

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
INSTRUCTION DIVISION
Second Semester 2002-2003
Course Handout (Part-II)

Date : 07-01-2003

In addition to Part I (General Handout for all courses appended to the Time Table), this portion gives further specific details regarding the course.

Course No. : CHE G641
Course Title : Reaction Engineering
Instructor-in-Charge : Dr. B.V.BABU

Course Description:

Design of multi-phase reactors; analyses of gas-liquid and gas-liquid-solid reactions; intrinsic kinetics of catalytic reactions; residence time distribution models for micro- and macro-mixing; mathematical models for gas-liquid-solid reactors; laboratory reactors; dynamics and design of various multi-phase reactors such as trickle bed reactors, bubble column reactors, segmented-bed reactors, slurry reactors, spouted bed reactors, pulsating reactors, fluidized bed reactors, etc.; optimization of chemical reactors.

Scope & Objective:

This course deals with advanced aspects of Chemical Reaction Engineering such as analysis and design of multiphase reactors with respect to stability and control. It also provides an insight into the Residence Time Distribution and models for macromixing, methods of optimizing a sequence of reactors, and a detailed kinetic study of solid catalytic reactors. It takes the student to the enchanting world of the design aspects of gas-liquid-solid catalytic reactors incorporating the heat and mass transfer effects.

Text Books:

- T1 Yatish T. Shah, "Gas-Liquid-Solid Reactor Design", McGraw Hill, New York (1979).
- T2 H. Scott Fogler, "Elements of Chemical Reaction Engineering", Prentice Hall of India Private Limited, New Delhi (1997).

Reference Books:

- R1 Westerterp K.R., Van Swaaij W.P.M., and Beenackers A.A.C.M., "Chemical Reactor Design and Operation", John Wiley & Sons, New York (1978).
- R2 James J. Carberry, and Arvind Varma, "Chemical Reaction and Reactor Engineering", Marcel Dekker, Inc., New York (1987).
- R3 Edgar, T.F., Himmelblau, D.M., and Lasdon, L.S., "Optimization of Chemical Processes", McGraw Hill, Boston (2001).
- R4 Gianetto A., and Silveston P.L., "Multiphase Chemical Reactors – Theory, Design, Scale-up", Hemisphere Publishing Corporation, New York (1986).

Course Plan:

Lecture No.	Learning Objectives	Topics to be covered	Reference Chap./Sec. (Book)
1	Introduction to Multi-phase reactors, reaction kinetics, and design aspects.	Introduction	Ch. 1 of T1 & R4
2-6	Review of chemical kinetics and reactor design.	Review of Kinetics	Ch. 1-8 of T2 & Ch 1-3 of R1
7-9	Types of gas-liquid-solid reactions, multi-phase reactors (trickle bed reactor, bubble column reactor, segmented bed reactor, slurry or fluidized bed reactor, agitated slurry reactor, etc.), design parameters, types of industrial gas-liquid-solid reactors.	Industrial Reactors	Ch. 1 of T1
10-13	Film theory analysis, Penetration theory analysis, methods of estimating transport resistances, heat effects.	Analysis of Gas-Liquid & Gas-Liquid-Solid Reactions	Ch. 2 of T1
14-19	Tracers, methods of obtaining Residence Time Distribution (RTD), problem areas, models for macromixing in the reactor, RTD and scale up problems.	RTD & Macromixing Models	Ch. 3 of T1 & Ch. 13 of T2
20-23	Models based on contact effectiveness (for TBRs), reactor performance based on RTD, models for three-phase slurry reactors, models for packed-bubble-column gas-liquid reactors.	Mathematical Models for Gas-Liquid-Solid Reactors	Ch. 4 of T1
24-26	Laboratory gas-liquid-solid reactors, Reactors used for gas-solid reactions that can be adapted to three-phase systems, Reactors normally used for gas-liquid reactions which can be used for the measurement of absorption rates in dilute gas-liquid-solid slurries.	Laboratory Reactors	Ch. 5 of T1
27-33	Diffusion and reaction in catalyst pellets of various geometries (slab, sphere, raschig ring, short cylinder, long cylinder), effective diffusivity, tortuosity, effectiveness factor, internal & external effectiveness factors, falsified kinetics, overall effectiveness factor, estimation of diffusion- and reaction-limited regimes, mass transfer and reaction in a packed bed, determination of limiting situations from reaction data, CVD reactors.	Intrinsic Kinetics	Ch. 11 of T2 & R4
34-36	Flow regimes, pressure drop, liquid holdup, radial and axial gas and liquid distributions, effective catalyst wetting, axial dispersion, gas-liquid mass transfer, solid-liquid mass transfer, heat transfer characteristics.	Trickle Bed Reactors	Ch. 6 of T1, R2 & R4

37-39	Flow regimes, pressure drop, gas and liquid holdups, axial dispersion in the gas and liquid phases, gas-liquid interphase mass transfer, liquid-solid mass transfer, heat transfer.	Cocurrent-upflow Fixed-bed Reactors	Ch. 7 of T1
40-41	Flow regimes, pressure drop, gas and liquid holdups, gas- and liquid-phase axial dispersion, wetted area, gas-liquid mass transfer, liquid-solid mass transfer, heat transfer	Countercurrent-flow Fixed-bed Reactors	Ch. 8 of T1
42-43	Hydrodynamics, Gas-, liquid-, and solid-holdups, axial dispersion in gas-, liquid-, and solid-phases, gas-liquid interface mass transfer, liquid-solid mass transfer, wall mass transfer in slurry reactor, heat transfer.	Gas-Liquid Suspended-solid Reactors	Ch. 9 of T1

Evaluation Scheme:

EC No.	Evaluation Component	Duration	Weightage	Date, Time & Venue	Nature of Component
1.	Test-I	50 mts.	20	10/02 M-4 1211	Closed Book
2.	Test-II	50 mts.	20	14/04 M-4 1211	Open Book
3.	Compre	3 hrs.	40	06/05 (AN)	Closed Book
4.	Project		20		

Chamber Consultation Hour: To be announced in the class.

Notices: All notices concerning this course will be displayed on the Chemical Engineering & Workshop Notice Boards.

Make-up Policy: Make-up is granted only for genuine cases with valid justification and prior permission of Instructor-in-charge.

Instructor-in-charge
CHE G641