

1.85 WATER AND WASTEWATER TREATMENT ENGINEERING HOMEWORK 4

Question 1 (5 points)

A suspension of three sizes of spherical particles is to be filtered at a rate of 15 m/hr through a 60-cm rapid sand filter. The bed sand has a diameter of 0.5 mm and a porosity of 0.4. Particle counting indicates that there are 5, 25, and 125 mg/L each of 0.1, 1.0, and 10.0-micron diameter particles, respectively. The particles have a density of 1.05 g/cm³. The water temperature is 25C.

- a. Assuming discrete particle settling, determine the single collector efficiency, η , for each particle size using the theoretical model of Yao et al. (1971) as given in the notes for Lecture 7. (2 points)
- b. If the attachment efficiency, α , is 0.2, what is the concentration of each particle after the water passes through the filter bed? (2 points)
- c. If the attachment efficiency, α , is 1.0, what is the concentration of each particle after the water passes through the filter bed? (1 point)

Question 2 (5 points)

Design a sedimentation treatment system for a raw water with the following characteristics:

Maximum daily flow = 4 m³/s
 Average daily flow = 3 m³/s
 Coagulant = alum
 Settling velocity for floc = 3.2 m/hr

Your design should be for a horizontal-flow rectangular basin with a chain and scraper sludge removal system. You can assume a dynamic viscosity for water of 0.00131 kg/m-s and a density of 999.7 kg/m³. You should specify the number of sedimentation basins, the basin dimensions, and the basin overflow rate and hydraulic residence time. Sludge scrapers come in a standard 6-meter length, so your basin width should be in increments of 6 meters. Design guidelines for horizontal-flow rectangular tanks are excerpted below from MWH (2005):

Parameter	Units	Value
Minimum number of tanks*	Unitless	2
Water depth	Meters	3 to 5
Minimum length-to-depth ratio	Unitless	15:1
Width-to-depth ratio	Unitless	3:1 to 6:1
Minimum length-to-width ratio	Unitless	4:1 to 5:1
Overflow rate	m/hr	1.25 to 2.5
Horizontal mean-flow velocity = V_f	m/min	0.3 to 1.1
Detention time	hr	1.5 to 4
Outlet weir loading rate	m ³ /m-hr	9 to 13

* Number of tanks should be sufficient to allow one tank to be taken off-line for maintenance without causing overloading of remaining tank(s).