**Section 370.900 Trickling Filters**

a) General

1) Applicability

Trickling filters may be used for treatment of sewage amenable to treatment by aerobic biologic processes. Trickling filters shall be preceded by settling tanks equipped with scum and grease collecting devices, or other suitable pretreatment facilities.

2) Design Basis

Filters shall be designed so as to provide the required reduction in biochemical oxygen demand, ammonia nitrogen, or to properly condition the sewage for subsequent treatment processes.

3) Multiple Units

Multiple trickling filter units capable of independent operation are recommended for all plants and must be provided for those plants where the design average flow exceeds 100,000 gallons per day. Plants not having multiple units shall include other provisions to assure continuity of treatment.

b) Dosing Equipment

1) Distribution

A) All hydraulic factors involving proper distribution of sewage on the filter should be carefully calculated and submitted with the basis of design.

B) The sewage may be distributed over the filter by rotary distributors or other suitable devices which will permit reasonably uniform distribution to the surface area. At design average flow, the deviation from calculated uniformly distributed volume per square foot of the filter surface shall not exceed plus or minus 10 percent at any point.

2) Dosing and Recirculation

A) Sewage may be applied to the filters by siphons, pumps or by gravity discharge from preceding treatment units when suitable flow characteristics have been developed. Application of the sewage should be continuous except for low rate filters. A hydraulic system for recirculation shall be provided for new facilities and should be considered where existing trickling filter units are included in treatment plant upgrading.

B) The piping system, including dosing equipment and distributor, shall be designed to provide capacity for the peak hourly flow rate including recirculation rates determined under subsection (h).

3) Distributor Head Requirements

For reaction type distributors, a minimum head of 24 inches between low water level in siphon chamber and center of arms is required. Similar allowances shall be made in design for added pumping head requirements where pumping to the reaction type distributor is used. The design shall include the head required at the center column for the full range of flows, taking into account all head losses from the center column back to the dosing facility at all water levels. Calculations shall be submitted to justify the basis of design.

4) Clearance

A minimum clearance of 6 inches between media and distributor arms shall be provided. Refer to subsection (e)(4).

c) Media

1) Quality

The media may be crushed rock, slag or specially manufactured material. The media shall be durable, resistant to spalling or flaking, and be relatively insoluble in sewage. The top 18 inches shall have a loss by the 20-cycle, sodium sulfate soundness test of not more than 10 percent, as prescribed by ASCE Manual of Engineering Practice, Number 13, the balance to pass a 10-cycle test using the same criteria. Slag media shall be free from iron. Manufactured media shall be resistant to ultraviolet degradation, disintegration, erosion, aging, all common acid and alkalies, organic compounds, and fungus and other biological attack. Such media shall be structurally capable of supporting a man's weight or a suitable access walkway shall be provided to allow for distributor maintenance.

2) Depth

The filter media shall have a minimum depth of 6 feet above the underdrains. For rock media filters (subsection (c)(3)(A)), only the top 7 feet of the volume of the filter shall be considered in BOD removal credit computations. For manufactured media filters see subsection (c)(3)(B).

3) Size and Grading of Media

A) Rock, Slag and Similar Media

i) Rock, slag and similar media shall not contain more than 5 percent by weight of pieces whose longest dimension is 3 times the least dimension.

ii) Media shall be free from thin elongated and flat pieces, dust, clay, sand, or fine material and shall conform to the following size and grading when mechanically graded over vibrating screen with square openings:

Passing 4 1/2 inch screen – 100% by weight

Retained on 3 inch screen – 95-100% by weight

Passing 2 inch screen – 0-2% by weight

Passing 1 inch screen – 0-1% by weight

B) Manufactured Media

Suitability of size, space, media configuration and depth will be evaluated on the basis of experience with installations handling similar wastes and loadings. To ensure sufficient void clearance, media with a specific surface area of no more than 30 square feet per cubic foot may be used for filters employed for carbonaceous reduction, and media with a specific surface area of no more than 45 square feet per cubic foot may be used for second stage ammonia reduction. See subsection (c)(1) for quality requirements.

4) Handling and Placing of Media

A) Material delivered to the filter site shall be stored on wood planks or other approved clean hard surfaced areas.

B) All material shall be rehandled at the filter site and no material shall be dumped directly into the filter. Crushed rock, slag and similar media shall be rescreened or forked at the filter site to remove all fines.

C) The material shall be placed by hand to a depth of 12 inches above the tile underdrains and all material shall be carefully placed so as not to damage the underdrains. The remainder of the material may be placed by means of belt conveyors or equally effective methods approved by the engineer.

D) Manufactured media shall be handled and placed as recommended by the manufacturer and approved by the engineer.

E) Trucks, tractors, or other heavy equipment shall not be driven over the filter during or after construction.

d) Underdrainage System

1) Arrangement

Underdrains with semi-circular inverts or equivalent should be provided and the underdrainage system shall cover the entire floor of the filter. Inlet openings into the underdrains shall have an unsubmerged gross combined area equal to at least 15 percent of the surface area of the filter.

2) Slope

The underdrains shall have a minimum slope of 1 percent. Effluent channels shall be designed to produce a minimum velocity of 2 feet per second at design average flow of application to the filter and shall have adequate capacity for the peak hourly flow rate including the required recirculation flows.

3) Flushing

Provision should be made for flushing the underdrains. In small filters, use of a peripheral head channel with vertical vents is acceptable for flushing purposes. Inspection facilities should be provided.

4) Ventilation Requirements for Underdrains

The underdrainage system, effluent channels, and effluent pipe should be designed to permit free passage of air. The size of drains, channels, and pipe should be such that not more than 50 percent of their cross-sectional area will be submerged under the design hydraulic loading. Consideration should be given in the design of the effluent channels to the possibility of increased hydraulic loading.

e) Special Features

1) Flooding

Provision shall be made in the design of conventional rock filter structures so that the media may be flooded.

2) Maintenance

All distribution devices, underdrains, channels and pipes shall be designed so that they may be properly maintained, flushed or drained.

3) Flow Measurement

Devices shall be provided to permit measurement of flow to the filter, and of recirculated flows.

4) Protection From Freezing

Trickling filters shall be covered to protect from freezing, and to maintain operation and treatment efficiencies. The filter cover shall be constructed of appropriate corrosion resistant materials and designed to allow operator access for maintenance, repair and replacement of the filter dosing equipment.

5) Ventilation of Covered Filters

Forced ventilation shall be provided for covered trickling filters to insure adequate oxygen for process requirements. Windows or simple louvered mechanisms so arranged to insure air distribution throughout the enclosure shall be provided. The ventilation facilities shall be designed to allow operator control of air flow in accordance with outside temperature. Design computations showing the adequacy of air flow to satisfy process oxygen requirements shall be submitted.

f) Two-Stage Filters

The foregoing standards also apply to second stage filters.

g) Special Applications

1) Roughing Filters

In some instances it is desirable to partially reduce the organic strength of wastewaters. In such cases trickling filters may be used for roughing treatment. Design parameters and contaminant removal efficiencies will be approved on a case-by-case basis. Refer to subsections (h)(2) and (h)(3).

2) Nitrifying Filters

Trickling filters may, under favorable conditions, be used as nitrification devices. Design parameters and contaminant removal efficiencies will be approved on a case-by-case basis. Refer to Section 370.1210(d).

h) Efficiency

1) Single Stage, Settling Tank – No Recirculation

Expected reduction of BOD of settled normal domestic wastewater by a single stage filter, packed with crushed rock, slag or similar material and with subsequent settling, shall be determined from Appendix F, Figure No. 3. In developing this curve, loading due to recirculated sewage has not been considered.

2) Single or Multi-Stage, Settling Tank – Recirculation

Expected BOD removal efficiencies may also be determined by theoretical and empirical formula if accompanied by detailed explanation, particularly for roughing filters and for filters with recirculation. (Refer to WEF Manual of Practice (MOP) No. 8, "Design of Municipal Wastewater Treatment Plants", vol. 1 (1992).)

3) Single or Multi-Stage, No Settling Tank – Recirculation Filters not followed by a settling tank and discharging into a subsequent treatment process shall not be credited with BOD removal efficiencies as in subsections (h)(1) and (h)(2) above. Expected performance in such cases, including filters packed with manufactured media, shall be determined from prototype testing and full-scale plant experience.

(Source: Amended at 21 Ill. Reg. 12444, effective August 28, 1997)