CHEMICAL REACTOR ANALYSIS AND DESIGN

Course Code: 13CH2104

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Prerequisites: The student should have knowledge
of chemical reaction engineering.

Course outcomes:
On successful completion of the course, the student should be able to

CO1 : Describe the two parameter models for non-ideal flow reactors.

CO2 : Explain and Design the various types of contacting in gas-solid operations.

CO3 : Explain and Design the various factors to be considered in selecting a gas liquid contact.

CO4 : Define catalysis, catalyst deactivation, diffusion and reaction in porous catalysts.

CO5 : Discuss the non isothermal reactor design and multiple steady states and solve the problems on adiabatic flow reactors at steady state.

UNIT-I
Models for Non-Ideal flow Reactors: Two- parameter models- Real CSTR modeled using bypass and dead space, real CSTR modeled as two CSTR interchange, testing a model and determining its parameters.
Mixing of fluids: Zero parameter models-Segregation model, and qualitative concept of Maximum Mixedness model.

UNIT-II
Fluid-Particle reactions–Design: Various types of contacting in gas-solid operations; Development of performance equation for frequently met contacting pattern assuming uniform gas composition- Particles of a single size, plug flow of solids, Mixture of particles of different but unchanging sizes, plug flow of solids, Mixed flow of particles of a single unchanging size, Mixed flow of a size mixture of particles of unchanging size. Application to a fluidized bed with entrainment of solid fines.

UNIT-III

Fluid-Fluid Reactions- design: Factors to consider in selecting a gas liquid contactor, Straight mass Transfer: Plug flow G/Plug flow L – counter current flow in a tower. Mass transfer plus not very slow reaction: Plug flow G/Plug flow L – mass transfer and reaction in a countercurrent tower. Plug flow G/Plug flow L – mass transfer in a cocurrent tower.

UNIT-IV

Catalysis and catalytic reactors: Design of reactors for gas-solid reactions. Heterogeneous data analysis for reactor design; catalyst deactivation–Types of Deactivation, Moving bed Reactors.
External diffusion effects on heterogeneous reactions- External resistance to mass Transfer: Mass transfer coefficient, mass transfer to a single particle, mass transfer limited reactions in packed beds.
Diffusion and reaction in porous catalysts- Diffusion and reaction in spherical Catalyst pellets, Internal effectiveness factor, Falsified kinetics, Overall effectiveness factor

UNIT-V

Non- isothermal reactor design- energy balance, non- isothermal adiabatic, CSTR, PFR, Flow, reactors at steady state, equilibrium conversion; multiple steady states- ignition- extinction curve.

TEXTBOOKS:

1. Froment G, Bischoff K and De Wilde J, *"Chemical Reactor Analysis and Design",* 3rd Edition, John Wiley and Sons, 2011

REFERENCE:

1. Fogler, H.S., *"Elements of Chemical Reaction Engineering",* 4th Edition, Prentice Hall, New Jersey, 1986.
2. Levenspiel, O., *"Chemical Reaction Engineering"*, 3rd Edition, John Wiley and Sons, 2007.

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