CE 412 A: Water Supply & Wastewater Disposal Systems

Tutorial – 2022-23 II ● Part II: Wastewater Management

TUTORIAL 4 ● Tuesday, March 28, 2023

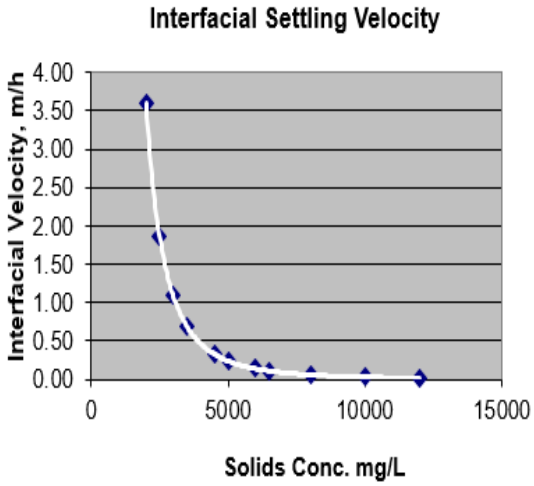
Design Primary Settling Tank(s) followed by Secondary Treatment operations adopting an Activated Sludge Process for a locality with following information for which Preliminary Treatment Operations (Screen Chamber, Grit Chamber and Equalization Tank) were designed in Tutorial 3.

Water Supply	=	250 lpcd
Population density	=	350 person per hectare
Area served	=	690 hectares
Wastewater reaching sewers	=	80% of W/S
Peak Factor	=	3.0
Infiltration Rate	=	7391 l per day per hectare
Design Flow Reaching Sewage Treatment Plant (STP)	=	50 MLD
Some Relevant Parameters/Data/Information		
Primary Settling Tank		
Surface Overflow Rate for PST	=	32 - 48 $m^3/m^2/d$
Outlet Weir Loading Rate	=	
HRT in PST	=	< 4 h
BOD Removal in PST	=	25 – 40 %
Suspended Solids Removal	=	50 – 75 %
Solids Concentration in Settled Sludge	=	4000 – 6000 mg/L
Activated Sludge Process – Influent & Effluent Parameters		
Design Value of BOD	=	350 mg/l
Concentration of Fixed Suspended Solids	=	50 mg/L
Effluent Total BOD	=	30 mg/L
Effluent Soluble BOD	=	5 mg/L
Activated Sludge Process – Growth & Kinetic Parameters		
Maximum Specific Substrate Utilization Rate, q_{max}	=	4 /d
K_s	=	25 mg/L
True Yield Coefficient, Y_T	=	0.5
Endogenous Respiration Coefficient, k_d	=	0.05 /d
Activated Sludge Process – Range of Some Design Parameters		
Mixed Liquor Suspended Solid Concentration, X	=	1,500 – 3,000 mg/L
Suspended Solids Concentration in Settled Sludge from SST, X_r	=	8,000 – 10,000 mg/L
Hydraulic Retention Time, θ	=	4-12 h
Activated Sludge Process – Related to Design of Aeration System		
Oxygen Required in Aeration Tank, kg/d] = [BOD_u Removed, in kg/d] – 1.42.[Sludge Wasted, kg/d		
Aerator Rating:		
1, 2, 5 KW	=	Area of Influence: 5m x 5m x 3m (depth)

10, 25, 50 KW	=	Area of Influence: 6m x 6m x 4m (depth)
Standard O_2 transfer efficiency (SOT)	=	2.0 kg O_2/h/KW
Actual O_2 transfer efficiency (AOT)	=	80 % of Under Standard Conditions
Energy requirements for maintaining completely mixed conditions in the aeration tank	=	15 – 20 W/m^3
Activated Sludge – Related to N & P Requirement/Removal		
Nutrient Requirement/Removed: 0.121 g N and 0.022 g P per g biomass produced (or wasted)		
Activated Sludge – Related to Secondary Clarification		

Interfacial Velocities of Sludge Solids

Solids (C+X) mg/L	u, m/hr
2000	3.60
2500	1.86
3000	1.09
3500	0.69
4500	0.33
5000	0.24
6000	0.14
6500	0.11
8000	0.06
10000	0.03
12000	0.02



$$u = g\,c^{-h}; g = 2 * 10^{10}; h = 2.9521$$

u = Interfacial settling velocity (in m/hr);

C = Mixed Liquor Suspended Solids Concentration (in mg/L) = $X + C_o * (\theta_c/\theta)$

X = Biomass Concentration in Aeration Tank (AT), mg/L

C_o = Fixed Suspended Solids Concentration in inlet to AT, mg/L

Area and Depth Choice:

1. Clarification Criteria → Q/A = u = Interfacial settling velocity
2. Solids Concentration in Under Flow
3. Retention Time < 2.5 to 3 h

SOR for Limiting Solids Flux is given by following expression:

$$\frac{Q}{A} = \frac{g(h-1)(\frac{h}{h-1})^h (R)^{h-1}}{(C_0)^h (1+R)^h}$$