M&M ENVIRONMENTAL SERVICES

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Wastewater Design Factors

Primary Clarifiers

Design Factors

- Detention Time: My references: 1 to 4 hours, 2 hours average
- Surface Loading Rate or Surface Overflow Rate
  - My references
    - 600 gpd/sf
  - Iowa DNR
    - < 1,000 gallons per day per square foot at AWW flows
    - <1,500 gallons per day per square foot for PHWW flows
  - 10-State Standards
    - 1,000 gpd/ft^2 at Design Avg Flow
    - 1,500 – 2,000 gpd/ft^2 at Design Peak Hrly Flow
- Weir Overflow Rate
  - My references
    - 10,000 gpd/ft for < 1 mgd
    - 15,0000 gpd/ft for > 1 mgd
  - Iowa DNR
    - "Weir loadings shall not exceed 10,000 gallons per day per lineal foot for plants designed for AWW flows of 1.0 mgd or less"
    - "Higher weir loadings may be used for plants designed for larger AWW flows, but should not exceed 15,000 gallons per day per lineal foot"
  - 10-State Standards
    - Design Peak Hrly Flow: 20,000 gpd/lin ft for < 1 mgd (less than or equal to)
    - Design Peak Hrly Flow: 30,000 gpd/lin ft for > 1 mgd

Removal Efficiency

- BOD:
  - My references: 25 – 35%
  - Iowa DNR: 30 to 35% of the influent BOD at recommend designed loading rates
  - 10-States Stds: 1/3 of influent BOD at recommend designed loading rates
- TSS: My references: 40 – 60%
- Settleabls Solids
  - My references: 90 – 95%

Trickling Filters

DesignFactors/Loading Rates

- **Standard Rate Trickling Filters**
  - Hydraulic Loading Rate: 25 to 100 gpd/sf or 1.1 to 4.4 mgad
  - Organic Loading Rate: 5 to 25 lbs BOD/1000 cf/day **or**
    400 to 600 lbs BOD/acre-ft/day
  - Effluent BOD: 20 to 25 mg/L

- **High Rate Trickling Filters**
  - Hydraulic Loading Rate: 100 to 1,000 gpd/sf **or** 8.7 to 44 mgad
  - Organic Loading Rate: 25 to 50 lbs BOD/1000 cf/day **or** up to 3,000 lbs BOD/acre-ft/day
  - Effluent BOD: 20 to 50 mg/L

Removal Efficiencies

	Standard Rate	High Rate	Roughing
BOD	80 to 85%	65 to 80%	Up to 50%
TSS	80 to 85%	65 to 80%	Up to 50%

Activated Sludge

Design Factors/Loading Rates

Activated sludge factors include aeration rate, organic loading rates, detention time, mean cell residence time (MCRT or solids retention time, SRT), F/M, and sludge age for the aeration tank; and detention time, surface settling rate, and weir overflow rate for the final clarifier.

Aeration rate design factors are:
- 1,500 cf of air/lb of BOD in the aeration tank
- 0.5 to 1.5 cf of air/gal of wastewater in the aeration tank

Modifications

	Detention Time, hrs	MLSS, mg/L	F/M	Organic Loading Rate, lbs BOD/day/1000 cf
Conventional	• 6 to 8 for diffused aeration • 9 to 12 for mechanical	1,000 to 3,000	0.2 to 0.5	30 to 40
Tapered Aeration	6 to 8	1,000 to 3,000	0.2 to 0.5	30 to 40
Step Aeration	4 to 6	2,000 to 3,000	0.2 to 0.5	40 to 60
High Rate	2 to 3.5	600 to 800	2.0 to 3.5	100
Extended Aeration	Over 24	3,500 to 5,000	0.05 to 0.2	15 to 25
Contact Stabilization	• Contact -- 0.2 to 1.5 • Reaeration -- 1.5 to 3.8	• Contact: 2,500 • Reaeration: 4,000 to 6,000	0.2 to 0.5	60 to 75

	Return Sludge Flow	MCRT or SRT, days	Efficiency, %
Conventional	0.1 to 0.3	6 to 15	90 to 95
Tapered Aeration	0.1 to 0.3	6 to 15	90 to 95
Step Aeration	0.2 to 0.35	6 to 15	90 to 95
High Rate	0.5 to 4	3 or less	50 to 75
Extended Aeration	Return all sludge, no wasting	20 to 30	75 to 85
Contact Stabilization	0.4 to 1.25	6 to 15	85 to 90

Wastewater Design Factors

Anaerobic Digesters

Design Factors/Loading Rates/Control Factors

- Iowa DNR
  - Completely mixed
    - Up to 80 lbs of VS/1000 cf/day
    - Minimum sludge retention time: 15 days
  - Moderately mixed
    - Up to 40 lbs of VS/1000 cf/day
    - Minimum sludge retention time: 30 days
- 10-State Standards
  - Minimum SWD: 20 ft
- My references
  - Capacity for conventional single stage, heated anaerobic digesters
    - Trickling Filter plants: 4 to 5 cf/person
    - Activated Sludge plants: 4 to 6 cf/person
  - Temperature: Best performance at 95^{o}F; rapid changes are most damaging
  - Detention time: At least 30 days
    - Depends on mixing and temperature
    - Mesosphilic (at 95^{o}F): 5 to 50 days
      - Normally 25 - 30 days
    - Thermophilic (120^{o}F - 135^{o}F): 5 - 12 days
  - pH: Best between 6.8 to 7.2
  - Volatile acids: 100 to 300 mg/L
  - Alkalinity: 1,000 to 3,000 mg/L
  - Volatile acids:Alkalinity ratio: Best less than 0.1
    - Problems when ratio > 0.3
  - Organic/inorganic content of digested sludge: 50% organic, 50% inorganic
  - Gas production
    - 8 to 12 cf of gas/lb of volatile solids destroyed
    - 65 to 70% methane
    - 550 to 650 BTU/cf of gas
    - 1 cf of gas/person/day

Removal Efficiencies

- Volatile solids reduction
  - Typically: 50% reduction
  - 503 Regs: 38% reduction