

Course Title: Math Applications in Wastewater Treatment

Course Hours: 33 (3.3 CEUs)

Course Description:

This course focuses on math concepts related to wastewater treatment operation and maintenance and applies these concepts to work-related math problems. Operators practice solving math problems while getting step-by-step instructions. This course covers topics that operators encounter on the job. It does not attempt to cover the topics of any state certification exam.

Course Objectives:

Upon completion of this course, participants will be able to perform math calculations typically used in wastewater treatment. Course objectives include:

- Solve problems related to flow rate and calculate the concentration of a chemical or pollutant.
- Practice basic calculations dealing with wastewater treatment.
- Calculate the total amount of screening accumulated in a given time.
- Calculate velocity or flow rate based on their relationship.
- Calculate the time needed for particles to settle at the bottom of a grit channel.
- Calculate the length needed for a grit channel to allow particles to settle.
- Calculate the efficiency of a treatment process based on influent and effluent concentrations.
- Compute the detention time of a clarifier based on the flow rate into the clarifier and the volume of the clarifier.
- Solve problems related to loading rates of a clarifier, including weir overflow rate, surface loading rate, and solid loading rate.
- Describe an activated sludge system.
- Describe and perform calculations for activated sludge in an activated sludge system, including return activated sludge (RAS) and waste activated sludge (WAS).
- Describe and perform flow balance for an activated sludge system.
- Perform calculations related to different forms of solids in wastewater.
- Perform calculations related to secondary clarifiers and related topics.
- Perform calculations related to mean cell residence time (MCRT) and solids residence time (SRT).
- Understand the basic configuration and functioning of trickling filter systems.
- Understand the effects of rotational speed on flushing rates and loading rates, and perform related calculations.
- Perform calculations to determine recirculation ratios.
- Perform calculations related to hydraulic and organic loading rates.
- Understand the basic configuration of RBCs and how RBCs function.
- Perform calculations related to hydraulic and organic loading rates.
- Perform calculations related to recirculation rates.
- Calculate the detention time of a pond system based on inflow rate and the volume of the pond system.
- Calculate the hydraulic loading rate of a pond system based on the surface area of the pond and the inflow rate into the pond system.

- Calculate the organic (BOD) loading rate of a pond system based on the inflow rate, average concentration of BOD in the inflow stream, and the surface area of the pond system.
- Calculate the population served per unit surface area of a pond system, given the population served and the surface area of the pond system.
- Calculate the removal efficiency of a pond system based on influent and effluent concentration of BOD (or any constituent of interest).
- Solve problems related to disinfection processes in treating wastewater.
- Understand problems related to disinfection processes in treating wastewater.
- Solve math problems in the following topics: laboratory units, metric system, concentrations and solutions, mixing solutions, titration, composite samples, solids, pH (hydrogen ion), nitrogen, and most probable number (MPN).
- Calculate the volume of a digester based on its configuration.
- Calculate the volume and weight of solids based on the volume-to-weight relationship.
- Calculate the efficiency (percent) of volatile matter removal through digestion.
- Calculate the volume of water in a sludge using the solids content of the sludge.
- Calculate the volume of seed sludge needed to start a digester.
- Perform a solids mass balance for a digester.

Course Outline:

- 1) Basic Math Concepts (250 minutes)
 - a. Numbers and Operations
 - b. Order of Operations
 - c. Basic Algebra
 - d. Percentages
- 2) Intermediate Math Concepts (290 minutes)
 - a. Units
 - b. Area
 - c. Volume
 - d. Mass and Weight
 - e. Density and Specific Weight
 - f. Concentration
 - g. Velocity and Flow Rate
 - h. Force and Pressure
 - i. Work, Head, and Power
 - j. Metric System
- 3) Advanced Math Concepts (320 minutes)
 - a. Pumps
 - b. Evaluating Pump Performance
 - c. Analyzing and Presenting Data
 - d. Describing Data or Results
 - e. Moving Averages
 - f. More Applications of Graphing and Charting
 - g. Regression Analysis (Prediction Equations, Trends, and Correlations)
- 4) Overview of Math Applications in Wastewater Treatment Operation (5 minutes)
 - a. Introduction

- 5) Basic Calculations in Wastewater Treatment (60 minutes)
 - a. Discussion of flow rate and velocity relationship
 - b. Discussion of detention time
 - c. Discussion of solids
 - d. Watch 1 video about settleable solids
 - e. Work through example problems 1–5
 - f. Estimate concentration of a chemical or pollutant
- 6) Preliminary Treatment (60 minutes)
 - a. Discussion of preliminary treatment
 - b. Work through example problems 1 – 6
 - c. Discussion of amount of screening accumulated in a given time
 - d. Discussion of calculating velocity or flow rate based on their relationship
 - e. Discussion of settling velocity in a grit channel
- 7) Primary Treatment (60 minutes)
 - a. Calculate the efficiency of a treatment process based on influent and effluent concentrations
 - b. Compute the detention time of a clarifier based on the flow rate into the clarifier and the volume of the clarifier
 - c. Solve problems related to loading rates of a clarifier, including weir overflow rate, surface loading rate, and solid loading rate
 - d. Watch 1 video about primary treatment
 - e. Watch 1 video about primary clarifier overview
- 8) Activated Sludge System (165 minutes)
 - a. Discussion of an activated sludge system
 - b. Work through example problems 1 and 2
 - c. Complete flow balance check exercise
 - d. Work through example problems 3 – 8
 - e. Discussion of MCRT
 - f. Work through example problem 9
 - g. Discussion of estimating suspended solids leaving the sludge system
 - h. Perform calculations for activated sludge in an activated sludge system, including return activated sludge (RAS) and waste activated sludge (WAS)
 - i. Work through example problem 10
 - j. Discussion of MCRT
 - k. Work through example problems 11-18
 - l. Discussion of difference between SRT and Q_{was}
 - m. Discussion of secondary clarifier design
 - n. Discussion of SVI
- 9) Trickling Filter System (80 minutes)
 - a. Discussion of trickling filters
 - b. Discussion of hydraulic and organic loading rate
 - c. Work through example problems 1 – 4
 - d. Calculate flushing intensity and rotational speed
 - e. Work through example problem 5
 - f. Calculate recirculation ratio
- 10) Rotating Biological Contactor (60 minutes)
 - a. Discussion of rotating biological contactor

- b. Discussion of hydraulic and organic loading rate
 - c. Work through problems 1 – 6
 - d. View RBC configuration diagram
- 11) Wastewater Treatment Ponds (Lagoons) (90 minutes)
- a. Discussion of wastewater treatment ponds (lagoons)
 - b. Watch 1 video about lagoon elements
 - c. Work through problems 1 – 5
 - d. Discussion about calculating pond surface areas and volumes
 - e. Work through problems 6 - 11
- 12) Wastewater Disinfection Processes (60 minutes)
- a. Overview of wastewater disinfection processes
 - b. Watch 1 video about UV disinfection overview
 - c. Chlorination process
 - d. Work through problems 1 – 3
 - e. Discussion about dechlorination
 - f. Work through problem 4
- 13) Laboratory and Sampling Procedures (240 minutes)
- a. Laboratory and Sampling procedures
 - b. Laboratory Units: Metric System
 - c. Work through problems 1 – 14
 - d. Discussion of titration
 - e. Work through problems 15 – 29
 - f. Discussion of nitrogen
 - g. Discussion of most probable number (MPN)
 - h. Water quality tests
 - i. Watch 2 videos about MPN
 - j. Work through problems 30 - 32
- 14) Solids Handling (145 minutes)
- a. Solids handling in wastewater treatment
 - b. Watch 1 video about solids and sludge handling
 - c. Sludge digestion process
 - d. Volume of a digester
 - e. Discussion of solids and volume relationship
 - f. Work through problems 1 - 17
- 15) Final Exam (120 minutes)

Course Format: This course will be delivered online.

Assessment Methodology: Cumulative online assessment (final exam, 120 minutes)

Prerequisites: None

Textbook: None

Recommended Reading: "Operation of Wastewater Treatment Plants, Vol 1," 8th Edition.
Office of Water Programs, www.owp.csus.edu