Environmental Engineering-Chemical Processes

Civil Engineering

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Department: Civil Engineering

Course Intro: : Chemical, biological and physical processes are at the root of Environmental Engineering. A critical understanding of each process is required for an Environmental Engineer to be able to critically analyze a relevant problem. The current course on chemical processes, will enable a student of this course to: ï‚· Apply equilibrium equations and material balance equations to calculate conditions in environmental systems at equilibrium using the concept of components. ï‚· Use chemical equilibrium programs such as VMINTEQ to calculate conditions in environmental systems at equilibrium. ï‚· Apply kinetic equations, stoichiometric relationships and material balances to calculate conditions in environmental systems in which reactions occur that are not at equilibrium. ï‚· Apply fundamental aspects of thermodynamics to describe equilibrium conditions in environmental systems. ï‚· Define equilibrium and kinetic limitations as relating to environmental systems and be able to discuss the relative importance of each for chemical processes in environmental systems. ï‚· Demonstrate knowledge of important terminology for chemical processes occurring in environmental systems.

Pre Requisites: : Entry level chemistry course
Core/Elective: : Core
UG/PG: : PG
Industry Support : CPCB, SPCB, Degremont, ERM, Ramky Enviro Engineers, Veolia Water, SFC Environmental Technologies Pvt. Ltd., Nalco Water, VA Tech Wabag, Thermax

Reference : 1. Water Chemistry, M. Benjamin, Waveland Press, Long Grove, Illinois, 2010 (ISBN 1577666674) , 2- Water Chemistry: An Introduction to the Chemistry of Natural and Engineered Aquatic Systems, Patrick L. Brezonik, William A. Arnold, Oxford University Press, New York, 2011, 3- Aquatic Chemistry, 3rd Edition, W. Stumm, J.J. Morgan, John Wiley and Sons, New York, 1996. 4- Aquatic Surface Chemistry, W. Stumm (Ed), John Wiley and Sons, New York, 1987.

About Instructor: Dr. 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 PLAN

SL.NO	Week	Module Name
1	1	Introduction, Fundamentals of Equilibrium and kinetics, Equilibrium-Process Feasibility(Criteria and Driving Forces), Gibbs Energy at standard and non-standard conditions (Activity, Temperature, Pressure), Phase Equilibrium
2	2	Equilibrium Model- Component Balance, Introduction to Kinetics, Rate of Reaction, Type of Ideal Reactors-Batch, CSTR, Plug Flow Reactor, Application of mass balance.
3	3	Mass Balance, reaction kinetics for reversible reactions, Determination of Rate Equation (Rate and Concentration based: Liner, Linearized and Non-linear regression), Acid and Base Reactions-Introduction and importance, System at Equilibrium, Single Reaction-Henderson-Haselbach Equation.
4	4	Ionization Fractions and practical application of Acid-Base reactions, Models for multiple reactions, Introduction and use of VMINTEQ Software, Recipe Problems and InverseDose Problems.
5	5	Log C-pH graph, Carbonate System for Closed and Open Systems: Application of VMINTEQ, Titration (Equivalence Point), Buffers: Application of VMINTEQ
6	6	Buffer Intensity at various pH ranges, Design of Buffers, Alkalinity-Theoretical and Practical, Acidity â€“ Mineral, Phenolphthalein and Total Acidity, Multiple Equivalence Points, Effect of addition of acidbase.
7	7	Practical applications of Alkalinity-Acidity related concepts, Mixing problems & conservative quantitycomponent balances, Alkalinity due to carbonate and non-carbonate Species.

8	8	Aqueous Complexes, Equilibrium, strength of Complexes, Equilibrium models for Complex Formation, Introduction to Precipitation and Dissolution, Practical application, Kinetics & Stages of precipitation, Controlling Precipitation
9	9	Equilibrium models for precipitation, Solubility, Competitive Precipitation, Predominance Area Diagrams, Saturation Indices
10	10	Redox Reactions- Introduction, Applications, Formation of Half Reactions, Balancing of reactions, Kinetics and its relevance, Kinetic models for redox reactions
11	11	Equilibrium, Reaction Feasibility: QK approach, pe approach (Relevance of pe, pe0)
12	12	Reaction feasibility: Eh approach (Galvanic Cell, Nernst Equation, Relationship between Eh, pe and Gibbs Free Energy), Oxidation-Reduction Potential (ORP) Measurement, Predominance Area Diagrams, Corrosion.