

4720.3945 RAPID RATE GRAVITY FILTERS.

Subpart 1. **Pretreatment.** Rapid rate gravity filters must only be used after coagulation, flocculation, and sedimentation.

Subp. 2. **Number.** At least two filter units must be provided. Provisions must be made to meet the maximum day demand at the approved filtration rate if one filter is out of service.

Subp. 3. **Rate of filtration.** The permissible rate of filtration shall be determined after consideration of factors such as raw water quality, the degree of pretreatment provided, the filter media, and water quality control parameters. In all cases the filtration rate must be reviewed and approved by a registered engineer and approved by the commissioner before the preparation of final plans.

Subp. 4. **Structural details and hydraulics.** The filter structure must be designed to:

- A. provide vertical walls within the filter;
- B. prevent protrusion of the filter walls or other structures into the filter media or the area between the top of the media and the high water line during backwashing;
- C. provide cover by superstructure;
- D. provide head room to permit normal inspection and operation;
- E. provide a minimum filter depth of 8-1/2 feet;
- F. provide a minimum water depth three feet over the surface of the media;
- G. provide a trap on the effluent pipe or conduit to prevent backflow of air to the bottom of the filter;
- H. prevent drainage from the floor to the filter with a minimum four-inch curb around the filter;
- I. prevent flooding by providing overflow if this is not provided in a pretreatment unit;
- J. provide a maximum velocity of treated water in the pipe and conduits to the filter of two feet per second;
- K. provide cleanouts and straight alignment for influent pipes or conduits where solids loading is heavy or following lime-soda softening;
- L. provide wash water drain capacity to carry maximum backwash flow;
- M. provide walkways around filters not less than 24 inches wide; and
- N. provide safety handrails or walls around the filter areas adjacent to the walkways.

Subp. 5. **Wash water troughs.** Wash water troughs must be designed to provide:

- A. a bottom elevation above the maximum level of expanded media during washing;
 - B. a top elevation not exceeding 30 inches above the filter surface;
 - C. a two-inch freeboard at the maximum rate of wash;
 - D. a top or edge which is level;
 - E. spacing so each trough serves the same number of square feet of filter area;
- and

F. a maximum horizontal travel of suspended particles not exceeding three feet in reaching the trough.

Subp. 6. **Filter media.** Filter media must meet the standards specified in this subpart.

- A. Sand must be:
 - (1) clean silica sand having a depth no less than 24 inches and no more than 30 inches;
 - (2) an effective size from 0.45 millimeter to 0.55 millimeter, depending upon the quality of the raw water; and
 - (3) have a uniformity coefficient no greater than 1.65 millimeters.

B. Clean crushed anthracite, or sand and anthracite may be used as a filter media if supported by experimental data obtained from the project. Anthracite used as the only media must have an effective size from 0.45 millimeter to 0.8 millimeter and a uniformity coefficient no greater than 1.6 millimeters. Anthracite used to cap sand filters must have an effective size from 0.7 millimeter to 1.2 millimeters and a uniformity coefficient no greater than 1.85 millimeters.

C. Granular activated carbon may be used as a filter material only if approved by the commissioner. A request for approval must:

- (1) include a report from a registered engineer detailing raw water quality, the results of pilot plant studies, proposed flow rates, process controls to be provided, proposed operational adjustments, and justification for the project proposals;
- (2) specify criteria for the media;
- (3) provide for a chlorine residual in the water following filtering and before distribution;
- (4) provide for periodic treatment of the filter bed to control possible bacterial and other growths; and

(5) include plans showing any proposed modification of facilities.

D. Other media may be approved by the commissioner, but only on the basis of pilot tests and experience which demonstrate that the requirements of this part will be met.

E. Except as provided in item F, sand and gravel must be provided as supporting media according to subitems (1) and (2).

(1) A three-inch layer of sand must be used as a supporting media for the filter sand. The sand must have an effective size from 0.8 millimeter to 2.0 millimeters, and a uniformity coefficient no greater than 1.7 millimeters.

(2) Gravel, when used as the supporting media, must consist of hard, rounded particles and must not include flat or elongated particles. The coarsest gravel shall be no more than 2-1/2 inches in diameter in any direction when the gravel rests directly on the strainer system, and must extend above the top of the perforated laterals or strainer nozzles. No less than four layers of gravel shall be provided according to the following size and depth distribution when used with perforated laterals or strainer nozzles:

(a) 2-1/2 to 1-1/2 inches, five to eight inches deep;

(b) 1-1/2 to 1/4 inches, three to five inches deep;

(c) 1/4 to 1/2 inches; three to five inches deep;

(d) 1/2 to 3/16 inches, two to three inches deep; and

(e) 3/16 to 3/32 inches, two to three inches deep.

F. If the supplier submits substantiation to the commissioner that proprietary filter bottoms are used, the commissioner may allow elimination of certain layers of supporting media or a reduction in the depth of the layers of supporting media that are required in item E.

Subp. 7. **Filter bottoms and strainer systems.** Departures from the standards in this subpart by using proprietary bottoms may be approved by the commissioner on a case-by-case basis if the effectiveness of the method is demonstrated by the supplier. Porous plate bottoms must not be used where iron or manganese may clog them or with water softened with lime. The design of a manifold-type collection system must:

A. minimize loss of head in the manifold and laterals;

B. assure even distribution of wash water and an even rate of filtration over the entire area of the filter;

C. provide a ratio of the area of the final openings of the strainer system to the area of the filter of not more than 0.003;

D. provide a total cross-sectional area of the laterals at least twice the total area of the final openings of the strainer system; and

E. provide a cross-sectional area of the manifold at 1-1/2 to two times the total cross-sectional area of the laterals.

Subp. 8. **Surface wash.** Surface wash facilities consisting of either fixed nozzles or a revolving mechanism are required. All devices must be designed for:

A. water pressures of at least 45 pounds per square inch;

B. a volume of flow of 2.0 gallons per minute per square foot of filter area with fixed nozzles and 0.5 gallons per minute per square foot with revolving arms; and

C. a vacuum breaker installed above the high water elevation in the filter or other device approved by the commissioner to prevent back siphonage.

Subp. 9. **Appurtenances.** The following shall be provided for every filter:

A. a sampling tap on the effluent line;

B. a loss-of-head gauge;

C. controls to indicate flow rate;

D. a drain to waste with appropriate measures for backflow prevention;

E. a means of monitoring the effluent from each filter for turbidity on a continuous basis or on a selective basis where one turbidimeter would monitor more than one filter on a rotating cycle. The turbidimeter must have a recorder. Access to the filter interior through wall sleeves must be provided in several locations to allow the installation of sampling lines, pressure sensors, and other devices, at different depths in the filter media; and

F. a one to 1-1/2 inch pressure hose and rack at the operating floor for washing the filter walls.

Subp. 10. **Backwash.** Facilities must provide for the washing of filters as follows:

A. by filtered water at a rate no less than 15 gallons per square foot per minute from wash water tanks, a wash water pump from a reservoir, or a high service main, or a combination of these;

B. by wash water pumps in duplicate unless an alternate means of obtaining wash water is available;

C. by no less than 15 minutes wash of one filter at the design rate of wash;

D. by a wash water regulator or valve on the wash water line to obtain the desired rate of filter wash;

E. by a rate-of-flow indicator and totalizer on the main wash water line, located for convenient reading by the operator during the washing process; and

F. by a method which prevents rapid changes in the backwash water flow.

Subp. 11. **Roof drains.** Roof drains must not discharge into the filters and basins or the conduits preceding the filters.

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