GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering Syllabus

Subject Code : 3164402

Subject Name : Chemical Reaction Engineering - II

WEF Academic Year :	2021 - 22
Semester :	6
Category of the Course :	Professional Core

Prerequisite :	Chemical reaction engineering - I
Rationale :	The course aims to acquaint students with the fundamentals of gas-solid catalytic and non-catalytic reactors, as well as gas-liquid reactors. It also covers topics related to catalytic kinetics, the mechanistic understanding of catalysts, and the design and evaluation of catalytic reactors, along with the design considerations for gas-liquid reactors.

Course Scheme :

Teaching Scheme			Total Credits	Assessment Pattern and Marks				Total Marks
				Theory		Practical		
L	T	PR	C	ESE (E)	PA(M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Course Content :

Sr. No.	Course Content	No. of Hours	% of Weightage
1	Heterogeneous Reactions: Introduction: Rate steps involved in heterogeneous systems, Overall rate expression for linear and non linear process, contacting patterns for two-phase systems.	6	14
2	Fluid-Fluid systems: Rate equation, rate equation for straight mass transfer, kinetic regimes of mass transfer and chemical reaction, rate equation for mass transfer and chemical reactions, film conversion parameter, fluid-fluid reactor design.	8	16
3	Fluid-Particle systems: Fluid partial reaction kinetics, selection of a model, Shrinking Core Model for unchanging and changing size spherical partials, Diffusion through gas film and through ash layer controlling, Chemical reaction controlling, Shrinking core model, its limitations, Determination of rate controlling step.	8	18

4	Introduction to Catalysis, Catalysts, Physical properties of catalyst, surface area, void volume, solid density, pore volume distribution, Classification and preparation of catalyst, catalyst promoters. Catalyst inhibitors, Catalyst poisons, Nature and Mechanism of Catalytic reactions.	8	16
5	Solid-Catalyzed reactions: Kinetics: Adsorption isotherms and rates of adsorption and desorption. Kinetic regimes, rate equations for surface kinetics, Pore diffusion, determining rate controlling step, experimental methods for finding rates, product distribution in multiple reactions.	8	16
6	Catalytic reactions, introduction to LHHW (Langmuir-Hinshelwood-Hougen-Watson) kinetic model. Introduction to Catalytic Reactors: Packed bed catalytic reactors, fluidized bed reactors, trickle beds, slurry reactors. Design concepts, Mass transfer correlations for various reactors, Isothermal and non-isothermal interphase effectiveness factor	10	20
	Total	**48**	**100**

Reference Book :

1. Chemical Reaction Engineering by K. A. Gavhane.
2. Elements of Chemical Reaction Engineering by H. S. Fogler.
3. Chemical Reaction Engineering by by Octave Levenspiel.

Course Outcome :

After Completion of the Course, Student will able to:

No.	Course Outcomes	RBT Level*
CO-1	To understand the nature and mechanism of catalytic reactions.	25
CO-2	To identify regions of mass transfer control and reaction rate control and calculate conversion.	25
CO-3	To predict the rate controlling step for the fluid - particle reactions.	25
CO-4	To develop conceptual framework for designing catalytic reactors.	25

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Suggested Course Practical List :

1. To conduct any experiment involving heterogeneous catalysis in the fixed bed reactor.
2. Experiment on predicting breakthrough curves in adsorption of any selected system with environmental application.
3. Experiment on detection of the influencing factors contact time, temperature and mode of operation.
4. Kinetic modeling study of heterogeneously catalyzed chemical synthesis reactions.

5. Catalytic oxidation experiment to demonstrate the principles of
   i) reaction rate determination, ii) reactor design, iii) heterogeneous catalysis, etc.
6. Experiment on fluidized bed catalytic reactor.
7. Study the effect of surface area on adsorption.

List of Laboratory/Learning Resources Required :

1. Students can refer to video lectures available on the websites including NPTEL.
2. Students can perform experiments on Virtual lab by IITs.
3. Students can develop their own programs for the solutions of problems.

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