Tsinghua University **Spring 2017**

ENVIRONMENTAL TRANSPORT PROCESSES

Course Description:
This course covers the fundamentals of mass transport of chemicals between air, water, soil, and biota. Material is divided into three subject areas: mass transfer theory, transport processes related to engineered reactors, and transport in the natural environment. The focus of the course is on chemical calculations particular to dilute systems, with emphasis on quantifying chemical transport rates and distributions in natural and engineered environments. Special topics of interest to Environmental Engineers include biofilm models, bioreactors, chemical partitioning in thin fluid films, and fate of anthropogenic chemicals from spills and discharges into the environment (rivers, lakes, and groundwaters).

Grading: Exams: 30% each (Take-home exam, no makeup exams permitted)
Homework: 40%, 10% each

Text: Logan, B.E. 2012. Environmental Transport Processes, 2nd edition. Wiley.
(Electronic resource available on lib.tsinghua.edu.cn)

Meeting Times: Tuesday 3:20 – 4:55 pm, SOE Rm 720

Instructor: Dr. Fang Zhang, 707 School of Environment
Office hours: Monday 10:00 – 11: 30 am, or by appointment.
Email: fangzhang@tsinghua.edu.cn, Phone: 010-62789655.

COURSE OUTLINE

CLASS	DATES	TOPIC	HW*	TEXTBOOK
1a		Introduction. Notation for multiphase systems; review of ppm, ppb; concentration conversions.		Chapter 1, Appendix A.
1b		Chemodynamics: equilibrium vs. steady state; thermodynamic calculations; fugacity; fugacity calculations for dilute environmental systems; air-liquid partitioning.		2.1-2.4 2.5-end
2a		Soil-water partitioning; fugacity calculations and examples. Fick's laws of diffusion.	A1	Chapter 2
2b		Estimating gas and liquid diffusion coefficients.		3.1-3.4
3a		Experimental calculation of diffusivities in water; molecular weight separations and distributions; steady state mass balances and control volumes.		3.5-end
3b		Derivation of the general mass transport equation and more familiar simplified forms. Similarity of the “three laws”.		4.1-4.4
4a		Differential mass transport equation forms. Rate of diffusion through a stagnant gas film;		4.5-4.6 5.1-5.2
4b		Diffusion into stagnant films with and without reaction (absorption with homogeneous reaction. Wetted wall- absorption.		Sect 5.2
5a		Wetted wall- absorption, cont’d	D1, A2	
5b		Penetration theory and wetted wall reactors such as air strippers and trickling filters.		5.2

CLASS	TOPIC	HW	TEXTBOOK
6a	Surface renewal theory and boundary layer theory		6.1-6.2, 5.3
6b	Introduction to mass transport coefficients and the three theories interpreted in terms of mass transport coefficients.		6.1-6.2, 5.3
7a	Mass transport in cylindrical and spherical coordinate systems.		6.3
7b	Interphase mass transport; multiple resistances in aeration of bioreactors.		7.1-7.4
8a	Shear in bioreactors; chemical transport in sheared reactors; Kolmogorov microscale; mass transfer correlations for spheres	D2, A3	7.5-7.6
8b	Experimental determination of mass transfer coefficients in aerated reactors. Mass transfer to flocs in sheared reactors.		8.1-8.4
9a	Models of mass transfer to suspended microorganisms.		8.5, 9.1
9b	Mass transfer to aggregates using zero and first order kinetics.		9.1 - 9.3
10a	Effectiveness & relative uptake factors; Biofilm reactors		
10b	Biofilm reactors.		
11a	Dispersion fundamentals		
11b	Laminar versus turbulent dispersion coefficients.		10.1-10.3
12a	Longitudinal dispersion coefficients, dispersion in rivers, lakes and oceans	D3, A4	10.4, 11.1-11.3, 11.5
12b	Chemical transport from oil slicks and sediments.		11.6, 12.1-2
13a	Groundwater hydraulics.		12.3-12.4
13b	Contaminant transport in the subsurface		12.5-12.6
14a	Derivation and interpretation of retardation coefficients. Ganglia in porous media.		
14b	Effect of groundwater flow on gangalie: non-aqueous phase liquids (NAPLs) in groundwaters		12.6-12.7
15a	Fundamentals of particles and particle size spectra.	D4	13.1. 13.3. 13.4, 14.1
15b	Introduction to particle coagulation.		14.2, 14.4, 15.1-15.6
16a	Particle coagulation- monodisperse systems. Introduction to filtration theory.		15.1-15.6
16b	Colloid and biocolloid transport in different porous media.		
	****** EXAM ****** During finals week, (Chapters 12-15, selected sections)		

*HW :A=assignment, D=due;
Be aware that all dates are tentative.