

ENCE 4323 FIRST EXAM

October 13, 2010

Name: _____

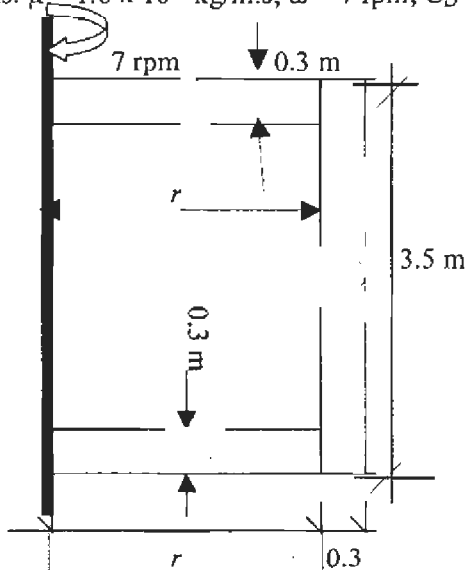
Instructions:

The test is open book, open notes. Time available: 1 hour. Complete both parts A and B.

PART A

Solve **only two** of the following three problems:

1. A flocculation tank has a vertical shaft with a paddle wheel consisting of a single arm with three blades assembled as shown in the sketch below. The tank has the following dimensions: length = 6 m, width = 6 m, water depth = 4.0 m. Find the value of the paddle radius r required to get a velocity gradient $G = 60 \text{ s}^{-1}$ using the following constants: $\mu = 1.6 \times 10^{-3} \text{ kg/m.s}$; $\omega = 7 \text{ rpm}$; $C_D = 1.8$; $k = 0.25$; $\rho = 1000 \text{ kg/m}^3$



2. A first order reaction takes place in two CFSTRs connected in series. The influent reactant concentration in the first reactor is 200 mg/L. Batch reactor tests on the same reaction, with an initial concentration of 150 mg/L, gave a reactant half-life of 1.5 seconds (half-life is the time required for the concentration to drop to one-half of the original value). If the mean detention time in the first reactor is 150 seconds and 100 seconds in the second CFSTR, find the effluent concentrations in the first and in the second reactors.
3. A suspension of discrete particles having an average density of 1500 kg/m^3 is to be treated in a settling tank designed to remove 100% of particles with a diameter = 0.038 mm. The particle settling velocity distribution is given below. Find the total fraction of particles removed. The liquid kinematic viscosity is $1.3101 \times 10^{-6} \text{ m}^2/\text{s}$, and the density is 1000 kg/m^3 .

Particle settling velocity, m/s	Mass Fraction
2.5×10^{-5}	0.10
5.2×10^{-5}	0.20
9.2×10^{-5}	0.25
13.8×10^{-5}	0.15
21.2×10^{-5}	0.05
29.3×10^{-5}	0.15
36.0×10^{-5}	0.05
49.3×10^{-5}	0.05

PART B

Answer the following questions in the space provided:

1. If you have a first order reaction, what type of continuous flow reactor would you recommend if you want to minimize the reactor size for a given conversion? Explain.

For a first order reaction, the CSTR is the best choice to minimize reactor size for a given conversion. This is because the CSTR has a higher average rate of reaction compared to the PFR. The CSTR has a higher average rate of reaction because the concentration of the reactant is higher throughout the reactor. The PFR has a lower average rate of reaction because the concentration of the reactant decreases as it moves through the reactor.

2. What is the main difference between primary and secondary drinking water standards?

The main difference between primary and secondary drinking water standards is that primary standards are enforceable and protect public health, while secondary standards are non-enforceable and protect aesthetics. Primary standards are based on health effects, while secondary standards are based on aesthetic effects. Primary standards are based on the maximum contaminant level (MCL) and the maximum contaminant level goal (MCLG). Secondary standards are based on the maximum contaminant level (MCL) and the maximum contaminant level goal (MCLG).

3. Can you remove colloidal particles by plain sedimentation? Give a brief explanation.

NO. Colloidal particles are too small to settle by gravity. They are held in suspension by Brownian motion and electrostatic repulsion.

4. What is tapered flocculation and how do you achieve it?

Tapered flocculation is a process where the rate of flocculation decreases as the particles grow. This is achieved by using a series of flocculation tanks with decreasing mixing intensity. The first tank has a high mixing intensity to break up small particles into larger flocs. The second tank has a lower mixing intensity to allow the flocs to grow larger. The third tank has a very low mixing intensity to allow the flocs to settle.

5. Briefly explain how high rate settling works.

High rate settling works by using a series of shallow settling tanks. The shallow tanks allow for a high rate of settling because the distance the particles have to travel is short. The tanks are arranged in a series so that the particles settle in one tank and then move to the next tank. This allows for a high rate of settling and a high degree of clarification.

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$$11. \quad = \frac{2x^2(x-1) + x^2(x-1)^2}{x^2}$$

$$12. \quad = \frac{1}{4} + \frac{1}{2} \left(\frac{1}{x} + \frac{1}{x^2} \right)$$