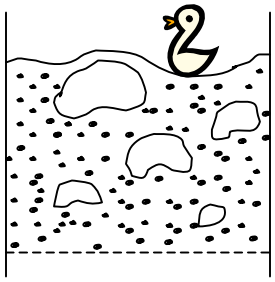
CHBE 561
Particulate and Multiphase Systems
Fall 2004
Course Syllabus

Course (Calendar) Description
Topics vary from year to year and include electrokinetic colloidal phenomena; packed beds; filtration; sedimentation; two- and three-phase fluidized beds; spouted beds; hydraulic and pneumatic transport; gas, liquid and solid particle mechanics; multiphase flows.

Lecturer
Prof. Naoko Ellis, nellis@chml.ubc.ca; 604.822.1243; CHML room 217.



Pre-requisites
Transport Phenomena or equivalent.

Course Objectives
After taking this course, students should be able to:
- Understand the forces acting on the motion of single particles in fluids;
- Display knowledge of particle characterization: methods and significance;
- Draw momentum and mass balance for a multiphase system;
- Demonstrate basic knowledge of fluidized bed phenomena and technology;
- Understand bubble mechanics, stability and quality of fluidization;
- Demonstrate comprehension of different flow regimes and their attributes in fluidization;
- Apply various signal analysis methods to signals obtained in multiphase systems;
- Demonstrate appreciation toward fluidized bed reactor modeling including the current status of CFD in simulating fluidized bed reactors;
- Display knowledge of design, scaling and applications of fluidized bed reactors;
- Develop ability to critically review scientific papers and to facilitate discussion based on the review;
- Acquire and understand technical knowledge as part of life-long learning;
- Acquire tools to critically evaluate scientific paper;
- Develop skills in facilitating discussions.

Topics Covered
- Introduction: industrial significance of multiphase systems, in particular fluidized bed systems.
- Single Particle Suspension:
  - Motion of solid particles in a fluid
  - Drag coefficient
  - Terminal setting velocity
  - Particle characterization
- Multiple Particle Systems:
  - Momentum balance for multiphase system
  - Fluid flow through particle beds
  - Ergun's equation
  - Fixed bed reactors
- Fluidization:
  - Fundamentals
  - Minimum fluidization velocity
  - Geldart's classification of powders
  - Bubble mechanics

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  - Stability and quality of fluidization
- Fluidization Flow Regimes:
  - Flow regime diagrams for G/S, bubble column and GLS systems
  - Hydrodynamics of bubbling, turbulent, and fast fluidized beds, and pneumatic conveying
  - Flow regime characterization and transitions through signals
- Signal Analysis Methods:
  - Statistical and spectral analysis methods
  - Chaos, fractal and wavelet transformation analysis
- Fluidized Bed Reactor Modeling
  - Two-phase flow model
  - Numerical model
  - CFD for multiphase systems
- Design and Scaling of Fluidized Bed Reactors
  - Scale-up issues
  - Scaling low
  - Cyclone, hopper, distributor plate design
  - Industrial applications

Assessment

5 assignments at 10% each	50%
Facilitate in-class discussion on a chosen topic	20%
Design or simulate particle-gas systems	20%
Individual contribution to meaningful learning	10%

Course Material

All course material will be available through WebCT.

Course Credit and Class Time

3 credit course. 3 hours/wk class time.

Additional Reading Material

- Fluidization Engineering, Kunii, D. and Levenspiel, O., Butterworth-Heinemann, Boston (1991), TP156.F65K8, ISBN: 0409902616.
- Particulates and Continuum: Multiphase Fluid Dynamics, Soo, S.L., (1989).
- Theory of Multicomponent Fluids, Drew, D.A. and Passman, S.L. Springer, New York (1999), QA1.A647 V.135, ISBN: 0387983805.
- Fluidization-Dynamics: the Formulation and Application of a Predictive Theory for the Fluidized State, Gibilaro, L.G., Butterworth-Heinemann, Boston (2001), TP156.F65G53, ISBN: 0750650036.
- Multiphase Flow and Fluidization: Continuum and Kinetic Theory Descriptions, Gidaspow, D., Academic Press, Boston (1994), TA357.5.M84, ISBN: 0122824709.
- Thermo-Fluid Dynamic Theory of Two-Phase Flow, Ishii, M., Eyrolles, Paris (1975), QA922.I83.
- Bubbles, Drops, and Particles, Clift, R., Weber, M.E. and Grace, J.R., Academic Press, New York (1978), QA922.C56, ISBN: 012176950X.
- Introduction to Particle Technology, Rhodes, M., John Wiley & Sons, New York (1998), ISBN: 0471984825 or 0471984833.

Course Scheduling Meeting

September 07, 2004.