4200:461/561 SOLIDS PROCESSING Fall 2004

CATALOGUE DATA:

Comprehensive problems in sedimentation, fluidization, drying and other operations involving mechanics of particulate solids in liquid and gas phases.

TEXTBOOK: W.L. McCabe, J.C. Smith, and P. Harriott, *Unit Operations of Chemical Engineering*, 6th ed., McGraw Hill, 2000.

REFERENCES:

M. Rhodes, *Principles of Powder Technology*, Wiley, N.Y., 1990.

R.H. Perry, D.W. Green, and J.O. Maloney, *Perry's Chemical Engineer's Handbook*, 6th ed. McGraw Hill, NY, 1984.

T. Allen, Particle Size Measurement, Vol. 1, Chapman & Hall, London, 1997.

D. Kunii & O. Levenspeil, *Fluidization Engineering*, 2nd ed, Butterworth, Boston, 1991.

J.M. Coulson and J.F. Richardson, *Chemical Engineering, Vol 2, Particulate Technology and Separation Processes*, 4th ed., Pergamon, Oxford, 1991.

COURSE OBJECTIVES:

1. Explain the unique challenges facing engineers in designing processing of solids.
2. Use existing correlations to design processes for operations such as pneumatic conveying, sedimentation, filtration, and handling of bulk powders.
3. Understand the limitations of existing correlations used in the design of solids handling equipment.
4. Understand how to select equipment and how various items of equipment influence down stream operations of a chemical plant.

COURSE MECHANICS:

1. The class will meet two days/week (M, W 5:10 – 6:25 PM) Whitby 210
2. There will be one mid-term exam (4 Oct) and a final exam (4:00 PM Monday 13 Dec).
3. Grades will be determined from the total number of points that you earn. Points are obtained from:

	UNDERGRADUATE POINTS	GRADUATE POINTS
MIDTERM EXAM	100	100
FINAL EXAM	100	100
HOMEWORK	40	40
LABS	100	----
PARTICIPATION	10	10
WRITTEN PAPER	----	100
TOTAL POINTS	350	350

4. Graduate students will write a paper on a selected aspect of fluid/solids separations (literature review and summary on a specific topic, item of separations equipment or process). Undergraduate students are not required to write a paper, but will conduct lab experiments.
5. Lab exercises will begin on designated periods, but may exceed class time. Students will schedule time with the TA to complete the labs.

OFFICE Dr. George Chase Whitby 411A Phone 330-972-7943, gchase@uakron.edu
Hours: 3:00 – 4:00 daily. Others by appointment.

CLASS OUTLINE
SOLIDS PROCESSING 4200:461/561

WK	DATE	WEEKLY CLASS TOPICS	REFERENCE	Assignments due Mondays	Comments
1	30 Aug 1 Sep	Introduction Properties of Particulate Solids	TA chapt 1 CR chapt 1 MS chapt 28 MR chapt 2		
2	6 Sep 8 Sep	NO CLASS (Labor Day) Drag on a spherical particle	TA chapt 2 CR chapt 3 MS chapt 7 MR chapt 3	1.1 2.1	
3	13 Sep 15 Sep	Lab 1 particle size distribution Particle size & size distribution Drag on non-spherical particles	CR chapt 3 MR chapt 3 MS chapt 7 TA chapt 6	3.1 3.3 3.4	Lab is in room ASEC 81
4	20 Sep 22 Sep	Bulk properties of particulate solids Momentum transport properties Hindered settling	CR chapt 5 PH chapt 5 MS chapt 7,29	3.7 3.8	CD – stress Photos
5	27 Sep 29 Sep	Fluidization Fluidization/Elutriation EXAM 1 out	KL CR chapt 6 PH chapt 5,20	3.5 4.1 4.4 4.6	Hindered Setl expt CD hindered setl CD fluidization
6	4 Oct * 6 Oct	Segregation, Hoppers Hoppers	MR chapt 4 CR chapt 7 PH chapt 19	Exam 1	Video segregation CD segregation CD hopper
7	11 Oct 13 Oct	Hoppers (KJ) Lab 1 discussion, Lab 2	MR chapt 5	4.8 5.1 Lab 1 due Wed	
8	18 Oct 20 Oct	Grade Efficiency Cyclones	PH chapt 7 MR chapt 7 MS chapt 29	7.1 7.2	CD cyclone
9	25 Oct * 27 Oct	Pneumatic Conveying Pneumatic Conveying	MR chapt 7 PH chapt 5	10.1 10.2	Video: Waeschle Rotary Valves & Rot. press CD pneu conv photos
10	1 Nov 3 Nov	Pneumatic Conveying Intro to Solid/Liquid Separations/Treatment	CR chapt 7 MS chapt 29 MR chapt 14	10.3 10.7	
11	8 Nov 10 Nov	Pretreatment Selection of S/L Separation equipment	MR chapt 14 CR 7	5.3 11.1	
12	15 Nov * 17 Nov	Lab time Dust explosions, safety	MR chapt 11, 12		Video, Dust Expl
13	22 Nov 24 Nov	Plant design project	TBA	10.9 13.1 Lab 2 due Wed Term paper Wed	CD dust expl
14	29 Nov 1 Dec	Plant design project		13.3	
15	6 Dec 8 Dec	Plant design project Plant design presentation		Presentations	
F	? Dec	Final exam pm			

Texts: On reserve at the library

MS = McCabe & Smith
CR = Coulson & Richardson
MR = Martin Rhodes
PH = Perry's Handbook
TA = Terence Allen
KL = Kunii & Levenspeil

* VCR/TV requested

Lab 1: Particle size measurement.

Class is split into groups. Each group uses a different apparatus (microscope, BR8, and hydrometer). Start with the seives to get a rough size distribution. Then, BR8 only uses the smallest size and get a size distribution; the hydrometer uses the large particle sample, and the microscope is applied to whole range.

Groups write a short report on their results and how their results compare with the other groups. Each group makes a 10 min presentation to the class, explaining the measurement technique and how they got their results.

Lab 2: Hopper design

Class is divide into groups. Each group tests a different material on the rotating ring shear tester for the coefficients of friction. The data is used to predict mass or funnel flow in the lab hopper. The prediction is verified by actually testing in lab hopper. Groups are encouraged to bring in their own powders for testing (laundry soap, processed sugar, birdseed, etc.).

IDEAS FOR FUTURE LAB EXERCISES:

Lab 3: Pneumatic conveying friction factor

Determine the friction factor for pneumatically conveyed solids (1) through a straight section of smooth pipe, (2) around a pipe bend, and (3) through a rough pipe.

Lab 4: Janssen coefficient.

Design, construct, and run an experiment to measure/calculate the Janssen coefficient for several materials. Use the principle of lifting a weight by lifting a cord with a plug on the end in a hole in the weight, and the hole is filled with the material in question.

Lab 5: Filter Press experiment

Design and run an experiment to determine the filtration properties of a filter cake using the bench scale filter press. Use these results to predict scale-up. What are the limitations of such a scale-up?

Lab 6: Settling experiment

Design and run an experiment to test the rate at which different additives improve or worsen the rate of settling of select materials. Do the additives cause the particles to flocculate? How do you determine if the particles form flocs?