This document is an instructional module package prepared in objective form for use by an instructor familiar with operation and maintenance of a trickling filter wastewater treatment system. Included are objectives, instructor guides, student handouts and transparency masters. This is the first level of a three module series and considers the purpose, use, components, operation and maintenance, and expected performance of a trickling filter system. (Author/RH)
BASIC TRICKLING FILTERS
Training Module 2.110.2.77

Prepared for the
Iowa Department of Environmental Quality
Wallace State Office Building
Des Moines, Iowa 50319

by

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Neosho, Missouri 64850

The publication of these training materials was financially aided through a contract between the Iowa Department of Environmental Quality and the Office of Planning and Programming, using funds available under the Comprehensive Employment and Training Act of 1973. However, the opinions expressed herein do not necessarily reflect the position or policy of the U. S. Department of Labor, and no official endorsement by the U. S. Department of Labor should be inferred.

September, 1977
Module Number
112 DWM

Module Title
Basic Trickling Filters

Apx. Time
11 Hours

Submodule Titles:
1. Introduction to Biological Treatment
2. Overview Trickling Filters - Component Parts
3. The Purpose of the Trickling Filter
4. Normal O & M For A Filter
5. Safety in Trickling Filter Work
6. Field Visit to a Trickling Filter Plant, Including Checklist

Overall Objectives: Upon completion of this module, the trainee will be able to describe the reason for using, the use of, the components of, the normal O & M of, and the expected performance of the trickling filter concept of trickling filter operations in wastewater treatment.

Instructional Aids:
Overhead Transparencies
35 mm Slides With Key
Handouts
Diagrams
Check lists
Instructor Key Points

Instructor Approach:
Submodules 1-5 Lecture + Discussion
Submodule 6 Lecture (Brief)
plus Demonstration
plus Discussion

References:
1) WPCF - MOP 41, 1977. "Operation of Wastewater Treatment Plants".
2) WPCF - MOP 14, 1967. "Wastewater Treatment Plant Operator Training Course Two".
4) R. Antonie, 1976. "Fixed Biological Surfaces - Wastewater Treatment".
5) NAVFAC, 1969. "NTTC Course 216, Intermediate Sewage".
6) EPA, 1970. "Operation of Wastewater Treatment Plants - A Field Study Training Program".
1) Instructor will follow detailed audio visual presentations and checklists - distributing material to trainee as indicated.

2) Instructor will evaluate trainee objectives accomplishment by (a) field trip assignment, and (b) 50 question examination (written) at end of the basic trickling filter module. All six of the sub-modules use the same type of instructional aids and instructional approach and references.
<table>
<thead>
<tr>
<th>Module No:</th>
<th>Module Title</th>
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<td>112DWW</td>
<td>Basic Trickling Filter</td>
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<table>
<thead>
<tr>
<th>Submodule Title:</th>
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<tr>
<td>Introduction to Biological Treatment, Aerobic vs Anaerobic Processes</td>
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<table>
<thead>
<tr>
<th>Objectives:</th>
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</thead>
<tbody>
<tr>
<td>The trainee will:</td>
</tr>
<tr>
<td>1) Describe the terminology and objectives of trickling filter operations.</td>
</tr>
<tr>
<td>2) Identify aerobic vs anaerobic systems and the necessary relationships of each.</td>
</tr>
<tr>
<td>3) Recognize the need for adequate pre and primary treatment before trickling filter operations.</td>
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<tr>
<td>4) Discuss personal experiences (if any) with trickling filter operations.</td>
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<tr>
<td>Slide #</td>
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<tr>
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</tr>
<tr>
<td>1</td>
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<td>4</td>
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<td>5</td>
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<td>6</td>
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</tbody>
</table>
Anaerobic Process
(no free oxygen)
(septic)

(1) Too much food
(2) Too little oxygen
(3) Bugs-different from aerobic (touch upon facultative)
(4) Odors, nuisance, unstable sludge.
(5) Occurs in T.F. operation-clogged vents, incorrect loadings, toxic loads.

Trickling filter needs:
Food-BOD/N/P

100/24 Ratio

(1) Compare to trainee breakfast-BOD gives energy & new growth nitrogen gives amino acids and proteins-phosphoros is energy source
(2) Trickling filter won't work without this minimum ratio.

Oxygen (air=20%O2)

(1) Vent systems give oxygen, draft effect-filter must not be septic
(2) No oxygen-"bugs" die

"Bugs"
(1) Aerobic, facultative bacteria eat solids
(2) Algae (green or surface)
(3) Fungi-favored if low DO and low pH
(4) Protozoans-eat bacteria
(5) Nematodes
(6) Snails-eat slime
(7) Fly (psychoda, others)

(1) Chief workhorse-refer to slide 6
(2) Indicator of "shock loads"
(3) Often indicates septic conditions have or will occur soon
(4) Help with cbliform count
(5) Sensitive indicator of shock conditions
(6) Often cause stoppages problem
(7) Nuisance-no real health hazard
(8) Zooglea film-bugs slime layer
(9) Discussion - In depth can be accomplished if trainee need dictates. expansion of
<table>
<thead>
<tr>
<th>Page</th>
<th>Pretreatment and Primary Treatment—keys to Trickling filter performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>(1) Stress need for sewer use ordinance (refer to WPCF MOP3 or EPA course 179.2) (2) Review sewer use ordinance guidelines established for state (3) Key Point—&quot;Everything affects everything&quot;</td>
</tr>
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<table>
<thead>
<tr>
<th>Page</th>
<th>You should know:</th>
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<tbody>
<tr>
<td>12</td>
<td>(1) Types of treatment primary, secondary, tertiary (2) Solids in wastewater (3) Purpose of trickling filter (4) Importance of secondary clarifier (5) Three items for aerobic process: food, bugs, oxygen</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Page</th>
<th>You also should know:</th>
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</thead>
<tbody>
<tr>
<td>13</td>
<td>(1) Aerobic sewage treatment process (2) Anaerobic sewage treatment process (3) Trickling filter needs: BOD/N/P 100/2/1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Page</th>
<th>Also that food, oxygen and &quot;bugs&quot; effect performance</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Page</th>
<th>Sewer use ordinance</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>(1) Lead short discussion (5 minutes) on problems experienced by group in this area. For example, vents broken, snail problems; supercooling, or others.</td>
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</table>

<table>
<thead>
<tr>
<th>Page</th>
<th>Questions!</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>(1) Emphasize—only poor question is the one you don't ask (est. 5 min)</td>
</tr>
<tr>
<td>Module No.</td>
<td>Basic Trickling Filter</td>
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<td>------------------------</td>
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<tr>
<td>112DWW</td>
<td>Hours 3 &amp; 4</td>
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<tr>
<td>Overview of a Trickling Filter - The Component Parts.</td>
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<table>
<thead>
<tr>
<th>Objectives</th>
<th>The trainee will:</th>
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<tbody>
<tr>
<td>1)</td>
<td>Identify and list the four component parts of a trickling filter.</td>
</tr>
<tr>
<td>2)</td>
<td>Discuss and list the functions of the component parts.</td>
</tr>
<tr>
<td>3)</td>
<td>List the BOD/N/P concept and its importance in trickling filter operations.</td>
</tr>
<tr>
<td>4)</td>
<td>Identify a &quot;typical&quot; or normal trickling filter plant flow diagram.</td>
</tr>
<tr>
<td>5)</td>
<td>Identify the component parts of a trickling filter.</td>
</tr>
</tbody>
</table>
### Slide Description

<table>
<thead>
<tr>
<th>Overhead Slide #</th>
<th>Slide Description</th>
<th>Instructor Key Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>The four component parts of a trickling filter are: Underdrain System, Media, Distributor Arm and influent structure, Retaining Wall</td>
<td>Ask class to write them down before you show slide.</td>
</tr>
</tbody>
</table>
| 2-2              | What Does Each Part Do?  
1) Underdrain System | 1) Allows collection of treated wastewater.  
2) Allows air (oxygen) through filter.  
3) Stress aerobic. |
| 2-3              | Types of Underdrain System Blocks | Design discussed later |
| 2-4              | How about the media?  
What types are used? | Simply show slide and ask trainee to write answer. |
| 2-5              | Types of Media:  
- Stone  
- Brick  
- Redwood  
- Plastic  
- Coconut Shells  
- Other | 1) Ask question – why can these various materials be used? (answer: only surface used)  
2) Design covered later |
| 2-6              | Distributor Arm and influent structure components:  
- Influent pipe  
- Distributor base  
- Arms  
- Splash plates  
- Arm cleanout  
- Level adjustment  
- Turn buckles | Review list from slide |
| 2-7 | Retaining wall and vent ports | List-ask question--why use a retaining wall? - cold weather and other. |
| 2-8 | Trickling filter with 4 parts illustrated | 1) Courtesy EPA-Kerri manual.  
2) Discuss 4 component parts - good construction necessary, good operation critical. |
| 2-9 | What are the four components of the trickling filter?  
List them | Review 4 parts |
| 2-10 | What are we trying to accomplish with these four components | Read slide and stimulate answer. |
| 2-11 | Convert dissolved and colloidal solids to settleable solids. | 1) Slide  
2) Let's 'look inside the filter bed. |
| 2-12 | Biological Action on a trickling filter | 1) Explain trickling filter not filtration  
2) Respiration process - bacteria breathe oxygen and give off carbon dioxide.  
3) Biological oxidation by "zoogleal" film - same as aerobic treatment. Slide (use of needed)  
4) "Sloughing off" gives trickling filter humus or secondary sludge. |
| 2-13 | Trickling Filter needs food (sewage)  
oxygen (air)  
"Bugs" | Relate this to human needs - trickling filter is the home. |
| 2-14 | Typical Sewage Description | 1) Emphasize food  
2) Illustrate BOD/N/P Ratio of 100/2/1  
3) Stress toxic or shock loads in filter.  
4) Equal distribution by rotary distributor and clean orifices.  
Idea is to provide food in optimum fashion; |
| 2-15 | Oxygen and vent system | 1) Emphasize aerobic nature of filter  
2) Temperature differential of 4 deg. F. for air movement.  
3) Vents must not be broken, etc.  
4) Leaves, stoppages, ponding, etc covered later. |
| 2-16 | "Bugs" | 1) All types in sewage, many of them downplay "enzymes".  
2) Toxic effects of sewer use ordinance should be stressed |
| 2-17 | Typical Trickling Filter Plant flow diagram | Stress:  
1) Sewer use ordinance  
2) Pre & primary treatment must be adequate "everything effects everything"  
3) Primary sludge removal & scum removal—a must—carryover gives clogged orifices & filters, septic sludge or wastewater, not compatible with filter operation.  
4) Stress components of trickling filter  
5) Mention recirculation (high rate filters)  
6) Secondary settling tank use as a necessary part of the system  
7) Touch on sludge disposal problems with humus. |
<table>
<thead>
<tr>
<th>Slide #</th>
<th>Illustrates</th>
<th>Instructor Key Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Influent Area - Red Color</td>
<td>Pretreatment and Sewer Use Ordinance Important</td>
</tr>
<tr>
<td>2</td>
<td>General View - Well Maintained</td>
<td>Point out 4 Compounds of Trickling Filter</td>
</tr>
<tr>
<td>3</td>
<td>Underdrain - Vents</td>
<td>Aerobic Conditions</td>
</tr>
<tr>
<td>4</td>
<td>Underdrain - Openings To Inspect</td>
<td>Safety</td>
</tr>
<tr>
<td>5</td>
<td>Inside Trickling Filter</td>
<td>Safety - Fines</td>
</tr>
<tr>
<td>6</td>
<td>Media - Stone</td>
<td>Size, Color, Odors, Problems</td>
</tr>
<tr>
<td>7</td>
<td>Media &amp; Plastic</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Distributor Arms</td>
<td>Stress - Influent, Seals, Arms, Splash Plates, Arm Cleanout, Level Adjustment</td>
</tr>
<tr>
<td>9</td>
<td>Distributor Orifices and Splash Plates</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Retaining Wall</td>
<td>Odors, Fly Problems, Mosquitos, Freezing Problems</td>
</tr>
<tr>
<td>11</td>
<td>Dosing Tank</td>
<td>Leaves, Grease</td>
</tr>
<tr>
<td>12</td>
<td>Recirculation Pumps</td>
<td>Normal O&amp;M of Pumps</td>
</tr>
<tr>
<td>13</td>
<td>Overview of Series Operation of Trickling Filter</td>
<td>Answer Questions</td>
</tr>
</tbody>
</table>

Part 2
Apx. 25 minutes

Questions
Approximately 10 minutes for answering questions

END
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<tr>
<th>Submodule Title:</th>
<th>Purpose of the Trickling Filter</th>
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### Objectives

The trainee will:

1. List the 3 necessary items in trickling filter operations and the factors influencing them.
2. Identify normal vs abnormal trickling filter performance.
3. Calculate a % removal for a trickling filter.
4. Identify normal values for trickling filter performance.
### The Purpose of the Trickling Filter

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<th>Slide Description</th>
<th>Instructor Key Points</th>
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</thead>
<tbody>
<tr>
<td>3-1</td>
<td>Object of Trickling Filter to Convert Suspended (NON-Settleable) and Dissolved Solids to Trickling Filter Humus (Settleable Solids) Called Secondary Sludge</td>
<td>1) Review &amp; Reemphasize Biological Process</td>
</tr>
<tr>
<td>3-2</td>
<td>Remember: Food Oxygen Bugs</td>
<td>1) BOD/N/P Ratio 2) Toxics &amp; Sewer Use Ordinance 3) Pre &amp; Primary Treatment</td>
</tr>
<tr>
<td>3-4</td>
<td>Temperature vs Saturation of D.O. Values</td>
<td>1) Explain Graph, show how to Read Results 2) Have Trainee Read Two Values For Two Temperature 3) Explain Correction for Altitude and Lower D.O. Values 4) Explain Correction for Salt Water (High Ion Concentration) Correction vs D.O. Values 5) Apply 3 &amp; 4 to Mountain and Coastal Treatment Plants</td>
</tr>
<tr>
<td>3-5</td>
<td>What Would The Expected Oxygen (D.O.) Level Be For A Normal Trickling Filter Operation (Effluent)</td>
<td>1) Review</td>
</tr>
<tr>
<td>3-6</td>
<td>Right! Saturation Value</td>
<td>1) Review</td>
</tr>
</tbody>
</table>
### What Factors Effect Saturation?

1. Review

<table>
<thead>
<tr>
<th>3-8</th>
<th>Right!</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Temperature</td>
<td></td>
</tr>
<tr>
<td>2. Altitude</td>
<td></td>
</tr>
<tr>
<td>3. Salt Concentration</td>
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</tbody>
</table>

1) Review and Reemphasize

### What Other Two Things Were Needed For Normal Filter Operation?

1) Slide, ask question

<table>
<thead>
<tr>
<th>3-9</th>
<th>Right!</th>
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</thead>
<tbody>
<tr>
<td>Food (Sewage)</td>
<td></td>
</tr>
<tr>
<td>and Bugs</td>
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</tbody>
</table>

1) Review

### How About The Food?

<table>
<thead>
<tr>
<th>3-10</th>
<th>Right!</th>
</tr>
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<tbody>
<tr>
<td>Food (Sewage)</td>
<td></td>
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</table>

1) Review

### BOD Means—Biochemical Oxygen Demand — 5 Days at 20°C, Normal Values—Raw Sewage 204 mg/l, Trickling Filter Effluent 30-40 mg/l

<table>
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<tr>
<th>3-11</th>
<th>BOD/N/P 100/2/4</th>
</tr>
</thead>
</table>

1) Review BOD Concept
2) Review "Standard Values"
3) Show That .17 Pounds of BOD5/person/day and 100 gpcd Sewage Gives 204 mg/l
4) Stress: Sewage is Food!

### Trickling Filter Plant (Primary Units Plus Trickling Filter plus Secondary Clarifier)

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<tr>
<th>3-12</th>
<th>Influent 204 mg/l</th>
</tr>
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<tbody>
<tr>
<td>Effluent 30 mg/l</td>
<td></td>
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</tbody>
</table>

Removal was:

204 - 30 = 174 mg/l BOD

(Removed as Sludges)

1) Review Primary if Needed
2) Stress Trickling Filter, Must Be Evaluated After Secondary Clarifier
3) Biological Oxidation Process Gave Removal
4) Removal is In-Out
<table>
<thead>
<tr>
<th>3-14</th>
<th>How Efficient Is This Filter In BOD (Food) Removal?</th>
<th>1) Ask Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-15</td>
<td>Right! 87% OR In-Out x 100 = % Removal OR 204-30 - x 100 = 87%</td>
<td>1) Stepwise - Calculate %: (87) 2) DO additional - Example: 204 mg/l 35% Removal of BOD in Primary Find Effluent BOD (Answer - 133 mg/l)</td>
</tr>
<tr>
<td>3-16</td>
<td>Nitrogen Cycle Chart</td>
<td>1) Review What Is Happening In Oxidation from Ammonia (Actually NH₄⁺) To Nitrite (NO₂⁻) to Nitrate (NO₃⁻)</td>
</tr>
<tr>
<td>3-17</td>
<td>What Should The Trickling Filter Effluent Contain? Ammonia or Nitrite or Nitrate</td>
<td>1) Again, Question, then Relate to &quot;Oxidation&quot; NH₄⁺ → NO₂⁻ → NO₃⁻</td>
</tr>
<tr>
<td>3-18</td>
<td>Right! Nitrate or NO₃⁻</td>
<td>1) Answer Questions on Nitrogen Oxidation 2) Nitrate Levels Vs Nitrite Levels Indicates Degree of Oxidation and Need for More Recirculation (discussed later)</td>
</tr>
<tr>
<td>3-19</td>
<td>High Nitrates (Effluent) Indicate Good Performance</td>
<td>1) Discuss Testing for Nitrates and NH₃/NO₂/NO₃ Ratio as Indicator of Normal and Expected Filter Performance</td>
</tr>
<tr>
<td>3-20</td>
<td>Phosphates - High Level Also PO₄³⁻</td>
<td>1) Indicate Phosphates Used As Catalyst 2) Usually High In Effluent As PO₄³⁻</td>
</tr>
</tbody>
</table>
### Purposes of Trickling Filter

1. Solids conversion - Removal
2. Saturated Dissolved Oxygen
3. BOD Removal
4. Oxidation of Nitrogen
5. Phosphates In Effluent

### Questions

Encourage trainee questions (allow aprox. 5 minutes)
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<tr>
<th>2 Hours</th>
<th>Submodule title</th>
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<tr>
<td></td>
<td>Normal O &amp; M for Trickling Filters</td>
</tr>
</tbody>
</table>

### Objectives

The trainee will:

1. Identify the 10 areas of trickling filter O & M and factors affecting each.

2. Identify parallel vs. series operational modes for a trickling filter.
### BASIC TRICKLING FILTER - 112DWW MODULE

#### Instructor Lesson Guide

Trickling Filter O & M

Hours 6 & 7 of 11

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<th>Slide #</th>
<th>Slide Description</th>
<th>Instructor Key Points</th>
</tr>
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<tbody>
<tr>
<td>4-1</td>
<td>Trickling Filter O &amp; M</td>
<td>Title Slide</td>
</tr>
</tbody>
</table>
| 4-2     | Areas of Trickling, Filter O & M | 1) Pretreatment  
2) Primary Treatment  
3) Grounds and Housekeeping  
4) Trickling Filter Retaining Wall  
5) Distributor Arms, Orifices, and Center Column  
6) Media  
7) Underdrain System  
8) Dosing Tanks (where applicable)  
9) Recirculation Pumps  
10) Multi-Filter Operation | Word Slide To Introduce  
10 Subject Areas - Each Will Use Question And Answer Technique |
| 4-3     | Why Consider Pretreatment As A Part of Trickling Filter Q & M? | 1) Ask Question - With Slide - Stimulate Trainee Response |
| 4-4     | Everything - Effects - Everything Sewer Use Ordinance  
High or Low pH | Kill "Bugs"  
High BOD/COD | Septic Filter  
Heavy Metals | Toxic Loads  
Grease | Coat Media  
Others | 1) Word Slide - Use Table  
Stimulate Discussion of Need for Strict Sewer Use Ordinance Compliance  
2) Ask for Examples By Trainees of Non-Compliance |
| 4-5     | Primary Treatment - Why Important to Trickling Filter Performance? | 1) Ask Question - Word Slide  
2) Stimulate Discussion |
| 4-6     | Poor Primary Effluent | 1) Stress "Everything Effects Everything"  
2) Must Have Good Primary Removal to Obtain Good Trickling Filter Performance |

### Areas of Trickling Filter O & M

1) Pretreatment
2) Primary Treatment
3) Grounds and Housekeeping
4) Trickling Filter Retaining Wall
5) Distributor Arms, Orifices, and Center Column
6) Media
7) Underdrain System
8) Dosing Tanks (where applicable)
9) Recirculation Pumps
10) Multi-Filter Operation

### Why Consider Pretreatment As A Part of Trickling Filter Q & M?

1) Ask Question - With Slide - Stimulate Trainee Response

### Everything - Effects - Everything

Sewer Use Ordinance
High or Low pH | Kill "Bugs"
High BOD/COD | Septic Filter
Heavy Metals | Toxic Loads
Grease | Coat Media
Others

### Primary Treatment - Why Important to Trickling Filter Performance?

1) Ask Question - Word Slide
2) Stimulate Discussion

### Poor Primary Effluent

- Septic (no DO) | Cause Filter To Decrease Removal
- Solids | Clog Filter – Decrease Carry Over (Sludge) | Removal

### Instructor Lesson Guide

Trickling Filter O & M

Hours 6 & 7 of 11
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<tr>
<th>4-6 continued</th>
<th>Grease Clog Filter Carry Over Coat Stones</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-7</td>
<td>What are Good Grounds and Housekeeping Practices?</td>
</tr>
<tr>
<td>4-8</td>
<td>Right!</td>
</tr>
<tr>
<td>1)</td>
<td>Good Grass and Mowing Edge Work</td>
</tr>
<tr>
<td>2)</td>
<td>No Vines or Weeds Near Filters (fly &amp; mosquito problem)</td>
</tr>
<tr>
<td>3)</td>
<td>Flowers (optional) Near Filters</td>
</tr>
<tr>
<td>4)</td>
<td>No Trees Near Filter (leaf problems)</td>
</tr>
<tr>
<td>5)</td>
<td>Sidewalks Clean, and Clear</td>
</tr>
<tr>
<td>6)</td>
<td>Prevent Odor Problem</td>
</tr>
<tr>
<td>4-9</td>
<td>O &amp; M on Retaining Walls?</td>
</tr>
<tr>
<td>4-10</td>
<td>Retaining Wall O &amp; M,</td>
</tr>
<tr>
<td>1)</td>
<td>Inspect for Cracks, Breaks, Repair as Needed</td>
</tr>
<tr>
<td>2)</td>
<td>Remove High Grass and Weeds Nearby</td>
</tr>
<tr>
<td>3)</td>
<td>Remove and Prevent Organic Growth and Black Slime From Interior Wall (odors)</td>
</tr>
<tr>
<td>4)</td>
<td>If Structure Painted or Coated, reapply as Needed</td>
</tr>
<tr>
<td>5)</td>
<td>Other?</td>
</tr>
<tr>
<td>4-11</td>
<td>O &amp; M of Distributor Center Column, Arms, and Orifices. What To Do</td>
</tr>
<tr>
<td>4-12</td>
<td>Center Column O &amp; M</td>
</tr>
<tr>
<td>1)</td>
<td>Mechanical Seal - Inspect and Replace Following O &amp; M Manual Guidelines</td>
</tr>
<tr>
<td>2)</td>
<td>Inspect Oil Level For Bearings on Weekly Basis - Change, Following Manufacturer's Specifications</td>
</tr>
<tr>
<td>3)</td>
<td>No Mercury Seals!</td>
</tr>
</tbody>
</table>
| 4-13 | Slide of Mechanical Seal Manufacturers, literature on mechanical seals.
1) Describe How Seal, Bearings, and Oil Function
2) Ask for And Answer Questions On |
| 4-14 | Distributor Arms O & M?
Question/Discussion |
| 4-15 | O & M Distributor Arms
1) Inspect for Corrosion, Paint Failure, Rust
2) Adjust Level of Arms Using Surveying Techniques for Summer vs Winter Operation (Turn Buckles)
3) Flush Weekly — Rod If Necessary
1) Paint, Clean, Rework As Required
2) Indicate Arms Should Be Slightly Raised When Empty Because of Weight of Water |
| 4-16 | O & M Distributor Orifice’s O&M?
Question/Discussion |
| 4-17 | O & M Distributor Orifices
1) Keep Clean With Wire Brush—Daily if Needed — Remember Safety
2) Can Run "Pan Test" To See If Equal Flow Pattern Obtained
3) Cold Weather Adjustment To Prevent Freezing Decrease Spray Pattern
4) Inspect for Snail Problem
Word Slide
2) Place Pans On Filter Surface — Measure Water After Several Passes — See WPCF MOP 11
3) As Required
4) Discuss "Snails" and Problem Solving in Section 3 |
| 4-18 | O & M for Media?
Question and Answer |
| 4-19 | Trickling Filter Media O&M Inspect Several Times Each Day for:
Color—green, how much
Odor—None
Industrial Wastes
Comment on:
1) Color — Good Growth vs "Shock" Killed Filter
Too much — Use HTH or Cl₂
2) Odor—Industrial Waste or Septic
3) Industrial Wastes 1 & 2 above |
<table>
<thead>
<tr>
<th>Page</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-19 continued</td>
<td><strong>Primary Treatment, Solids</strong>&lt;br&gt;Filter Fly Problems&lt;br&gt;Filter Ponding (Pools of Water)&lt;br&gt;Black Slime in Voids&lt;br&gt;Snail Problems&lt;br&gt;Growth on Filter Stones (Use Glove) Biological Forms (Microscope)</td>
</tr>
<tr>
<td>4-20</td>
<td><strong>Under Drain O &amp; M</strong>&lt;br&gt;What Should You Do?</td>
</tr>
<tr>
<td>4-21</td>
<td><strong>Trickling Filter Underdrain and Vent O &amp; M</strong>&lt;br&gt;1) Inspect Weekly:&lt;br&gt;   - Water Levels for Clogging&lt;br&gt;   - Look for Fine Solids from Filter Breakup&lt;br&gt;   - Snail Carcasses&lt;br&gt;2) Flush Out as Required&lt;br&gt;3) Control Snail Carcasses&lt;br&gt;4) Clean and Remove Stoppages&lt;br&gt;5) Safety Section Must Be Read First</td>
</tr>
<tr>
<td>4-22</td>
<td><strong>Trickling Filter Dosing Tanks O &amp; M</strong>&lt;br&gt;Where Used?</td>
</tr>
<tr>
<td>4-23</td>
<td><strong>Trickling Filter Dosing Tanks O &amp; M</strong>&lt;br&gt;1) Used With &quot;Older&quot; Standard Rate Filter&lt;br&gt;2) Check for Leaves, Grease, or Other Stoppages&lt;br&gt;3) Check Vent-No Stoppage&lt;br&gt;4) No Solids or Odors Use Good Housekeeping</td>
</tr>
<tr>
<td>4-24</td>
<td><strong>Dosing Siphon</strong>&lt;br&gt;How it Works (Figure)</td>
</tr>
</tbody>
</table>
| 4-25 | O & M of Recirculation Pumps  
1) Normal Pump O & M  
Manufacturer Recommendations  
2) Flow Equalization and No Flooding  
3) Recirculation Rate vs BOD Loading | 1) Discussed Later in Detail  
2) No Flooding Because Of Simultaneous Pump Operation  
3) Discussed in Detail Later, but Introduce Concept of Higher BOD Means Higher Recirculation Rate |
| 4-26 | Multi-Filter O & M  
1) Normal Filter O & M as Above  
2) Parallel vs Series Operation  
3) Flow Equalization | 1) Review 9 Items Above  
2) Cold Water and Ice Problems vs Series Operation  
3) Time Filters, - Equal Flow is Usually Equal Time Of Rotation (also do pan test item 4-17 (2)) |
| 4-27 | O & M Records  
Laboratory Control  
Safety Considerations | Word Slide |
<p>| 4-28 | Questions? | Stimulate Discussion approx. 5-10 Minutes and Answer Questions |</p>
<table>
<thead>
<tr>
<th>Module No.</th>
<th>112 DWW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour</td>
<td>8</td>
</tr>
<tr>
<td>Submodule Title:</td>
<td>Safety in the Trickling Filter Works</td>
</tr>
</tbody>
</table>

**Objectives**

The trainee will:

1) Identify the dangerous areas and accident causes in trickling filter operations.

2) List prevention procedures for these accident causes.
### Slide Description

#### Slide #5-1
**Safety in Trickling Filters**

#### Slide #5-2
**Wastewater Operations - Very Dangerous. WPCF Statistics List Wastewater Operations Many Times More Dangerous Than Other Occupations**

1. Instructor Should Stress The Actual Need for Safety Program Accidents Happen When You Don't Expect Them
2. Safety is Real - It is Needed - It Is Deadly Serious.

#### Slide #5-3
**Trickling Filter Accidents**
1. Poor Housekeeping
2. Poor Personal hygiene
3. Underdrain and Ventilation Work
4. Careless - Getting On Filters

#### Slide #5-4
**Accidents and Poor Housekeeping Examples**

- Stimulate Trainee Response To Share Ideas

#### Slide #5-5
**Poor Housekeeping**
1. Grease on Walkways - Slips and Falls
2. Piles of Debris - Falls, Cuts, Nail in Foot
3. High Grass - Snakes, Odors Turned Ankles
4. Filter Vent Grates - Open or off - Falls

- 1) Stimulate Personal Experience of Recent Accidents In the Area
- 2) Stimulate Trainee Thoughts
- 3) Discuss Prevention of Each Of The Four Items

#### Slide #5-6
**Accidents and Poor Personal Hygiene, Examples?**

- Stimulate Trainee Input
<table>
<thead>
<tr>
<th>5-7</th>
<th>Personal Hygiene</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Disease Transmission</td>
<td></td>
</tr>
<tr>
<td>- Sample Collection</td>
<td></td>
</tr>
<tr>
<td>- Picking Up Stones</td>
<td></td>
</tr>
<tr>
<td>- Unclean Clothing</td>
<td></td>
</tr>
<tr>
<td>- Cooking or Eating Near Plant</td>
<td></td>
</tr>
<tr>
<td>- Biting Fingernails</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5-8</th>
<th>Underdrain and Ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidents: What Are They?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5-9</th>
<th>Right!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suffocation and Explosion</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5-10</th>
<th>Prevention of Suffocation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Test for Oxygen Deficiency and Gases Such as Hydrogen Sulfide and Methane</td>
<td></td>
</tr>
<tr>
<td>2) Attach &quot;Approved Safety Hardness&quot; and Use Life Line Before Entering Vent Area</td>
<td></td>
</tr>
<tr>
<td>3) For Long Jobs - Repeat Gas Test Above (1) Or Use Scott Air Or Other Self Contained Units</td>
<td></td>
</tr>
<tr>
<td>4) Station 2 Men at Entrance To Vent System To Help With Life Line</td>
<td></td>
</tr>
</tbody>
</table>

| 1) Relate and Review Types Of Pathogenic Transmission: |
| cholera |
| typhoid |
| infectious hepatitis |
| many others |

| 2) Stimulate Trainee Ideas On Prevention of These: |
| gloves |
| leaving clothes away from their children |
| no eating in plant |
| or trickling filter area |

| 1) Ask trainees to answer word slide |

<table>
<thead>
<tr>
<th>5-9</th>
<th>Right!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suffocation and Explosion</td>
<td></td>
</tr>
</tbody>
</table>

| 1) Discuss Recent Occurrences of Both These Types of Accidents |
| 2) Stress that death or Disabling Accidents are Often Produced |

<p>| 1) Stress or Show How to Use Approved Gas Testing Indicators If Not Covered Elsewhere in Program Have Trainee Perform |
| 2) Demonstrate With A Trainee and Have Each Trainee Perform the Task in the Classroom |
| 3) Demonstrate and Have Trainee Put on and Use Available Equipment |
| 4) Stress Details of Lesson Relate Recent Deaths That Have Occurred |</p>
<table>
<thead>
<tr>
<th>5-11</th>
<th>Prevention of Explosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Test Area for Methane and Other Suspected Gases</td>
<td></td>
</tr>
<tr>
<td>2) Do Not Enter Unsafe Area</td>
<td></td>
</tr>
<tr>
<td>3) Use Safety Equipment On Last Slide</td>
<td></td>
</tr>
<tr>
<td>4) Avoid &quot;Sparking&quot; Tools—Lights, Torches, etc.</td>
<td></td>
</tr>
<tr>
<td>5) Wear Non-sparking (Static Electricity) Shoes—Rubber Preferred</td>
<td></td>
</tr>
<tr>
<td>6) Use Protective Gloves, Clothing, and EyeWear as Required</td>
<td></td>
</tr>
<tr>
<td>7) Use Forced Air Ventilation Where Required</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5-12</th>
<th>Carelessness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Open Vent Covers</td>
<td></td>
</tr>
<tr>
<td>2) Operator Walking or Running On Filter Surface</td>
<td></td>
</tr>
<tr>
<td>3) Horseplay</td>
<td></td>
</tr>
<tr>
<td>4) If Filter Valved Off or Stopped in Place—Tag and Lock (if possible) While Working On Filter—Pumps Included</td>
<td></td>
</tr>
</tbody>
</table>

| 1) Review Test Procedure If Required |
| 2) Not Worth The Risk |
| 3) Review Questions About |
| 4) Relate Methane to Cooking Gas Explosion |
| 5) Cite Recent Examples Of Accidents of This Type |
| 6) Ask for Trainee Experience or Questions |
| 7) Illustrate to Trainee This Type of Unit—If Available—If Not Covered In Detail in Field Inspection in Lesson 6 |

| 1) Discuss Falls—Especially at Night |
| 2) Slick and Dangerous Can't Stop Distributor |
| 3) Never |
| 4) Again Stress—Hydraulic Force Of Moving Filter Distributor |
| 5) Stimulate Trainee Thoughts and Comments |
### Solutions to Trickling Filter Safety

1. Initiate Management Safety Program
2. Initiate Operator Safety Program
3. Follow Guidelines Above
4. OSHA

### Questions or Personal Observations?

**1) Covered Elsewhere in Training Course. But Stress Management Is Key to Safety**
**2) Covered Elsewhere**
**3) Questions?**
**4) Review OSHA if Time Permits**

*Stimulate Trainee Discussion of Need for Safety and Trickling Filter Safety*
<table>
<thead>
<tr>
<th>Module No.</th>
</tr>
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<tbody>
<tr>
<td>112'DWW</td>
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<table>
<thead>
<tr>
<th>Hours</th>
</tr>
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<tbody>
<tr>
<td>9, 10, &amp; 11</td>
</tr>
</tbody>
</table>

| Basic Trickling Filter |

| 3 Hours |

<table>
<thead>
<tr>
<th>Submodule Title:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Visit to a Trickling Filter Plant, Including Checklist.</td>
</tr>
</tbody>
</table>

| Objectives |

| The trainee will: |

| 1) Identify and list various components, O & M procedures, and normal trickling filter performance by visiting an operational plant and completion of homework covering same. |

| 2) Complete a 50-question, comprehensive written examination of Module 112'DWW with a 70% or more correct score. |

END
Field Visit to a Trickling Filter Plant
Hours 9, 10, 11 of 11

Performing the Field Visit (3 Hours) Lecture with Tour

OBJECTIVE: To present the potential trainee with a suggested procedure for reviewing performance in a trickling filter plant.

Overview of Instructor Preparation

PREWORK: The instructor should review the plant plans, NPDES forms, previous O & M reports and other information available to him regarding the plant prior to the visit. If the instructor is a licensed plant operator, it will be of assistance. (See checklist before leaving the plant.)

STEP 1
Instructor Office Work - Pre-Study

BEFORE LEAVING FOR THE PLANT VISIT

<table>
<thead>
<tr>
<th>Items to Check</th>
<th>Suggested Sources of Information</th>
<th>Remarks or Actions That May Be Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Your knowledge of the safety in plant operations.</td>
<td>2. Various manuals and texts on trickling filter O&amp;M</td>
<td></td>
</tr>
<tr>
<td>C. The location and description of the plant, names of key people at the plant</td>
<td>1. Atlas and city map 2. Plans of plant as built drawings if possible; from the city or the design engineer.</td>
<td>1. Review carefully trickling filter processes used</td>
</tr>
<tr>
<td>D. The specific type and size of equipment</td>
<td>1. Design engineer's specifications or city O&amp;M manual. Copy in state pollution control office</td>
<td>1. Acquire from manufacturer the details of equipment in plant. Do not assume this will be at the plant.</td>
</tr>
<tr>
<td>E. Is the plant meeting EPA requirements for effluent?</td>
<td>1. NPDES form for plant. 2. State compliance report submitted usually on a monthly basis at the state pollution control office</td>
<td>1. Review at least 1 years date. Look for trends toward improved or inadequate plant effluent.</td>
</tr>
</tbody>
</table>
P. What safety problems have occurred at the plant?

G. Schedule time of plant visit with city manager and/or superintendent in advance

1. OSHA records
2. Workman's Compensation Records

1. May indicate a special area of concern.

1. Call-then follow up with a letter. Allow approx. 1 month before the visit unless it is an emergency visit.

1. Substantial cleanup will perhaps occur before the visit.
2. Ask in letter of visit special problems with equipment or materials that you might furnish to "help the city."

STEP 2
TELL THE TRAINEES WHAT TO EXPECT

1. Briefly describe the plant size, equipment, special problems, and other information. Answer questions:

2. Explain the trainee form to be filled out by each trainee and returned at the end of the classroom follow-up section after the plant visit.

Suggested form follows on next page.
TRAINEE PLANT EVALUATION FORM
Field Trip
Trickling Filter Wastewater Treatment Plant

Trainee Name ___________________________ Instructor ___________________________

Date ___________________________________________________________________________

Class __________________________________________________________________________

Plant Visited

Area Served: __________ sq.mi. ___________ pop.

Plant Design Flow __________ MGD
Peak Flow __________ MGD
Average Flow __________ MGD

Type of Collection System:

Lab Results:

BOD Sus:Solids Set:Solids

Separate Combined

Influent Secondary Effluent

Type of Equipment in Treatment System (Describe):

Screening ___________________________

Grit Removal ___________________________

Pre-Aeration ___________________________

Flow Meter ___________________________

Pumping ___________________________

Primary Treatment:

Type of Sedimentation Tank

Dimension of Each Tank (1) (2) (3) (4)

Capacity of each Tank ___________________________

Digestor ___________________________

Length of Weir ___________________________

Secondary Treatment:

Trickling Filter Diameter _______ Depth _______ Capacity _______ Area _______ Vol. _______

On reverse side, draw one line sketch of entire plant flows (including sludge)
### OTHER OBSERVATIONS

1. Condition of plant grounds
2. Color of media - dark green?
3. Do arms move at uniform rate?
4. Condition of receiving stream.
5. Maintenance and physical condition of filters.
6. Use of safety precautions - keep off filters.

---

**Trickling Filters - Common Deficiencies To Observe.**

1. Solids and grease in effluent
2. Seal leakage
3. Clogged nozzles
4. Splash plate adjustment

---

**Records to Review**

1. Flow records
2. Daily log, problems and maintenance
3. Test results - process controls
4. Test results - effluent
5. Pretreatment and industrial controls

---

**General Comments and Observations:**

---
STEP 3
WHEN YOU ARRIVE AT THE PLANT

Introduce yourself and trainees to the chief operator and indicate that your visit is to perform an O & M visit, not inspection, and that you would need his help during the plant visit. Specifically that you are interested in the trickling filter components in the plant.

Encourage the chief operator to walk the trainees through the entire plant and encourage questions. If there was evidence of operational deficiencies not identified by the plant operator, the instructor should make a visual inspection of plant equipment. Is normal maintenance being performed? Is it operational now? Review plant records for equipment failures concerning the trickling filter operation. Also review lab data on the plant and bacteriological test data. Make notes for the class briefing. Allow time for questions/answers and student input. Thank the plant personnel and return to classroom with trainees.
STEP 4
DEBRIEFING THE VISIT

1) Answer questions of trainees about the "Trainee Plant Evaluation Form".

2) Allow the trainee to complete the work assignment over a 2 or 3-day period. Use the summary of this work as a review for Section B on intermediate level trickling filter operation.

END
1. List the three types of wastewater treatment plants.
   1. 
   2. 
   3. 

2. A term used in preference to ppm is ___________.

3. Trickling filter sludge is often called ___________.

4. ___________. 
   Treatment processes require oxygen to function properly.

5. The three items required for biological sewage treatment are:
   1. 
   2. 
   3. 

6. "Stable" sludge is sludge that ___________.

7. An acceptable BOD/N/P ratio for biological treatment is ___________.

8. "Air" is apx. ___________ % oxygen.

9. Three biological forms found in a trickling filter are:
   1. 
   2. 
   3. 

10. List the four component parts of a trickling filter:
    1. 
    2. 
    3. 
    4. 
11. A trickling filter converts __________________ solid into __________________ solids.

12. A trickling filter actually filters out solids thus giving excellent BOD removal. True _______ False _______.

13. A temperature difference of apx. __________________ is required to get air movement through the filter.

14. A red color or foam in the effluent from the primary settling tank would indicate __________________.

15. Oxygen solubility when dissolved in water __________________ when the temperature rises and __________________ when you are located in high altitudes.

16. The normal (expected) DO level for a trickling filter would depend almost entirely upon __________________.

17. The "average" BOD of sewage coming to a trickling filter after primary treatment would be __________ mg/l.

18. If a plant receives 204 mg/l BOD$_5$ and discharges 20 mg/l BOD$_5$, what is the removal?

19. Normal trickling filter effluents would have __________ nitrate levels indicating a high degree of __________________.

20. List three items included in those things limited as discharge into a trickling filter-plant.

1. __________________

2. __________________

3. __________________

21. What does a high COD/BOD ratio indicate in the influent of a trickling filter plant?
22. "Septic" means ________________________________

23. List three good housekeeping items in good trickling filter operations.
   1. ________________________________
   2. ________________________________
   3. ________________________________

24. ________________________________ flies are a nuisance around trickling filters.

25. Mercury was often used in past years as a ________________________________ in a trickling filter, but is no longer approved.

26. A green color on a trickling filter surface indicates ________________________________

27. List one maintenance technique used on a dosing tank for a trickling filter.
   ________________________________

28. Three areas of potential accidents (not gas related) in a trickling filter plant are:
   1. ________________________________
   2. ________________________________
   3. ________________________________

29. Two gas related accidents in a trickling filter operation are:
   1. ________________________________
   2. ________________________________

30. Before entering a trickling filter system to inspect it, you should:
   ________________________________
31. - 33. Sketch a "typical" trickling filter plant flow diagram.
SEWAGE TREATMENT

PRIMARY TREATMENT = PHYSICAL TREATMENT (GRIT, SCUM, SLUDGE-OUT) SETTLING AND FLOATING

SECONDARY TREATMENT = BIOLOGICAL TREATMENT (TRICKLING FILTERS OR Activated SLUDGE)

TERTIARY TREATMENT = ANYTHING AFTER SECONDARY TREATMENT
SOLIDS OF A TYPICAL DOMESTIC WASTEWATER

INFLUENT

TOTAL SOLIDS
1,000 PPM

Dissolved Solids
700 PPM

Organic
400 PPM

Inorganic
300 PPM

WASTEWATER

99.9% WATER

0.1% SOLIDS

0.1% = 0.001

\[
\frac{1,000}{1,000} = 10 = 100 = \frac{1,000,000}{1,000,000}
\]

OR 1,000 PPM

Organic
260 PPM

Settleable
140 PPM

Non-Settleable
120 PPM

Suspended Solids
300 PPM

Organic
40 PPM

Settleable
30 PPM

Non-Settleable
10 PPM
TRICKLING FILTER IS BIOLOGICAL TREATMENT, SECONDARY TREATMENT, CONVERT SUSPENDED, NON-SETTLEABLE AND DISSOLVED SOLIDS TO SETTLEABLE SOLIDS.
TRICKLING FILTER SOLIDS CALLED "HUMUS" OR SECONDARY SLUDGE MUST USE SECONDARY CLARIFIER WITH TRICKLING FILTER.
SLIDE 5

AEROBIC PROCESS

(TRICKLING FILTER)

NEEDS

FOOD (SEWAGE)

OXYGEN (AIR)

"BUGS" (BACTERIA + OTHERS)
AERobic Process

1 Pound sewage + 1 1/2 pounds "Bugs" + D.O. + Aerobic produces sludge

C/N/P (food) + (oxygen) + aerobic produces sludge

Stable CO₂ + H₂O + SO₄⁻²

NO ODORS

N₂O₃ + PO₄³⁻
ANAEROBIC PROCESS

SEWAGE (TOO MUCH) + DO (TOO LITTLE) + "BUGS" ANAEROBIC PRODUCE UNSTABLE SLUDGE + CH₄ + H₂S + NH₃ + PU

STRONG ODORS
TRICKLING FILTER NEEDS:

\[
\text{FOOD} - \text{BOD/N/P} \\
100/2/1 \text{ RATIO}
\]
SLIDE: 9

OXYGEN

(AIR = 20% O₂)
SLIDE 10

"BUGS"

1. **AEROBIC, FACULTATIVE BACTERIA** eat solids

2. **ALGAE** (green on surface)

3. **FUNGI** - favored if low DO and low pH

4. **PROTOZOANS** - eat bacteria

5. **NEMATODES**

6. **SNAILS** - eat slime

7. **FLY** (Psychoda; others)
SLIDE 11

PRETREATMENT AND PRIMARY TREATMENT

KEYS TO TRICKLING FILTER PERFORMANCE
YOU SHOULD KNOW:

1. TYPES OF TREATMENT
   PRIMARY, SECONDARY, AND TERTIARY

2. SOLIDS IN WASTEWATER

3. PURPOSE OF TRICKLING FILTER

4. IMPORTANCE OF SECONDARY CLARIFIER

5. THREE ITEMS FOR AEROBIC PROCESS
   FOOD
   OXYGEN
   BUGS
YOU SHOULD ALSO KNOW:

1. AEROBIC SEWAGE TREATMENT PROCESS

2. ANAEROBIC SEWAGE TREATMENT PROCESS

3. TRICKLING FILTER NEEDS:
   BOD/N/P

100/2/1
SLIDE 14

FOOD

OXYGEN

& BUGS

EFFECT

PERFORMANCE
SLIDE 15

SEWER USE

ORDINANCE
QUESTIONS
THE FOUR COMPONENT PARTS OF A TRICKLING FILTER ARE:

- UNDERDRAIN
- MEDIA
- DISTRIBUTOR
- RETAINING WALL
SLIDE 2-2

WHAT DOES EACH PART DO?

UNDERDRAIN SYSTEM
SLIDE 2-3

TYPES

OF

UNDERDRAIN

SYSTEMS

BLOCKS
SLIDE 2-4

HOW
ABOUT
THE
MEDIA?

WHAT
TYPES
ARE
USED?
SLIDE 2-5

TYPES OF MEDIA:

STONE

BRICK

REDWOOD

PLASTIC

COCONUT SHELLS

OTHER
DISTRIBUTOR ARM AND INFLUENT STRUCTURE

COMPONENTS:

INFLUENT PIPE
DISTRIBUTOR BASE
ARMS
SPASH PLATES
ARM CLEANOUT
LEVEL ADJUSTMENT
TURN BUCKLES
SLIDE 2-7

RETAINING WALL AND VENT PORTS
SLIDE 2-9

WHAT ARE THE FOUR COMPONENT PARTS OF THE TRICKLING FILTER?

LIST THEM.
WHAT ARE WE TRYING TO ACCOMPLISH WITH THESE "FOUR COMPONENTS?"
SLIDE 2-11

CONVERT DISSOLVED AND COLLOIDAL SOLIDS TO SETTLEABLE SOLIDS
SLIDE 2-12

TRICKLING FILTER - BIOLOGICAL ACTION

WASTEWATER → ROCK → AIR → ROCK → SLOUGHING 

PORTION OF FILTER

ROCK → ADHESION OF SOLID PARTICLE

AIR → DO → O₂ → WASTEWATER

ROCK → BIOLOGICAL → AEROBIC → SLOUGHING

ROCK → ANAEROBIC → MAGNIFIED SECTION

70
SLIDE 2-13

TRICKLING

FILTER

NEEDS

FOOD (SEWAGE)

OXYGEN (AIR)

"BUGS"
DESCRIPTION OF SEWAGE

1. LITTLE ODOR
2. GRAY IN COLOR
3. SEWAGE SOLIDS SLIGHTLY DISINTEGRATED
4. DECOMPOSITION HAS BEGUN
5. DISSOLVED OXYGEN PRESENT
6. TEMPERATURE 40° TO 90° F.
7. CONTENTS

<table>
<thead>
<tr>
<th></th>
<th>PPM (MG/L)</th>
<th>Pounds Per Capita Per Day</th>
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<tbody>
<tr>
<td>SUSPENDED SOLIDS (TOTAL)</td>
<td>254</td>
<td>0.21</td>
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<tr>
<td>SUSPENDED SOLIDS (VOLATILE)</td>
<td>171</td>
<td>0.14</td>
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<tr>
<td>SETTLEABLE SOLIDS</td>
<td>200</td>
<td>0.17</td>
</tr>
<tr>
<td>BOD-5 DAY @ 20° C</td>
<td>204</td>
<td>0.17</td>
</tr>
<tr>
<td>pH</td>
<td>7.3</td>
<td></td>
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<tr>
<td>NITROGEN AS FREE AMMONIA</td>
<td>14</td>
<td>0.012</td>
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<tr>
<td>ORGANIC NITROGEN</td>
<td>22</td>
<td>0.018</td>
</tr>
<tr>
<td>BACTÉRIA</td>
<td>2,000,000 TO 20,000,000 PER ML</td>
<td></td>
</tr>
</tbody>
</table>
TYPICAL TRICKLING FILTER SEWAGE TREATMENT PLANT

Pretreated raw sewage from collection system

Bar screen
Grit chamber

Primary settling tank

Primary treatment

Recirculation (high rate)

Trickling filter distributor

Underdrain

To digester
Humus or head of plant

Secondary settling tank

Secondary sludge

Secondary treatment

Effluent

Chlorination tank

Sludge drying bed or other disposal
OBJECT OF TRICKLING FILTER IS TO CONVERT SUSPENDED (NON-SETTLEABLE) AND DISSOLVED SOLIDS TO TRICKLING FILTER HUMUS (SETTLEABLE SOLIDS) CALLED SECONDARY SLUDGE
SLIDE 3-2

REMEMBER

FOOD

OXYGEN

BUGS
SLIDE 3-3

ALSO AEROBIC PROCESS - EFFLUENT
SATURATED WITH DO
TEMPERATURE

\( y_s \)

SATURATION OF D.O. VALUES
SLIDE 3-5

WHAT WOULD BE THE EXPECTED OXYGEN (D.O.) LEVEL OF A NORMAL TRICKLING FILTER OPERATION (EFFLUENT)
SLIDE 3-6

RIGHT

SATURATION VALUE
WHAT FACTORS EFFECT SATURATION?
SLIDE 3-8

RIGHT.

1) TEMPERATURE
2) ALTITUDE
3) SALT CONCENTRATION
WHAT OTHER TWO THINGS WERE NEEDED FOR NORMAL FILTER OPERATION.
SLIDE 3-10

RIGHT

1) FOOD (SEWAGE)
2) BUGS
SLIDE 3-11

HOW ABOUT THE FOOD.

BOD/N/P

100/2/1
BOD MEANS - BIOCHEMICAL OXYGEN DEMAND

5 DAYS AT 20° C

NORMAL VALUES - RAW SEWAGE 204 mg/L

TRICKLING FILTER EFFLUENT 30-40 mg/L
TRICKLING FILTER PLANT (PRIMARY UNITS PLUS TRICKLING FILTER PLUS SECONDARY CLARIFIER).

INFLUENT: 204 mg/L

EFFLUENT: 30 mg/L

REMOVAL WAS:

$204 - 30 = 174 \text{ mg/L BOD}$

(REMOVED AS SLUDGES)
HOW EFFICIENT IS THIS FILTER IN BOD (FOOD) REMOVAL
SLIDE 3-15

RIGHT : 87%

OR

\[
\frac{\text{In - Out}}{\text{In}} \times 100 = \% \text{ Removal}
\]

OR

\[
\frac{204 - 30}{204} \times 100 = 87\%
\]
Fig. II-1. Nitrogen Cycle
SLIDE 3-17

WHAT SHOULD THE TRICKLING FILTER EFFLUENT CONTAIN?

AMMONIA OR NITRITE OR NITRATE
SLIDE 3-18

RIGHT.

NITRATE OR NO₃
SLIDE 3-19

HIGH NITRATES (EFFlUENT) INDICATE
GOOD PERFORMANCE
SLIDE 3-20

PHOSPHATES

HIGH LEVEL ALSO $\text{PO}_4^{3-}$
PURPOSES OF TRICKLING FILTER
1) SOLIDS CONVERSION - REMOVAL
2) SATURATED DISSOLVED OXYGEN
3) BOD REMOVAL
4) OXIDATION OF NITROGEN
5) PHOSPHATES IN EFFLUENT
TRICKLING FILTER OPERATIONS & MAINTENANCE (O & M)
SLIDE 4-2

AREAS OF TRICKLING FILTER O & M

1) PRETREATMENT
2) PRIMARY TREATMENT
3) GROUNDS AND HOUSEKEEPING
4) TRICKLING FILTER RETAINING WALL
5) DISTRIBUTOR ARMS, ORIFICES, AND CENTER COLUMN
6) MEDIA
7) UNDERDRAIN SYSTEM
8) DOSING TANKS (WHERE APPLICABLE)
9) RECIRCULATION PUMPS
10) MULTI-FILTER OPERATION
WHY CONSIDER PRETREATMENT AS A PART OF TRICKLING FILTER O & M?
EVERYTHING EFFECTS EVERYTHING - SEWER USE ORDINANCE

- HIGH OR LOW pH
- HIGH BOD/COD
- HEAVY METALS
- GREASE
- OTHERS

KILL "BUGS"

SEPTIC FILTER

TOXIC LOADS

COAT MEDIA
PRIMARY TREATMENT - WHY IS IT IMPORTANT TO
TRICKLING FILTER PERFORMANCE?
POOR PRIMARY EFFLUENT

SEPTIC (NO DO) EFFLUENT

SOLIDS CARRY OVER (SLUDGE)

GREASE CARRY OVER

CAUSE FILTER TO DECREASE REMOVAL

CLOG FILTER - DECREASE REMOVAL

CLOG FILTER - COAT STONES
WHAT ARE GOOD GROUNDS AND HOUSEKEEPING PRACTICES?
SLIDE 4-8

RIGHT.

1) INSPECT FOR CRACKS, BREAKS, REPAIR AS NEEDED

2) REMOVE HIGH GRASS AND WEEDS NEARBY

3) REMOVE AND PREVENT ORGANIC GROWTH AND BLACK SLIME FROM INTERIOR WALL (ODORS)

4) IF STRUCTURE PAINTED OR COATED, REAPPLY AS NEEDED

5) OTHER?
SLIDE 4-9

O & M ON RETAINING WALLS?
1) INSPECT FOR CRACKS, BREAKS, REPAIR AS NEEDED

2) REMOVE HIGH GRASS AND WEEDS NEARBY

3) REMOVE AND PREVENT ORGANIC GROWTH AND BLACK SLIME FROM INTERIOR WALL (ODORS).

4) IF STRUCTURE PAINTED OR COATED, REAPPLY AS NEEDED.

5) OTHER?
SLIDE 4-11

O & M OF DISTRIBUTOR CENTER COLUMN, ARMS, AND ORFICES. WHAT TO DO.
1) MECHANICAL SEAL - INSPECT AND REPLACE FOLLOWING O & M MANUAL GUIDELINES

2) INSPECT OIL LEVEL FOR BEARINGS ON WEEKLY BASIS - CHANGE, FOLLOWING MANUFACTURERS SPECIFICATIONS

3) NO MERCURY SEALS...
This part rotates

Distributor base

Adjustable rings

Mercury drain

Mercury overflow pocket

Mercury overflow drain

Oil level indicator and drain

Wastewater flow

Mercury seal prevents leakage

Bearing races

Felt oil seal

Mechanical seal

Slide 4-13

110
DISTRIBUTOR ARMS O & M?
SLIDE 4-15

O & M DISTRIBUTOR ARMS

1) INSPECT FOR CORROSION, PAINT FAILURE, RUST

2) ADJUST LEVEL OF ARMS USING SURVEYING TECHNIQUES FOR SUMMER vs WINTER OPERATION (TURN BUCKLES)

3) FLUSH WEEKLY - ROD IF NECESSARY
SLIDE 4-16

O & M DISTRIBUTOR ORFIÇES?
SLIDE 4-17

O & M DISTRIBUTOR ORIFICES

1) KEEP CLEAN WITH WIRE BRUSH, DAILY IP NEEDED: REMEMBER SAFETY

2) CAN RUN "PAN TEST" TO SEE IF EQUAL FLOW PATTERN IS OBTAINED

3) COLD WEATHER ADJUSTMENT TO PREVENT FREEZING, DECREASE SPRAY PATTERN

4) INSPECT FOR SNAIL PROBLEM
SLIDE 4-18

O & M FOR MEDIA??
TRICKLING FILTER MEDIA O & M

INSPECT SEVERAL TIMES EACH DAY FOR:

COLOR - GREEN, HOW MUCH?

ODOR - NONE.

INDUSTRIAL WASTES:

PRIMARY TREATMENT SOLIDS

FILTER FLY PROBLEM

FILTER PONDING (POOLS OF WATER)

BLACK SLIME IN VOIDS

SNAIL PROBLEMS

GROWTH-ON FILTER STONES (USE GLOVE) BIOLOGICAL FORMS.
(MICROSCOPE)
UNDER DRAIN O & M.
WHAT SHOULD YOU DO?
TRICKLING FILTER UNDER DRAIN VENT O & M

1) **INSPECT WEEKLY:**
   - WATER LEVELS FOR CLOGGING
   - LOOK FOR FINE SOLIDS FROM FILTER BREAKUP
   - SNAIL CARCASSES

2) **FLUSH OUT AS REQUIRED**

3) **CONTROL SNAIL CARCASSES**

4) **CLEAN AND REMOVE STOPPAGES**

5) **SAFETY SECTION MUST BE READ FIRST**
TRICKLING-FILTER DOSING TANKS O & M
WHERE USED?
SLIDE 4-23

TRICKLING FILTER DOSING TANKS: O & M

1) USED WITH "OLDER" STANDARD RATE FILTER

2) CHECK FOR LEAVES, GREASE, OR OTHER STOPPAGES

3) CHECK VENT - NO STOPPAGE

4) NO SOLIDS OR ODORS USE GOOD HOUSEKEEPING
SLIDE 4-24
DOSSING SIPHON

DISCHARGE LEVEL

VENT PIPE

BELL

VENT PIPE

MAIN TRAP

AIR VENT

BLOW-OFF TRAP

STEEL BALL

DEFLECTOR

AUTOMATIC SIPHON
OR DOSING CHAMBER

FIXED-SPRAY NOZZLES
SLIDE 4-25

O & M OF RECIRCULATION PUMPS

1) NORMAL PUMP O & M MANUFACTURER RECOMMENDATIONS

2) FLOW EQUALIZATION AND NO FLOODING

3) RECIRCULATION RATE vs BOD LOADING
MULTI - FILTER O & M

1) NORMAL FILTER O & M, AS ABOVE

2) PARALLEL vs SERIES OPERATION

3) FLOW EQUALIZATION
SLIDE 4-27

O & M RECORDS

LABORATORY CONTROL

SAFETY CONSIDERATIONS
SLIDE 5-1

SAFETY IN

TRICKLING FILTERS
SLIDE 5-2

WASTEWATER OPERATIONS -- VERY DANGEROUS.

WPCF STATISTICS LIST WASTEWATER OPERATIONS

MANY TIMES MORE DANGEROUS THAN OTHER OCCUPATIONS.
SLIDE 5-3
TRICKLING FILTER ACCIDENTS:

1) POOR HOUSEKEEPING

2) POOR PERSONAL HYGIENE

3) UNDERDRAIN AND VENTILATION WORK

4) CARELESS - GETTING ON FILTERS
SLIDE 5-4

ACCIDENTS AND

POOR HOUSEKEEPING

EXAMPLES
POOR HOUSEKEEPING

1) GREASE ON WALKWAYS - SLIPS AND FALLS

2) PILES OF DEBRIS - FALLS, CUTS, NAILS IN FEET

3) HIGH GRASS - SNAKES, ODORS, TURNED ANKLES

4) FILTER VENT GRATES - OPEN OR OFF - FALLS
SLIDE 5-6

ACCIDENTS AND POOR PERSONAL HYGIENE, EXAMPLES?
DISEASE TRANSMISSION

SAMPLE COLLECTION

PICKING UP STONES

UNCLEAN CLOTHING

COOKING OR EATING NEAR PLANT

BITING FINGERNAILS
UNDERDRAIN AND VENTILATION ACCIDENTS -- WHAT ARE THEY?
SLIDE 5-9

RIGHT,

SUDDEN DEATH

AND

EXPLOSION
PREVENTION OF SUFFOCATION

1) TEST FOR OXYGEN DEFICIENCY AND GASES SUCH AS HYDROGEN SULFIDE AND METHANE.

2) ATTACH "APPROVED SAFETY HARDNESS" AND USE LIFE LINE BEFORE ENTERING VENT AREA.

3) FOR LONG JOBS, REPEAT GAS TEST ABOVE (1) OR USE SCOTT AIR OR OTHER SELF CONTAINED UNITS.

4) STATION 2 MEN AT ENTRANCE TO VENT SYSTEM TO HELP WITH LIFE LINE.
SLIDE 5-11

PREVENTION OF EXPLOSION

1) TEST AREA FOR METHANE AND OTHER SUSPECTED GASES.

2) DO NOT ENTER UNSAFE AREA.

3) USE SAFETY EQUIPMENT ON LAST SLIDE.

4) AVOID "SPARKING" TOOLS, LIGHTS, TORCHES, ETC.

5) WEAR NON-SPARKING (STATIC ELECTRICITY)-SHOES, RUBBER PREFERRED

6) USE PROTECTIVE GLOVES, CLOTHING, AND EYE WEAR AS REQUIRED.

7) USE FORCED AIR VENTILATION WHERE REQUIRED.
SLIDE 5-12

CARELESSNESS

1) OPEN VENT COVERS

2) OPERATOR WALKING OR RUNNING ON FILTER SURFACE.

3) HORSEPLAY

4) IF FILTER VALVE OFF OR STOPPED IN PLACE, TAG AND LOCK (IF POSSIBLE) WHILE WORKING ON FILTER - PUMPS INCLUDED.
SOLUTIONS TO TRICKLING FILTER SAFETY

1) INITIATE MANAGEMENT SAFETY PROGRAM

2) INITIATE OPERATOR SAFETY PROGRAM

3) FOLLOW GUIDELINES ABOVE

4) OSHA