Department of Chemical Engineering

Water and Wastewater Treatment Processes (10626584)

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Total Credits	**3**

Elective Course

Course Contents

Application of fundamental engineering concepts to develop process design specifications for various unit operations and separation processes used for the treatment of aqueous (wastewater) and solid industrial effluents. In addition, some technologies for air pollution control will be introduced.

Course Learning Outcomes (CLO's):

At the end of this course, students will be able to:

I. Wastewater Treatment

1. List and describe the major causes of industrial wastewater.
2. Describe the wastewater treatment processes.
3. List and describe the mechanisms of the physical treatment unit operations, such as:
   a. Mixing and flocculation
   b. Sedimentation
   c. Filtration
   d. Membrane filtration
   e. Adsorption
   f. Gas transfer and stripping
   g. UV disinfection
4. List and describe the mechanisms of the chemical treatment processes, such as:
   a. Coagulation
   b. Chemical precipitation
   c. Ion exchange
   d. Water stabilization
   e. Chemical oxidation

II. Solid Effluent Treatment

Understand the Treatment, Reuse, and Disposal of biosolids; including:

a. Biosolid sources, characteristics and quantities
b. Regulations for the use and disposal of biosloids
c. Solids processing flow diagrams
d. Sludge and scum pumping
e. Preliminary operations sludge treatment
f. Thickening

III. Air Pollution Control

1. List and describe the major causes of air pollution.
2. Have an understanding of criteria air pollutants: types, sources, properties, and effects.
3. List and describe the unit operations and processes that can be utilized to control particles in a waste gas stream.

4. List and describe the unit operations and processes that can be utilized to minimize the various gaseous pollutants in a waste gas stream.

Textbook

There is no prescribed textbook for this course. Instead, printed notes for each lecture will be used throughout the course. The following books and reference materials are suggested as additional readings:

Title	Wastewater Engineering: Treatment and Reuse
Author (s)	Metcalf & Eddy, Inc.; G. Tchobanoglous; F. Burton; H.D. Stensel
Edition, Year	4th edition, 2003
Publisher	McGraw-Hill

Title	Fundamentals of Wastewater Treatment And Engineering
Author (s)	Rumana Riffat
Edition, Year	1st edition, 2013
Publisher	IWA, CRC Press, Taylor and Francis Group

Assessment Criteria	Percent (%)
Assignments and Quizzes	15
Term Project	20
Midterm Exam	25
Final Exam	40

Course Plan

Week	Topic
1	Introduction to process analysis and selection: • Course introduction and logistics; introduction to wastewater treatment and air pollution control • Reactors used for the treatment of wastewater; mass-balance analysis, and modeling ideal flow in reactors • Modeling non-ideal flow in reactors and modeling treatment process kinetics
2 – 4	Physical unit operations: a. Mixing and flocculation • Mixing of one substance completely with another • Blending of miscible liquids • Flocculation of wastewater particles • Continuous mixing of liquid suspension b. Sedimentation • Gravity separation theory • Primary sedimentation • High-rate clarification c. Filtration • General introduction to the depth filtration process • Introduction to filter clean-water hydraulics • Analyses of the filtration processes

	• Selection and design considerations for depth filters d. Membrane filtration • Membrane process terminology, classifications and configurations • Membrane operation and fouling • Applications of membranes • Electrodialysis • Pilot study for membrane applications • Disposal of concentrated waste streams e. Adsorption • Types of adsorbents • Fundamental of adsorption • Activated carbon (AC) adsorption kinetics • AC treatment process applications • Analysis and design of Granular AC contractor • Small-scale column test • Analysis and design of Powder AC contractor f. Gas transfer • Removal of VOCs by aeration g. Gas stripping • Analysis of gas stripping • Design stripping towers • Application h. UV disinfection • Source of UV radiation • UV disinfection system components and configurations • Estimating UV dose • Selection and sizing of a UV disinfection system • Environmental impact of UV radiation disinfection Chemical unit processes: a. Coagulation • Basics definitions for coagulation and flocculation • The nature of particles in wastewater • The development and measurement of surface charge • Consideration of particle-particle interaction • Particle destabilization with potential determining • Ions and electrolytes • Particle destabilization and aggregation with polyelectrolytes • Particle destabilization and removal with hydrolyzed metal ions
5	**Midterm Exam**
5 – 8	b. Precipitation • Chemical reactions in wastewater precipitation applications • Enhanced removal of SS in primary sedimentation • Independent physical-chemical treatment • Estimation of sludge quantities from chemical precipitation

	• Chemical precipitation for phosphorous removal • Chemical precipitation for removal of heavy metals and dissolved inorganic substances c. Ion exchange • Ion-exchange materials • Typical ion-exchange reactions • Exchange capacity of ion-exchange resins • Ion-exchange chemistry • Application of ion exchange • Operational consideration d. Water stabilization • pH adjustment • Analysis of scaling potential • Scaling control and Stabilization e. Chemical oxidation • Fundamentals of chemical oxidation • Chemical oxidation of BOD and COD • Chemical oxidation of ammonia • Advanced Chemical oxidation: - Theory of advanced oxidation - Technology used to produce HO· - Applications Solid treatment • Solid sources, characteristics and quantities • Regulations for the reuse and disposal of solids • Solid processing flow diagram • Sludge and scum pumping • Preliminary operations • Thickening • Dewatering Air pollution control • Introduction to major causes of air pollution: Air pollutants: types, sources, properties and effects. • Control of Stationary Sources, Gaseous Emissions: Absorbers, Condensers, SOx and NOx emissions control
9	Course review
9	**Final exam**

NOTES	• **Class time and place** Time: Sun/Mon/Tue/Wed – 12:30 – 2:00 pm Location: Blended – (on-campus) Engineering Building (11) Room G0190 – (Electronic) via Zoom • **Office hours:** Sun/Mon/Tue/Wed 11:00 – 12:30 pm (Visits outside office hours by appointment only) • **General behavior policies** 1. No mobile rings are allowed in class. Turn off your mobile phone before entering the class or put it on the vibrate mode. 2. No drinking (except for water), eating, socializing, etc., during the lecture. However, effective interaction and open discussion are recommended. 3. Wait for the instructor IN the classroom, NOT outside. 4. If the instructor is late: you are required to wait 10 minutes before you can assume that he won't show up and leave. This is a university policy. • **Attendance** Attendance and active participation in ALL SESSIONS are very important for your mastery of the subject material. In addition, important announcements are often made in class (students are responsible for any changes announced in class). Repeated absence will be observed and will negatively impact your understanding for the subject material.