ENVIRONMENTAL CHEMISTRY

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INTENDED AUDIENCE : Environmental engineering professionals and students pursuing a degree with emphasis in Environmental engineering

PREREQUISITES : Entry level chemistry course

INDUSTRIES SUPPORT : CPCB, SPCB, Degremont, ERM, Ramky Enviro Engineers, Veolia Water, SFC Environmental Technologies Pvt. Ltd., Nalco Water, VA Tech Wabag, Ther

COURSE OUTLINE : The course deals with the fundamentals and critical analysis of chemical processes one encounters in the field of Environmental Engineering. The course deals with:

• Application of equilibrium equations and material balance equations to calculate conditions in environmental systems at equilibrium using the concept of components.

• Use of chemical equilibrium programs such as VMINTEQ to calculate conditions in environmental systems at equilibrium

• Application of kinetic equations, stoichiometric relationships and material balances to calculate conditions in environmental systems in which reactions occur that are not at equilibrium.

• Application of fundamental aspects of thermodynamics to describe equilibrium conditions in environmental systems.

• Defining equilibrium and kinetic limitations as relating to environmental systems and the relative importance of each for chemical processes in environmental systems.

• Knowledge of important terminology for chemical processes occurring in environmental systems

ABOUT INSTRUCTOR :

Prof. Bhanu Prakash Vellanki, is an Assistant Professor at IIT Roorkee. He holds a PhD in Civil Engineering with a specialization in Environmental Engineering from Texas A&M University. During the course of his doctoral work, Dr. Vellanki developed a new class of treatment processes, called the Advanced Reduction Processes. His research interests include Advanced Redox Processes, industrial/hazardous waste treatment, and emerging contaminants.

Course layout

Week 1
I. Introduction
II. Fundamentals of chemical processes
- Introduction
- Equilibrium

1. Introduction (importance, definitions)
2. Gibbs free energy
3. Phase Equilibrium
4. Equilibrium Models

Week 2
1. Generalized Approach

- Kinetics

1. Reactions
2. Reactors

Week 3:
1. Determination of rate equation

- Requirements

1. Approaches
2. Regression

III. Acid/Base Reactions
- Introduction (importance, terminology)
- Kinetics
- Equilibrium

1. Single Reaction

Week 4
- Ionization Fractions

1. Models (multiple reactions)

- Recipe problems
- Inverse Problems
- Computer solutions (VMINTEQ)

Week 5

1. Log C-pH Graphs
- Introduction
- Preparation
- Example
1. Carbonate System
- Introduction
- Closed system
- Open system
1. Equivalence Point
2. Buffer
- Introduction
- Application by VMINTEQ

Week 6

- Buffer Intensity at various pH ranges
- Design of Buffers
1. Alkalinity, acidity
- Definitions
- Acidity
- Multiple Equivalence Points

Week 7

- Relationship among ALK,ACD, Ct,co3
- Mixing Problems
- Conservative quantities
- Example: Complex Acid/Base Problems

Week 8

IV. Aqueous Complex Formation
- Introduction
- Kinetics
- Equilibrium
1. Equilibrium Coefficients
2. Strength of complexes
3. Models

V. Precipitation
    A. Introduction
    B. Kinetics

Week 9

1. Steps
- Ostwald
- More crystalline, less soluble
1. Controlling precipitation
- Promoting precipitation
- Inhibiting precipitation

C. Equilibrium
- Coefficients
- Important concepts
- Models

Week 10

1. Competitive Precipitation
2. Predominance Area Diagram
3. Calcium carbonate precipitation

VI. Oxidation/Reduction
    A. Introduction
1. Terminology
2. Applications
3. Balancing Redox Reactions
    B. Kinetics
1. Importance
2. Models

Week 11

C. Equilibrium

1. Introduction
2. Alternatives for reaction feasibility

- Q/K approach
- pe approach

Week 12

- Eh approach

1. Oxidation-Reduction Potential (ORP) Measurement
2. Predominance Area Diagrams
3. Corrosion