IOWA WASTEWATER FACILITIES DESIGN STANDARDS

CHAPTER 18A

FIXED FILM MEDIA TREATMENT

18A.1 GENERAL

- 18A.1.1 Applicability
- 18A.1.2 Variances
- 18A.1.3 Explanation of Terms

18A.2 PROCESS SELECTION

- 18A.2.1 Applicability
- 18A.2.2 Specific Process Selection

18A.3 PRETREATMENT

18A.4 INDUSTRIAL WASTES

- 18A.4.1 General
- 18A.4.2 Prohibited Wastes

18A.5 DESIGN INFORMATION

18A.6 TRICKLING FILTERS

- 18A.6.1 General
  - 18A.6.1.1 Types of Processes
- 18A.6.2 Hydraulics
  - 18A.6.2.1 Distribution
  - 18A.6.2.2 Piping System
- 18A.6.3 Media
  - 18A.6.3.1 Manufactured Media
  - 18A.6.3.2 Rock Media

18A.6.4 Underdrainage System

18A.6.4.1 Arrangement
18A.6.4.2 Hydraulic Capacity and Ventilation
18A.6.4.3 Flushing

18A.6.5 Special Features

18A.6.5.1 Covers
18A.6.5.2 Recirculation
18A.6.5.3 Recirculation Measurement

18A.6.6 Rotary Distributor Seals

18A.6.7 Unit Sizing

18A.6.8 Activated Filters

18A.7 ROTATING BIOLOGICAL CONTACTORS

18A.7.1 Surface Area

18A.7.2 Accessibility

18A.7.3 Enclosures

18A.7.4 Design Considerations

18A.7.4.1 Dewatering
18A.7.4.2 Rotation
18A.7.4.3 Staging
18A.7.4.4 Weight Measurement
18A.7.4.5 Flow Control
18A.7.4.6 Other Design Requirements
18A.7.4.7 Other Design Recommendations

18A.7.5 Flexibility

18A.7.6 Organic Load

18A.7.7 Flow Equalization

18A.7.8 Design for Nitrification

IOWA WASTEWATER FACILITIES DESIGN STANDARDS

CHAPTER 18A

FIXED FILM MEDIA TREATMENT

18A.1 GENERAL

18A.1.1 Applicability

This chapter is applicable to construction, installation or modification of any disposal system required to obtain a construction permit from this Department under the Iowa Code Section 455B.183 and 900--64.2 of the Iowa Administrative Code.

18A.1.2 Variances [900--64.2(9)"c" I.A.C.]

When engineering justification satisfactory to the executive director is provided substantially demonstrating that variation from the design standards or siting criteria will result in either: at least equivalent effectiveness while significantly reducing costs, or improved effectiveness, such a variation from design standards or siting criteria may be accepted by the executive director.

18A.1.3 Explanation of Terms

The terms "shall" or "must" are used in these standards when it is required that the standard be used. Other terms such as "should" and "recommended" indicate desirable procedures or methods which should be considered but will not be required.

18A.2 PROCESS SELECTION

18A.2.1 Applicability

The fixed film media treatment processes discussed in this chapter include trickling filters and rotating biological contactors (RBC's). These processes can be used for roughing, secondary treatment, nitrification or polishing to treat wastewater which is amenable to biological treatment.

18A.2.2 Specific Process Selection

The fixed film media treatment processes and their modifications may be employed to accomplish varied degrees of removal of suspended solids and reduction of carbonaceous and nitrogenous oxygen demand. Choice of the process most applicable will be influenced by the proposed plant size, type of waste to be treated, treatability of waste, degree and consistency of treatment required and local factors.

18A.3 PRETREATMENT

RBC's and trickling filters must be preceeded by settling tanks or other pretreatment devices which provide for effective removal of grit, debris and excessive oil or grease. Bar screening or comminution are not suitable as the sole means of pretreatment.

18A.4 INDUSTRIAL WASTES

18A.4.1 General

Consideration shall be given to the type and effects of industrial wastes on the treatment process. It may be necessary to pretreat industrial wastes prior to discharge to the sanitary sewer system.

18A.4.2 Prohibited Wastes

The following wastes shall not be discharged to these processes without assessment of their effects upon the treatment process or discharge requirements in accordance with state and federal law:

a. Any toxic chemicals which may inhibit biological or bacteriological processes.

b. Any strong oxidizing agents or disinfectants in quantities sufficient to inhibit the growth of microorganisms.

c. Metal plating wastes or other toxic wastes containing heavy metals and/or toxic or noxious inorganic chemicals, such as cyanide, reduced sulfur compounds, arsenic and selenium.

d. Detergent wastes or other wastes containing excessive phosphorous or surfactants.

e. Plastics, pharmaceutical wastes and/or other synthetic organic chemicals not amendable to biological treatment.

f. Any wastes containing excessive amounts of nonbiodegradable oil and grease or tar.

g. Any acidic or alkaline wastes which because of quantity, strength or unequalized flow may upset the biological process.

h. Any wastes containing in excess of 1 milligram per liter phenols.

i. Any wastes containing radioactive chemicals.

j. Nutrient deficient wastes which cannot meet the normal ratio of 100 BOD_5: 5 Nitrogen: 1 Phosphorous necessary for the maintenance of the biological community. An example would be paper mill wastes.

k. Any wastes that might cause physical deterioration of the filter media, piping or structures.

l. Any other waste which may be defined as an incompatible pollutant.

18A.5 DESIGN INFORMATION

Fixed film media treatment processes shall be designed to provide for reduction in carbonaceous and/or nitrogenous oxygen demand in accordance with water quality standards and objectives for the receiving waters as established by the Department, or to properly condition the wastewater for subsequent treatment processes.

Information to be provided by the design engineer when proposing the use of fixed film media treatment processes shall include the following:

* influent BOD, TSS, TKN, and NH_3-N concentrations
* influent temperature
* wastewater heat loss through the various units
* calculations of expected BOD removal and TKN/NH_3-N removal (if appropriate)
* basis for sizing of units
* recirculation rates (if appropriate)

18A.6 TRICKLING FILTERS

18A.6.1 General

Where existing trickling filters are being utilized in the upgrading of wastewater treatment facilities, or where unusual conditions may exist, this Department may vary from these design criteria provided that adequate engineering justification is submitted.

18A.6.1.1 Types of Processes

Trickling filters shall be classified according to the applied hydraulic and organic loadings at AWW flow. The hydraulic loading is the total volume of

liquid, including recirculation, per unit time per square unit of filter plan surface area. Organic loading is the BOD, including recirculation, per unit time per cubic unit of filter volume. Typical loadings for the various classifications of filters are summarized in Table 1.

TABLE 1 TYPICAL DESIGN CRITERIA

Operating Characteristics	Classification of Filter				
	Low or Standard Rate	Intermediate Rate	High Rate	Super Rate	Roughing
Type of Media	Rock	Rock	Rock or Manufactured	Manufactured	Rock or Manufactured
Hydraulic loading:					
gpd/sq. ft. gpm/sq. ft.	25-90 0.017-0.063	90-230 0.063-0.160	230-900 0.160-0.625	350-2,100 0.243-1.458	700-4,200 0.486-2.917
Organic loading:					
lb BOD/1,000 cu. ft./day	5-25	15-30	25-300	Up to 300	100-500
Depth (ft)	6-8	6-8	3-8	10-40	3-20
Typical BOD removal (%)	80-85	50-70	65-80	65-85	40-65

Note: The BOD removal credits allowed will be based upon the calculations submitted.

18A.6.2 Hydraulics

18A.6.2.1 Distribution

a. The wastewater shall be distributed over the filter by rotary distributors or other suitable devices which will ensure uniform distribution to the surface area under all design flow conditions.

b. For rotary type distributors, a minimum head of 24 inches between low water level in the siphon chamber and the center of the arms is required or a similar allowance shall be added to pumping head requirements.

c. For rotary type distributors, a minimum clearance of six inches between media and distributor arms shall be provided.

18A.6.2.2 Piping System

The piping, pumps and distribution system must be capable of handling the PHWW flow, or other flows plus recirculation if the total of such flows is greater than PHWW flow.

18A.6.3 Media

18A.6.3.1 Manufactured Media

a. Description

Manufactured media is the term used to describe media made from plastic or other material (such as wood), as distinguished from rock media.

b. Quality

Manufactured media shall be resistant to ultraviolet degradation, disintegration, erosion, aging, all common acids, alkalies and solvents, organic compounds, and fungus and biological attack. Manufactured media shall be durable and insoluble in sewage.

c. Depth

Manufactured filter media depth shall not exceed 40 feet.

18A.6.3.2 Rock Media

a. Quality

The media shall be durable, resitant to spalling or flaking and 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 is to pass a 10-cycle test using the same criteria. Slag media shall be free from iron.

b. Depth

Rock and/or slag filter media depths shall not exceed 10 feet.

c. Size and Grading

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

They 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 screens 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

18A.6.4 Underdrainage System

18A.6.4.1 Arrangement

The underdrainage system shall cover the entire floor of the filter. Inlet openings into the underdrains shall have a total area equal to at least 15 percent of the surface area of the filter.

18A.6.4.2 Hydraulic Capacity and Ventilation

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 AWW flow.

The underdrainage system, effluent channels, and effluent pipe shall be designed to permit free passage of air. The sizes of drains, channels, and pipes shall be such that not more than 50 percent of their cross-sectional area will be submerged under the MWW flow, including proposed or possible future recirculated flows.

Consideration should be given to the use of forced ventilation for deep manufactured media filters or filters with high organic loadings.

18A.6.4.3 Flushing

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

18A.6.5 Special Features

18A.6.5.1 Covers

Covers shall be provided for all new filter installations. Covers shall be removable or shall be designed to provide adequate clear space for maintenance and for removal and replacement of equipment and media.

Covers shall be constructed of suitable corrosion resistant materials. Windows or simple louvered mechanisms which can be opened in the summer and closed in the winter shall be installed to provide adequate ventillation.

Non-metalic covers shall be firmly reinforced with corrosion resistant metal at points of attachment, movement and wear, including windows or ventilation ports, doors and base flanges where attached to walls or foundations. All hardware for ports, windows and doors shall be of corrosion resistant metal; plastic will not be acceptable.

18A.6.5.2 Recirculation

The piping system shall be designed for recirculation as required to achieve the design removal efficiency and maintain adequate surface wetting rates. The recirculation rate shall be variable and subject to plant operator control.

18A.6.5.3 Recirculation Measurement

Facilities shall be provided to permit measurement of the recirculation rate.

18A.6.6 Rotary Distributor Seals

Mercury seals are not permitted.

18A.6.7 Unit Sizing

Required volumes of filter media should be no less than those given in Section 18A.6.1.1, Table 1. The unit sizing shall be verified by utilizing an applicable equation from the literature (such as ASCE Manual of Practice No. 36, standard engineering texts or research literature).

18A.6.8 Activated Filters

Typical values for organic loadings to the filter should range from 100 to 350 lb BOD/1,000 cubic feet of filter media (4,300 to 15,000 pounds BOD per acre foot per day) and the hydraulic wetting rate should range from 1.0 to 5.5 gpm/sq.ft. Criteria for media should be in accordance with Table 1, Section 18A.6.1.1 and Section 18A.6.3.1. The aeration basin size and oxygen requirements should be estimated in accordance with Chapter 18B "Activated Sludge Biological Treatment". Calculations of mixed liquor suspended solids should consider the influent suspended solids and the solids sloughing from the filter in addition to growth of activated sludge due to removal of BOD.

18A.7 ROTATING BIOLOGICAL CONTACTORS

18A.7.1 Surface Area

a. Standard Density: Standard density media is defined as media with a surface area of 100,000 to 128,250 sq.ft. for a typical modular unit. A typical modular RBC unit has a maximum shaft length of approximately 27 feet with 25 feet occupied by media. Maximum media diameter is 12 feet.

b. High Density: High density media is defined as media with a surface area of 138,000 to 180,000 sq.ft. for a typical modular unit. (If typical modular units with surface areas between 128,250 and 138,000 sq.ft. become available, a determination will be made on a case-by-case basis on whether they are to be classified as standard density or high density media.)

18A.7.2 Accessibility

Access shall be provided for the repair or replacement of the media or shafts or entire RBC units. If it is proposed to use portable hoisting equipment for removal or replacement of units, the arrangement shall be such that the hoisting equipment can be located directly adjacent to any unit to be removed.

18A.7.3 Enclosures

RBC's shall be covered to protect the biological growth from cold temperatures and excessive loss of heat from the wastewater.

If individual enclosures are provided they shall be constructed of a suitable corrosion resistant material. Windows or simple louvered mechanisms which can be opened in the summer and closed in the winter shall be installed to provide adequate ventilation. The enclosure shall be adequately insulated to minimize heat loss.

Non-metalic enclosures shall be firmly reinforced with corrosion resistant metal at points of attachment, movement and wear, including windows or ventilation ports, doors, access hatches and base flanges where attached to foundations. All hardware for ports, windows, doors and access hatches shall be of corrosion resistant metal; plastic will not be acceptable.

All enclosures shall provide media inspection and shaft removal capabilities. If drive mechanisms and bearings are within the enclosures, properly sized and located access openings shall be provided for maintenance and repair.

If multiple RBC's are to be housed in a permanent structure or building, provision shall be made for complete removal of the roof over each unit to permit replacement of the unit, or other suitable means shall be provided for replacement of entire units without dismantling permanent portions of the building. The provisions of Section 18A.7.2 shall apply.

There should be adequate consideration of heating and ventilation requirements to control excess condensation and provide sufficient oxygen under both summer and winter conditions. Motors, control centers, lighting, electrical gear and ventilation equipment should be adequately designed to withstand the possible aggressive environment.

18A.7.4 Design Considerations

18A.7.4.1 Dewatering

The design shall provide for separate dewatering capabilities for each tank, with the flow being returned to the plant for adequate treatment.

18A.7.4.2 Rotation

Variable speed capability should be considered for all mechanical drive units to improve overall plant performance.

Provisions shall be made on mechanical drive units for sustained periods (three-four days) of reverse rotation to shear excess biomass without damage to the RBC units or associated equipment. This shall include the provision of anchored radial support arms for the drives for reverse rotation.

18A.7.4.3 Staging

Each RBC facility shall include at least two parallel trains with a minimum of two stages per train.

For smaller facilities, staging may be provided by installing baffles in the tank. The baffles shall be removable and shall be constructed such that solids deposition within the tank will not take place.

Standard density media shall be used in the first two stages of an RBC train.

18A.7.4.4 Weight Measurement

All units shall be equipped with suitable means for measuring the total weight of the shaft, media and biofilm at any time.

18A.7.4.5 Flow Control

The RBC design shall incorporate adequate flow control devices to insure that:

a. Flow is evenly divided among all trains in the system and flow to each train can be measured individually.

b. Flow is evenly distributed to prevent short-circuiting in each tank.

c. Solids shall be kept in suspension in flow splitter boxes.

18A.7.4.6 Other Design Requirements

Wastewater temperatures shall be taken into account during design, since available data indicate that organic removal and nitrification rates diminish at wastewater temperatures below 55°F.

The RBC system shall be designed to maintain a positive DO level in all stages.

Means for removing excess biofilm growth shall be provided, such as air stripping or chemical additives (in addition to rotation reversal on mechanical drive units).

18A.7.4.7 Other Design Recommendations

Periodic high organic loadings may require suplemental aeration in the first stage.

Evaluation of flow equalization vs. additional RBC media surface area is recommended when consistently low ammonia nitrogen levels are required in the effluent.

Providing power factor correction for all RBC mechanical and air drive systems should be considered.

High efficiency motors and drive equipment should be considered.

Consideration should be given to the provision of sampling points at the influent and effluent end of each RBC unit.

18A.7.5 Flexibility

The following operational and control strategies should be considered to provide adequate flexibility in process control:

a. Variable rotational speeds.

b. Positively controlled alternate flow distribution systems, such as step feed.

c. Positive air flow metering and control to each shaft when air drive units are used.

d. Recirculation of secondary clarifier effluent.

18A.7.6 Organic Load

The maximum loading on any stage having standard density media shall not exceed 3 lb. soluble BOD_5/day/1,000 sq.ft. Loading shall not exceed 2.0 lb. soluble BOD_5/day/1,000 sq.ft. for any high density media unit.

18A.7.7 Flow Equalization

Flow equalization should be considered if the MWW flow exceeds the AWW flow by a factor of more than 2.5.

18A.7.8 Design for Nitrification

Effluent concentrations of ammonia nitrogen from the RBC process designed for nitrification are affected by diurnal load variations. Therefore, it may be necessary to increase the design surface area proportional to the ammonia nitrogen diurnal peaking rates to meet effluent limitations. An alternative is to provide flow equalization sufficient to ensure process performance within the required effluent limitations.