETIC MEDIA PROVIDE ABOUT 95% VOID SPACE
PONDING
(CLOGGED VOID SPACES)

AIR
PONDING IS CAUSED BY:

- EXCESSIVE ORGANIC LOADING
- POOR PRIMARY CLARIFICATION
- MEDIA IS TOO SMALL or NOT UNIFORM IN SIZE

(non-uniform media will allow the smaller to fit between the larger and block the void space)
PONDING IS CAUSED BY:

- INSECT LARVAE or
- SNAILS
PROBLEM WITH PONDING

PONDING PREVENTS AIR CIRCULATION THAT IS VITAL TO MAINTAINING AN ACTIVE SLIME LAYER
POOR AIR CIRCULATION MEANS POOR BOD REMOVAL

WASTEWATER

AIR (OXYGEN)
RECIRCULATION

PRIMARY CLARIFIER → TRICKLING FILTER → SECONDARY CLARIFIER

RECYCLING TREATED EFFLUENT
RICIRCULATION:

• MAY BE CONSTANT OR INTERMITTENT

• MAY BE ONLY DURING LOW FLOWS TO KEEP THE DISTRIBUTORS MOVING

• IMPROVES BOD REMOVAL BECAUSE OF LONGER CONTACT TIMES
RECIRCULATION...

• PRODUCES MORE CONTINUOUS AND UNIFORM SLOUGHING

➤ WHICH PREVENTS PONDING AND IMPROVES VENTILATION

➤ PRESENTS A MORE AGGRESSIVE SURFACE FOR NEW SLIME GROWTH

➤ DECREASES THE PROBLEMS WITH PESTS—FILTER FLIES AND SNAILS
FLOW TO A TRICKLING FILTER IS GENERALLY REGULATED THRU A WET WELL OR DOSING CHAMBER
TRICKLING FILTERS CAN SUCCESSFULLY TREAT ALMOST ANY WASTE—EXCEPT THOSE WITH HIGH CONCENTRATIONS OF...

- TOXIC WASTES
- PESTICIDES
- HEAVY METALS or EXTREME pH WASTES
FOR MAXIMUM EFFICIENCY, TRICKLING FILTERS SHOULD BE KEPT AEROBIC BY...

• A PROPERLY DESIGNED COLLECTION SYSTEM (i.e. good flow to prevent septic conditions)

• PROPER OPERATION OF THE PRIMARY CLARIFIERS

• PRETREATMENT WITH AIR OR RECYCLED FILTER EFFLUENT
Trickling filters are also affected by:

- Temperature of the wastewater – 

  In general, the organisms increase as the temperature rises.
WOULD YOU EXPECT YOUR BEST BOD REMOVAL DURING WINTER OR SUMMER?
CLASSIFICATIONS OF TRICKLING FILTERS

BASED ON HYDRAULIC AND BOD LOADING...

HYDRAULIC LOADING:

GPD/SQ-FT

BOD LOADING:

Lbs BOD per day / 1000 cu-ft
CLASSIFICATIONS OF TRICKLING FILTERS

BASED ON HYDRAULIC AND BOD LOADING...

• STANDARD-RATE
• HIGH-RATE
• ROUGHING FILTERS
ROUGHING FILTER PRECEDES SOME OTHER FORM OF SECONDARY TREATMENT (SUCH AS ACTIVATED SLUDGE)
<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLOW</td>
<td>25-100 gpd/sq-ft</td>
</tr>
<tr>
<td>BOD</td>
<td>5-25 lbs BOD per day/1000 cu-ft</td>
</tr>
<tr>
<td>% BOD removal</td>
<td>90-95 %</td>
</tr>
<tr>
<td>PARAMETER</td>
<td>VALUE</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>FLOW (ROCK)</td>
<td>100-1000 gpd/sq-ft</td>
</tr>
<tr>
<td>FLOW (SYNTHETIC)</td>
<td>350-2100 &quot;</td>
</tr>
</tbody>
</table>
## High-Rate Trickling Filter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD (rock)</td>
<td>25-100 lbs BOD per day/1000 cu-ft</td>
</tr>
<tr>
<td>BOD (synthetic)</td>
<td>50-300</td>
</tr>
<tr>
<td>BOD removal</td>
<td>90 - 95 %</td>
</tr>
</tbody>
</table>
### Roughing Filter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow</td>
<td>(same as high-rate)</td>
</tr>
<tr>
<td>BOD</td>
<td>100–300 lbs BOD per day/1000 cu-ft</td>
</tr>
<tr>
<td>BOD removal</td>
<td>80 – 85 %</td>
</tr>
<tr>
<td>Category</td>
<td>Rate</td>
</tr>
<tr>
<td>-------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Standard Rate</td>
<td>25 to 100</td>
</tr>
<tr>
<td>High Rate (rock)</td>
<td>100 to 1000</td>
</tr>
<tr>
<td>High Rate (synthetic media)</td>
<td>350 to 2100</td>
</tr>
<tr>
<td>Roughing</td>
<td>100 to 2100</td>
</tr>
</tbody>
</table>
**COMPARISON OF ORGANIC LOADING:**

<table>
<thead>
<tr>
<th>Category</th>
<th>Rate Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Rate</td>
<td>5 to 25</td>
</tr>
<tr>
<td>High Rate (rock)</td>
<td>25 to 100</td>
</tr>
<tr>
<td>High Rate (synthetic)</td>
<td>50 to 300</td>
</tr>
<tr>
<td>Roughing</td>
<td>100 to 300</td>
</tr>
</tbody>
</table>
TWO-STAGE TRICKLING FILTER

(LOTS OF OPTIONS FOR RECIRCULATION)
TRICKLING FILTERS CAN BE OPERATED...

SERIES

PARALLEL
TRICKLING FILTER START-UP

BEST TO START-UP IN SPRING TO EARLY SUMMER.
TAKES SEVERAL WEEKS FOR GROWTH TO FULLY DEVELOP.
ROTATOR ARMS TURN ABOUT 1 RPM

NEVER STAND IN FRONT OF A TURNING ARM!
POOR FILTER PERFORMANCE

HIGH SUSPENDED SOLIDS:
• HEAVY SLOUGHING (weather changes)
• FLOW TOO HIGH?
• SOLIDS CARRY-OVER FROM CLARIFIERS (PRIMARY, SECONDARY, OR BOTH)
• SHOCK LOAD
DAILY OPERATION

• VERY LITTLE ROUTINE CONTROL NEEDED—VERY RELIABLE PROCESS

• CHECK FOR PONDING, FILTER FLIES, ODORS, PLUGGED ORIFICES, AND SEAL LEAKAGES
DAILY OPERATION (CON’T)

PONDING (LOSS OF OPEN AREA IN THE FILTER)

• CHECK PRIMARY CLARIFIER

• HIGH PRESSURE SPRAY ON ROCKS; HAND-TURN THE MEDIA; CHLORINATION; FILTER FLOODING; SHUT-DOWN AND LET DRY
DAILY OPERATION (CONT’T)

RECIRCULATION

• USE MINIMUM RECIRCULATION (MEET NPDES LIMITS W/O PROBLEMS) THAT WILL PROVIDE DISSOLVED OXYGEN CONCENTRATIONS OF 3-6 mg/L (for rocks) and 4-8 mg/L (synthetic media)
• Shouldn’t be odors if kept aerobic

• Increase recirculation rate or use “masking agent”
FILTER FLIES

PSYCHODA (sigh-COAT-AH)

NON-BITING PESTS CONTROLLED BY:

• INCREASING RECIRCULATION
• FLOODING FILTERS FOR 24 hrs
• GOOD HOUSE-KEEPING (CUT WEEDS, SHRUBBERY, TALL GRASS)
• PESTICIDES (GROWTH REGULATORS)
ANOTHER PROBLEM PEST — SNAILS
SNAIL REMOVAL
UNCONTROLLED SLOUGHING

ONE OF THE MOST COMMON PROBLEMS GENERALLY SOLVED BY INCREASING RECIRCULATION
COLD WEATHER PROBLEMS

• Sometimes freezing occurs near the distributor nozzles

• Cut back on recirculation (recirculated water is generally colder than that from the primary clarifier)

• Go from a series to a parallel operation
IN EXTREME COLD WEATHER...

MIGHT HAVE TO ENCLOSE TRICKLING FILTERS
VENTILATION

NEED A TEMPERATURE DIFFERENCE OF AT LEAST 3°F BETWEEN THE AIR AND THE WATER THROUGH THE FILTER TO GET GOOD NATURAL CIRCULATION.
PLANT INFLOW VARIATIONS
(DUE TO STORMS, INFLTRATION, OR INDUSTRIAL DISCHARGES)

3 OPTIONS:

• VARY THE NUMBER OF FILTERS ON LINE
• ADJUST THE RECIRCULATION RATE
• SWITCH FROM SERIES TO PARALLEL (OR VISA-VERSA)
MAINTENANCE

• SEALS: OLD UNITS HAD MERCURY SEALS. NEW UNITS HAVE OIL-BATH SEALS THAT SHOULD BE CHECKED WEEKLY

• CHECK OIL FOR CLEANLINESS AND REPLACE WHEN DIRTY
DISTRIBUTOR ARMS:

- Flush arms weekly by opening the end flush gate.
- Speed of the rotator arms is governed by flow from the orifices.
UNDERDRAIN MAINTENANCE

BEST WAY TO CLEAN IS TO USE CITY’S HIGH VELOCITY SEWER LINE CLEANER EVERY 6 MO.
TRICKLING FILTER CLARIFIER

- HUMUS IS HIGH IN BOD AND MUST BE REMOVED

- EXPECT TO PUMP 30-40% MORE SLUDGE FROM A SECONDARY CLARIFIER (THAN A PRIMARY CLARIFIER)